Journal of Learning Development in Higher Education ISSN: 1759-667X
Issue 24 September 2022

Advancing the understanding of the flipped classroom approach with students' perceptions of the learning environment: variation between academic disciplines

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Abstract

Abundant research supports the benefits of the flipped classroom approach on learning outcomes. Yet how students evaluate the flipped learning environment remains largely unknown. The present study aims to investigate 1) the students' perceptions of their flipped learning and 2) whether disciplinary differences can be observed in students' perceptions. Drawing upon the theoretical framework outlined in Brame (2013), our findings illustrated that students (*N* = 407) from different disciplines do vary their evaluation of the flipped learning environment. Those whose academic disciplines related to the application of knowledge evaluated the four components – exposure, incentive, assessment, and activities – more positively than those whose academic disciplines focus more on theoretical exploration. It is noteworthy that how subject knowledge is developed does not influence perception of the flipped learning environment. Such findings can supplement the traditional outcome-based approach of flipped classroom research by understanding the learning environment. All in all, the findings can point to practical and theoretical implications for designing a flipped classroom environment, highlighting the needs in designing the learning environment.

Keywords: flipped classroom; academic disciplines; learning environment; student evaluation.

Introduction

The flipped classroom approach is an instructional strategy that reverses in-class teaching and learning activities (Lage, Platt and Treglia, 2000). The flipped classroom approach is growing in popularity in face-to-face settings (Davies, Dean and Ball, 2013; Mason, Shuman and Cook, 2013; Ng et al., 2020) and even in fully virtual environments (Hew et al., 2020). Although sometimes the differences in learning outcomes between the flipped and non-flipped students are not statistically significant (e.g., Davies, Dean and Ball, 2013; Mason, Shuman and Cook, 2013), the positive effect of the flipped classroom approach on learning performance is convergently demonstrated across different empirical studies (e.g., Nouri, 2016; Tomas et al., 2019; Wang and Zhu, 2019; Gong, Yang and Cai, 2020). Beyond empirical studies, Chen et al. (2018) meta-reviewed the examination scores of 9,026 students from numerous studies, including four randomised controlled trials, 19 quasi-experimental studies and 23 cohort studies. Their meta-analytic results revealed that students who attended a flipped course showed higher examination scores and course grades than those in traditional lecture-based practice, as well as changes in examination scores compared to traditional lecture-based practice. In addition to the direct effect of flipped classrooms, factors that moderate the beneficial effect of the flipped classroom approach on learning outcomes have attracted research interest. These factors include academic disciplines (Cheng, Ritzhaupt and Antonenko, 2018; Al-Samarraie, Shamsuddin and Alzahrani, 2019), time of lesson (Cheng, Ritzhaupt and Antonenko, 2018), the ratio of flipped and traditional lessons of a course (Ng and Lam, 2020), and changes in instructors (Ng et al., 2020).

The success of the flipped classroom approach can be attributed to its rationale for transforming the learning process. In a flipped class, the learning activities that traditionally occurred inside the classroom are now moved before the class and vice versa (Lage, Platt and Treglia, 2000). In this way, the learning can be started before the regular class time, and valuable class time can be allocated for the in-depth learning activities. Thus, the flipped classroom approach holds not only the promise of enhancing learning outcomes but also enriches the learning environment. Here we refer to The Learning Environment, Learning Processes and Learning Outcomes (LEPO) Framework (Phillips, McNaught and Kennedy, 2010) to define the learning environment in a broader sense:

> Its characteristics include the campus setting, the structure of the degree program and the student's individual units of study. . . it specifies the content and resources (both traditional and electronic) which support this design. It also encompasses physical and virtual spaces, and the nature of the technology-enhanced environment. In addition, the learning environment specifies the teacher's design of the learning and assessment activities which will facilitate the learning processes undertaken by students. . . . At one level, the learning environment might specify the overarching activities and context of a unit of study over a semester, including the learning objectives, assessment activities and deadlines, and content to be covered. At a different level, the learning environment might specify the design of a computer simulation which covers a conceptually difficult area. (Phillips, McNaught and Kennedy, 2010, p.5).

The learning environment itself is designed by the teachers and the development team and is a medium for students to work in. It is designed to achieve the desired learning outcomes and the intended learning objectives (Phillips, McNaught and Kennedy, 2010). The design of the learning environment can be described in detail but it is important to evaluate whether the instructional approach is well-designed. Therefore, in addition to the traditional focus on the overall learning outcomes, research on the flipped classroom approach should also focus on studying the learning environment.

Moreover, the theoretical roots, such as student-centred learning and active learning, also support the importance of the learning environment of the flipped classroom approach. Student-centred learning intends to cultivate students to become autonomous and independent learners by providing opportunities for students to take full responsibility for their learning process in deciding what and how they want to learn (Rogers, 1983; Lea, Stephenson and Troy, 2003; O'Neill and McMahon, 2005; Lam et al., 2021). Likewise, active learning advocates the active participation of students in the learning activities so that they can learn by doing, experimenting, and trying (Prince, 2004). Both student-centred learning and active learning highlight the need to provide a learning environment where students can actively participate and take more responsibility during the learning process. Thus, the investigation of the flipped classroom approach should not only focus on the overall learning performance but also on the learning environment.

In contrast to the widely investigated overall learning outcomes (e.g., Chen et al., 2018; Gillette et al., 2018), the understanding of the flipped learning environment is growing but remains insufficient and unsystematic. Persky and McLaughlin (2017) provided useful suggestions for teachers designing a flipped learning environment. Yet, students' perceptions of the flipped learning environment remain largely unknown. Such perceptions should be particularly useful for teachers designing the curriculum of the flipped classroom approach. It is expected that students in a positively evaluated learning environment would be more motivated and more engaged in the learning activities. Hence, the objective of the present project is to investigate how students perceive the flipped learning environment and whether their perception and evaluation of the flipped learning environment varies by academic discipline.

The theoretical framework of the flipped learning approach

Brame (2013) provided a theoretical framework to investigate students' evaluation of the flipped learning environment. The framework spelled out that the flipped classroom approach should consist of four different components – exposure, incentive, assessment, and activities.

The exposure component denotes the essential features of providing learning opportunities to students before the regular class time. These learning opportunities can also be provided without digital technology, such as through pre-class readings. Such learning opportunities enable students to master the foundation knowledge before the class and, more importantly, increase students' learning autonomy so that they can learn according to their schedule and level of understanding (Foertsch et al., 2002; Davies, Dean and Ball, 2013).

The incentive component reflects the necessity to motivate students to engage in pre-class learning in the flipped classroom approach. The philosophy of the flipped classroom approach restructures the entire learning process by moving the learning of foundation knowledge to before the in-class time, thus requiring students to not only learn the basic materials before the class but also to attend the class with good preparation for

participating in the in-class learning activities. Hence, the techniques to motivate students to participate in the entire learning process are important in flipped learning.

The assessment component captures the importance of assessing students' understanding of the flipped classroom approach. Similar to traditional lecture-based learning, assessments assigned for students to complete during and after the learning process could assess students' level of understanding. Beyond this, the inclusion of pre-class assignments in the flipped classroom approach, such as online quizzes and worksheets, could help students pinpoint their areas of weakness during their preparation for the class. The results obtained from these formative assessments could help students focus on these areas for improvement before class and could help teachers to focus on these areas during the lessons. Hence, the assessments can provide useful information for both teachers and students.

The activities component describes the final feature of the in-class learning activities in the flipped classroom approach. The philosophy of the flipped classroom approach started with the mastering of basic knowledge before the classroom through students' self-learning, thus leaving valuable class time for in-depth learning activities that promote higher-level learning. There is a wide range of learning activities available, such as peer discussion (Khanova et al., 2015), role play (Critz and Knight, 2013), and simulation (Schaffzin, 2016). The rationale for teachers choosing the classroom learning activities is to focus on deepening students' understanding and to help them use their skillsets to apply the knowledge.

These four components specify the content, resources, and learning activities in the flipped classroom approach, describing the common components in the learning environment that teachers could pay attention to when designing the course (Phillips, McNaught and Kennedy, 2010). Brame (2013) provided an important framework to help understand the flipped learning environment. The first aim of the present project is to investigate the flipped learning environment with Brame's (2013) theoretical model. The four components – exposure, incentive, assessment, and activities – are required to naturally vary in importance according to the teaching purposes. For example, distributing readings is more relevant for the pre-class learning activity of a writing class, whereas watching videos is more relevant for a listening class. These variations may partly explain

why the findings on the flipped classroom approach do not all show significant improvement (e.g., Davies, Dean and Ball, 2013; Mason, Shuman and Cook, 2013). The results could possibly be improved by forming a supporting team with expertise in the flipped classroom approach. The supporting teams could ensure that the teaching practice can fulfil the basic requirements of the flipped classroom approach by giving suggestions on the curriculum design of the flipped learning environment.

The possible disciplinary differences

The second aim of this project is to investigate whether academic disciplines influence students' perception of the flipped learning environment. Although there is a limited understanding of the relation between academic discipline and flipped learning environment, various studies have illustrated that learning outcomes vary across disciplines (Cheng, Ritzhaupt and Antonenko, 2018; Al-Samarraie, Shamsuddin and Alzahrani, 2019; Hew et al., 2021). For instance, the subgroup analysis conducted by Chen et al. (2018) showed that the advantage of the flipped classroom approach was mainly observed in medical, pharmacy, and science education studies, but not in nursing education and other disciplines in health science education. Hence, it is also possible that students from different academic disciplines differ in their perception of the flipped learning environment. Specifically, if the nature of the subject aligns with the rationale of the flipped classroom approach, it would be easier to boost the learning performance and students' perception of the learning environment.

All in all, the present project intends to go beyond the existing dominant approach of investigating the effectiveness of the flipped classroom approach using course learning outcomes. The present project intends to advance the understanding of the flipped classroom approach by investigating students' perceptions of the flipped learning environment. Meanwhile, the present project also explores whether the academic disciplines play a part in influencing the flipped learning environment. Specifically, we adopt Biglan's (1973) model to classify academic disciplines. His work has received continuous interest (e.g., Becher, 1994; Jones, 2011; Lam et al., 2014; Fedi et al., 2021; Salto, 2021; Shin et al., 2021). Scholars usually adopt his model to classify the academic disciplines as any combination of soft versus hard, pure versus applied, and life versus

non-life. The soft versus hard classification focuses on the epistemological characteristics, in which hard disciplines indicate the use of a single paradigm in defining the research hypothesis, content, and method and soft disciplines indicate multiple paradigms. The pure versus applied classification focuses on the application value, in which pure disciplines focus on theoretical exploration and applied disciplines focus on applying knowledge to the real world. Finally, life versus non-life disciplines focuses on the object of study, in which life disciplines study living organisms and non-life disciplines study non-living organisms. The first two, soft versus hard (how the subject knowledge is developed) and pure versus applied (how much the subject knowledge is practical), are more relevant to the teaching pedagogies and instruction method because of their close relations with the core of the subject knowledge. Moreover, the focus of pure versus applied is closely matched with the rationale of the flipped classroom approach, in which both of them relate to the value of learning by application. Thus, we adopt the classification of soft versus hard and pure versus applied in the present project.

The study background

The data used in this paper is part of a large collaborative project in Hong Kong that intended to promote the flipped classroom approach in higher education. An inter-university network was established among five government-funded universities in Hong Kong, including The Chinese University of Hong Kong, the City University of Hong Kong, The Education University of Hong Kong, the Hong Kong Baptist University, and The Hong Kong Polytechnic University. As each course has its own requirement and curriculum needs, a supporting team was formed in each university to recruit teachers and provide institutional-based support for the flipped classroom. This supporting team with expertise in the flipped classroom approach can ensure that all the practices are of similar standard and can be easily adopted while balancing the teaching needs. The supporting teams met regularly to share experience and offered guidelines on how to flip the course to the participating teachers, including advice on curriculum design. The team guided the teachers in adopting the flipped classroom approach as the instruction method so that it would satisfy the requirement of the flipped classroom approach but also suit the needs and purpose of teaching practice. For example, a series of workshops guiding teachers on how to produce pre-class content and in-class interaction to meet the requirement of the

flipped classroom approach was provided. The supporting team also provided video editing services to ensure that the learning videos used for flipped learning were of similar quality, minimising the impact of video quality on learning outcomes (McGivney-Burelle and Xue, 2013).

Method

There were 407 valid responses for this project collected in the fall semester of the academic year 2018/19. These valid responses were gathered from students who attended courses taught by the participating teachers in the project. They were from diverse disciplines, including the Faculty of Business (20.1%), Faculty of Education (6.9%), Faculty of Engineering (14.5%), Faculty of Science (21.9%), and Faculty of Social Science (36.6%). Although teachers have freedom in the way they design the curriculum with the flipped classroom approach, almost all the courses provided videos with tests or quizzes on digital systems as pre-class learning materials.

The students filled in a survey on the flipped learning environment after their flipped learning experience. Before collecting the information, the survey was developed and validated by a panel of experts consisting of researchers on the topic and experienced professors. The survey consisted of following four measures. The first was a 4-item measure on exposure, comprising the items ‘The materials are interesting’, ‘The materials motivate me to learn more’, ‘The materials are helpful to prepare me for in-class activities’, ‘I feel comfortable to study the materials before class’. The second was a 3-item measure on incentive, comprising the items ‘The reasons for the flipped classroom style in this course are clearly explained’, ‘I understand the potential benefits of the flipped classroom style’, and ‘I have more control over my study with the flipped classroom style’. The third was a 3-item measure on activities, comprising the items ‘The activities clarify important concepts in this course’, ‘The activities help me apply what I have learnt in pre-class activities’, and ‘I am engaged with the in-class activities’. The last one was a 3-item measure on assessment, comprising the items ‘The assessments acknowledge my efforts in the learning process’, ‘The assessments require me to do more on creating, analysing, or evaluating the subject matter’, and ‘I receive sufficient feedback on the assessments’. Responses anchored on a 5-point Likert scale (1) to (5). These items were aggregated to

form a composite score of exposure, incentive, assessment, and activities. The higher the values, the higher the extent that the students endorse these components. The reliabilities of all four components were satisfactory: Cronbach's α = .84 for exposure, Cronbach's α = .80 for incentive, Cronbach's α = .78 for activities, Cronbach's α = .79 for assessment.

Results

We first followed the classification of Biglan (1973) to classify the academic disciplines as pure (*N* = 238) and applied (*N* = 169). The pure disciplines include courses from the Faculty of Science and the Faculty of Social Science, whereas the applied disciplines include courses from the Faculty of Education, the Faculty of Engineering, and the Faculty of Business. Then we computed the mean and standard deviation of the four components: exposure, incentive, activities, and assessment (see Table 1). In general, students whose academic discipline belonged to applied were consistently rated higher in exposure (*M* = 3.67, *SD* = .66), incentive (*M* = 3.66, *SD* = .73), activities (*M* = 3.71, *SD* = .70), and assessment (*M* = 3.67, *SD* = .67) than those whose were from pure subjects. Next, we conducted independent sample T-tests to compare the means of these components. Results indicated that the differences were all significant among the pure and applied academic disciplines, regardless of exposure (t (405)= -4.19, $p < .001$), incentive (t (405)= -3.07, $p < .01$), activities (t (405)= -3.40, $p < .01$), and assessment (t (405)= -4.01, $p < .001$).

Following Biglan (1973), we also classified the academic disciplines as soft (*N* = 259) and hard (*N* = 148). Examples of soft disciplines include courses from the Faculty of Social Science, the Faculty of Education, and the Faculty of Business, while the hard disciplines include courses from the Faculty of Science and the Faculty of Engineering. The independent T-test indicated that the two academic disciplines on the four components does not differ significantly with exposure (t (360.58)= .11, $p = .92$), incentive (t (405)= -1.03, $p = .30$), activities (t (405)=.33, $p = .74$), and assessment (t (362.68)= -.88, $p = .38$) (see Table 2).

For the sake of simplicity, the general results are summarised in Table 3.

Table 1. Independent sample T-Test for the learning environment for the pure-applied classification.

Variable	M	SD	T	
Exposure			-4.19	***
Pure (*N* = 238)	3.38	.71		
Applied (*N* = 169)	3.67	.66		
Incentive			-3.07	**
Pure (*N* = 238)	3.44	.70		
Applied (*N* = 169)	3.66	.73		
Activities			-3.40	**
Pure (*N* = 238)	3.47	.69		
Applied (*N* = 169)	3.71	.70		
Assessment			-4.01	***
Pure (*N* = 238)	3.38	.75		
Applied (*N* = 169)	3.67	.67		

Note. M and SD represent mean and standard deviation.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2. Independent sample T-Test for the learning environment for the soft-hard classification.

Variable	M	SD	T	p-value
Exposure			.11	.92
Soft (*N* = 259)	3.50	.76		
Hard (*N* = 148)	3.50	.61		
Incentive			-1.03	.30
Soft (*N* = 259)	3.50	.74		
Hard (*N* = 148)	3.58	.67		
Activities			.33	.74
Soft (*N* = 259)	3.58	.75		
Hard (*N* = 148)	3.55	.61		
Assessment			- .88	.38
Soft (*N* = 259)	3.48	.79		
Hard (*N* = 148)	3.54	.63		

Note. M and SD represent mean and standard deviation.

Table 3. Summary of the overall findings.

Components of The Flipped Learning Environment	Applied versus Pure Discipline	Soft versus Hard Discipline
Exposure, Incentive, Activities, Assessment	The applied disciplines are significantly higher than the pure disciplines.	There are no significant differences between soft and hard disciplines.

General discussion

The present project attempts to enrich the understanding of the process of the flipped learning approach. Specifically, the project investigates students' perceptions of the flipped learning environment and whether and how their academic disciplines affect students' evaluation of the flipped learning environment. The present project revealed that students from different academic disciplines differed in their perception of the learning environment when the flipped classroom approach was incorporated. It is noteworthy that the practical value of the academic disciplines does matter in the students' perception of the flipped learning environment, while the epistemological characteristics of the academic disciplines do not matter.

Students who were studying in an academic discipline that emphasises the application of abstract knowledge evaluated the four components – exposure, incentive, assessment, and activities – of the flipped classroom approach more positively than those who were studying in an academic discipline that emphasises theoretical explorations. In contrast, students who were studying in the disciplines that emphasise a single paradigm or multiple paradigms were found to evaluate the four components similarly. The following paragraphs discuss the possible underlying reasons for the differences obtained in each of the components.

The first component is exposure, in which students were required to master the foundation concept before the class. Students from the academic disciplines that emphasise the application of knowledge rated the pre-class learning opportunity more favourably than those from the pure disciplines. This illustrated that students in the applied disciplines

tended to view the opportunity of pre-class learning more favourably than in the pure disciplines. One possible reason is that the knowledge of the pure disciplines may be too abstract for students to learn on their own before class. Rather, learning the abstract theory could be easier with the explanations of the teachers during a traditional face-to-face lecture. In contrast, students in both soft and hard disciplines also had similar perceptions of the opportunities to conduct pre-class learning.

The second component is incentive. The flipped classroom approach is rooted in active learning, in which how teachers motivate students to prepare for the class and participate in the in-class learning activities is of utmost importance. The findings showed that students from the applied disciplines rated the incentive component more positively than those from the academic disciplines emphasising theoretical exploration, whereas no such difference was found in the soft and hard disciplines. It can be explained by the matches between the nature of the academic disciplines and the rationale of the flipped classroom approach. Learning how to apply the learning materials could be easier to match with the flipped classroom learning activities, which, in turn, may motivate students from the applied disciplines to learn with the flipped classroom approach. For example, students in the applied disciplines may be more motivated to learn in the flipped classroom approach when the teachers provide the opportunity for them to master the foundation knowledge and allocate all the class time for applying the theories. For example, teachers who teach science-related disciplines could distribute the learning materials on concepts and theory before class and allow students to focus on laboratory experiments during the lesson. Moreover, it should be noted that scores are the most common form of incentive adopted. Teachers in the current project usually assigned 5 to 20% of the final score to encourage students to conduct pre-class learning, even though extrinsic incentives may not always be the most effective measure.

The third component of the flipped learning experience is the inclusion of the assessment. Students from the academic disciplines that emphasise the application of knowledge evaluated the assessment more positively than those from the pure disciplines, whereas the soft and hard did not show this difference. It may be that students from the applied disciplines are used to and welcome formative assessments throughout their academic study.

The final component in Brame's framework (2013) is activities. Students from the academic disciplines that emphasise applying the learnt concepts perceived the activities component in the flipped classroom approach more positively than those whose disciplines emphasise theoretical exploration. Perhaps the difficulties of mastering abstract knowledge in the pure disciplines impact the effectiveness of the in-class learning activities. Specifically, pure disciplines emphasised the abstract understanding of theories, while applied disciplines applied knowledge in real-life situations. It is also possible that the learning activities in the applied disciplines can be more interesting with a wider range of options than those in the pure disciplines and thus are more suitable to learn with the flipped classroom approach. For example, pure disciplines usually involve peer discussion, but applied disciplines can have a wider selection of collaborative tasks, including role-play and simulation. In contrast, no significant difference was observed between soft and hard disciplines. It is interesting to note that students' presentations were the most popular in-class activities among the courses in the project.

In sum, the findings showed that practical value (pure versus applied) but not the development process (soft versus hard) of the subject knowledge influences students' perceptions of the flipped learning environment. Perhaps, the applied disciplines trained students to learn by applying the concept (which is more practical) rather than focusing on theoretical exploration (which is more abstract). They knew they had mastered the concept when they knew how to apply the learnt concept to solve real-life problems, and thus students from the applied disciplines favoured more in the application of knowledge. The flipped classroom approach allocated time for the in-depth learning activities, which were usually related to the application of knowledge. Hence, the rationale of the flipped classroom approach showed an excellent fit with the principle of applied disciplines that emphasise the application of the learnt concept. Beyond this, the flipped classroom approach can offer an instructional method for the applied disciplines to arrange the class time more effectively, thus providing more opportunities for students to apply the learnt concepts. Therefore, it is not surprising that students from the applied disciplines were more inclined to learn with the flipped classroom approach. Yet, the single or multiple paradigms of the academic disciplines did not vary significantly along the entire teaching process.

Practical implication

The present project showed that students in different academic disciplines had varied perceptions of the flipped learning environment. Such findings demonstrate the implications for teachers across different disciplines when adopting the flipped classroom approach in their teaching practice.

The level of difficulty of the pre-class learning materials may influence students learning. It is reasonable that the outcome may not be good if arranging overly complicated or overly abstract pre-class learning materials for the students to learn independently. Besides, the learning materials should be more concrete and concise for students to master the foundation knowledge before the class. Moreover, our experience told us that joint effort from the teachers and the support teams could reduce the difficulties in providing the pre-class materials which are mainly videos and in the preparation work of the flipped classroom approach.

The findings suggested the importance of applicability of knowledge in the flipped classroom approach. When designing the curriculum, teachers could consider placing the focus on turning abstract knowledge into practical, concrete, and solid knowledge. The learning objectives could be less focused on understanding and more on application. In setting the assessment method, students could be asked to apply the concept in explaining the natural phenomenon or the societal events that are more relevant to the students' daily lives. Using Psychology in the Faculty of Social Science as an example, assessment could be on writing a reflective paper on applying the theories for self-reflection. In setting the learning activities, focus should be on the application of knowledge. Another example uses Chemistry in the Faculty of Science. The learning activities of a chemistry class could be on understanding the properties of metals in real-life. Instead of telling the students that the window frame is made of aluminium, teachers could ask students to test the chemical and physical properties of the window frame.

Limitations and future directions

While the present project provided important groundwork for understanding the flipped learning environment, a few caveats and recommendations should be noted. First, the

present project conducted an investigation in five out of nine government-funded universities in Hong Kong with teachers and students from diverse academic disciplines. Provided that the popularity of the flipped classroom approach increases across the world, future research could triangulate the findings in other cultural groups.

The scale used in the present project was based on the collaborative efforts of researchers and professors with literature support, and its reliability was satisfactory. Due to resource constraints, we had not conducted a pilot test for the scale. Future research could further validate and test the developed instruments across cultures. The use of a validated scale as part of a larger quantitative study would be useful in understanding the nomological network of the flipped learning environment. Future research could also adopt a broader range of methods to collect further evidence from the learning environment to supplement the existing focus on learning outcomes, such as qualitative research design to yield a more sophisticated understanding of this interesting phenomenon or the big-data strategy in understanding the learning environment. While quantitative studies would be useful in drawing generalisations, qualitative studies such as interviewing or conducting focus groups would be useful to obtain a more in-depth understanding of the effect of the learning environment and perceptions of the learning process. In fact, both teachers and students can be interviewed. While the former can provide insight into their rationale and design of the learning environment, the latter can explain their perceptions of the learning environment. We suggest that future research investigates the relationship between learning environment and learning outcomes, though there is already theoretical support for this relationship. It is possible that the flipped learning environment could be the mechanism to explain the insignificant findings of the flipped classroom approach, or that the flipped learning environment could be a moderating factor influencing the effect of the flipped classroom approach on learning outcomes. Additional evidence could also be adopted to understand the most influential factors among the flipped learning environments. Such investigation could directly provide insight to the teachers in identifying the most critical factor when designing the flipped classroom approach. The critical factor may also be possible for other instructional methods, and thus holds the promise to benefit the educational research in a broader sense. It would be advantageous to provide empirical evidence on such a relationship. It will help enrich the learning experience and learning outcomes because the learning environment designed and specified by the teaching practitioners is highly modifiable.

The present project revealed that students' perception of the learning environment of the flipped classroom approach varies between different academic disciplines. Future research could also investigate the disciplinary differences of the flipped classroom approach. Yet, as in other cross-disciplinary research, it is a challenge to minimise the effect of confounding variables while testing the disciplinary differences. An overly stringent control will dilute the disciplinary difference and it would not even be possible in a real-life educational context to fulfil the diverse needs of curriculums and institutions, especially in the variable of assigning scores for pre-class learning. Future research could consider testing the disciplinary differences with the control of a more standardised scoring system. Such understanding has promising potential for curriculum design using the flipped classroom approach, which in turn provides insights into maximising the benefit of the flipped classroom approach.

All in all, the current research provides evidence for the study of the learning environment. In fact, another important area that would benefit from future research is the investigation of how to persuade teachers to overcome the challenges of adopting the flipped classroom approach. When flipping a classroom, teachers are usually required to shift their mindset, such as adopting a new role of facilitator in the classroom (Lage, Platt and Treglia, 2000) and redesigning their curriculum (Kim et al., 2014). Future research could further this line of research to persuade teachers to adopt the flipped classroom approach in their classes.

Conclusion

To conclude, our study advanced the understanding of both the flipped classroom approach from the learning environment perspective and how academic disciplines influence students' perceptions of the learning environment. In general, students from applied disciplines rated the components of the flipped classroom higher. The results are not intended to discourage educators who teach pure disciplines to give up on the flipped classroom approach. Instead, when adopting the flipped classroom approach to teach pure disciplines, some practical modifications can be made. For example, instead of focusing on applying the learnt concept, other in-depth teaching and learning activities can be provided for the students from the pure disciplines, such as Mathematics (Bhagat,

Chang and Chang, 2016; Hodgson et al., 2017), language literacy (Wang, 2016), and Politics (Jenkins, 2015). In this way, students from both the pure and applied disciplines can benefit from the flipped classroom approach to make class time more valuable and effective.

Declaration

Availability of data and materials

The datasets used and analysed during the present project are available from the corresponding author on reasonable request.

Funding

This work was supported in part by the University Grants Committee Funding Scheme for Teaching and Learning Related Proposals (2016–2019 Triennium) awarded to the second author by the University Grants Committee.

Acknowledgments

The authors would also like to thank all the staff, teachers, and students for their contribution to this project.

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