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Exploring student perceptions, learning outcome and gender differences in a flipped mathematics course

So-Chen Chen, Stephen J.H. Yang and Chia-Chang Hsiao

So-Chen Chen is a PhD candidate of Computer Science and Information Engineering in National Central University. His recent research interests include blended learning, information services and technology education. Stephen J.H. Yang is a distinguished professor of Department of Computer Science and Information Engineering in National Central University. His research interests include Mobile phone Applications, Cloud computing, mobile, AR, Big data analysis, IoT applications, 3D virtual world and creative design. Chia-Chang Hsiao is an associate professor of Mathematics in National Central University. His main research interest is mathematics education. Address for correspondence: Prof Stephen J.H. Yang, Department of Computer Science and Information Engineering, National Central University, No. 300, Jung-da Road, Jhongli 32001, Taiwan. Email: jhyang@csie.ncu.edu.tw

Abstract

The flipped classroom approach has recently gained prominence in education. However, a review of previous studies shows that the relationship associated with gender difference, student perceptions and learning outcomes has still remained unexplored, and there has been little discussion regarding flipped classroom environment. To fill this gap, this study aimed to provide a further study by developing an empirical study, extending perspectives of research for flipped classroom in education. This study was conducted to respond and investigate two main student perceptions in a flipped precalculus course, namely, situational interest and course satisfaction. By the self-developed perception measures, situational interest contained feeling, value and topic interest (three factors), while course satisfaction contained course design, system quality, course arrangement and online assessment (four factors). To respectively determine factors on final grades, we assessed the predicting power among those factors. Students' feedback and gender differences were also evaluated to provide a holistic profile of this flipped course. Results showed that feelings predict the final grades in males, while course design predicts the final grades in females. Moreover, the result also showed that even if females and males showed different topic interest in this course, they performed equally well. Some suggestions to effectively implement a flipped course were also provided from students' feedback. The implications of the results were provided for instructors' guidance in implementing flipped classroom. Finally, the study concluded that students' perceptions may be considered as motivational strategies in teaching and learning process to involve students in academic activities for improving their grades in flipped course.

Introduction

A flipped classroom is a classroom inverting the traditional teaching methods which were done by teachers offering lectures in the classroom. For example, Lage, Platt and Treglia (2000) have tried a teaching model which allows events that have traditionally taken place inside the classroom, now taken place outside the classroom and vice versa in an introductory economics course. This

Practitioner Notes

What is already known about this topic

- Flipped classroom might match various learning styles.
- Comparing flipped classroom to traditional classroom.
- Learners' perceptions in a blended learning.

What this paper adds

- Situational interest in a flipped course.
- Course satisfaction in a flipped course.
- Gender difference in a flipped course.

Implications for practice and policy

- Online assessment should meet students' needs.
- Classroom time should be carefully designed.
- Gender difference exists in the relationship between learning outcome and course perceptions.

kind of teaching was called "inverted classroom." Lage and Platt (2000) claimed that Internet allows the instructors to invert the classroom without sacrificing content coverage, and then, a larger program of teaching might match more learning styles for diverse students' need. Moreover, just as Forsey, Low and Glance (2013) claimed, "It is a model committed to shifting the face-to-face engagement between students and teachers away from lectures to various forms of symposia actively engaging students in processes of discovery and consolidation of knowledge." An inverted (or flipped) classroom is a teaching model (from teachers' points of view) or a learning model (from students' points of view) which can have free classroom time for learner-oriented activities such as active and problem-based learning, while content delivery includes video lectures watching outside of the classroom (Bishop & Verleger, 2013; Kim, Kim, Khera & Getman, 2014; Mason, Shuman & Cook, 2013). In many respects the flipped classroom is not a new creation. In some traditional classroom-based teaching approaches, teachers expect students to come to class prepared so that they can carry out group discussion in the classroom. With the rapid development of digital technology as well as learning resource (eg, Khan Academy), digital multimedia and instructional technology facilitate the implementation of flipped classroom instruction. As a result, much more teachers are currently trying such models of flipped teaching, including teachers in Taiwan (Chen, Wang & Chen, 2014; Chua & Lateef, 2014; Yarbro, Arfstrom, McKnight & McKnight, 2014).

The research on flipped classroom is given increasing attention in field of education (Goodwin & Miller, 2013; Hamdan, McKnight, McKnight & Arfstrom, 2013). Appreciation of the flipped classroom approach has emerged in the last decade (Bishop & Verleger, 2013; Chua & Lateef, 2014; Love, Hodge, Grandgenett & Swift, 2014; Missildine, Fountain, Summers & Gosselin, 2013; Yarbro *et al*, 2014). Although students have positive perception of flipped classroom and produce better learning outcomes than traditional instruction (Baepler *et al,* 2014; Berrett, 2012; Butt, 2014; Kong, 2014; Pierce & Fox, 2012), the relationship between students' perception of flipped classroom and learning outcome still remains open for discussion. In addition, gender may be one of many factors that reflected learners' perceptions on the usefulness of multimedia instruction (Wehrwein, Lujan & DiCarlo, 2007). It has also shown that gender plays a vital role affecting the perception of students in different learning environments (Huang, Hood & Yoo, 2013; Yau & Cheng, 2012). Therefore, exploration of gender difference may also provide more insights in

response to flipped classroom approach. To further examine the effect of gender difference in relation to flipped classroom environment, this study also employed gender difference as a variable to expand the scope of research, attempting to offer useful suggestions for educators eventually benefit students.

Here, we will first present the general concepts showing in students' feedback for this course, and then we will emphasize the relationship between final grades and situational interest as well as course satisfaction. Gender differences will also be explored for comparative analysis. This study provides a better understanding of implementing a flipped course and we anticipate that it will have some suggestions for those who plan to implement similar flipped courses.

Research context

In May 2013, one university in northern Taiwan initiated a massive open online course (MOOC) platform based on Edx (ie, one MOOC platform in America) frame structure called NCUx. The first course of NCUx was a 5-week precalculus course designed for high school students who just received admission to universities. This course contained a 2-hour online lecture and a 2-hour classroom discussion every week. The 2-hour online lecture was separated into several self-learning segments, and each learning segment was about 10–15 minutes. There was an online test after one to three segments, and an online quiz was given after completion of the entire chapter (almost weekly). Students' final grades were based on online assessments (60%), final written examination (40%) and their attendance at face-to-face classroom participation time (extra 10% bonus). Students who passed the course (higher than or equal to 60 points) could earn one credit.

Using a flipped classroom approach the lecturing of this course was basically dependent solely on NCUx which also contains interfaces for students to communicate and interact with each other simultaneously and asynchronously. Certain progress needed to be accomplished each week, and students needed to complete the online weekly exercises before due date. Late submission of exercises would not be accepted as one of criteria (by system mechanism), and of course their grades would be influenced. Students were required to discuss their questions for better understanding during classroom time with the lecturer. Finally, 632 students coming from 15 senior high schools enrolled the course and 265 students achieved for completion of the credit unit. This course might be the first flipped course using a MOOC in Taiwan. The experience showed here was expected to have some suggestions for those who plan to implement a similar mode of flipped course in future.

Literature review

Situational interest and learning outcome

The relation between interest and learning has long been studied. In the early 20th century, Dewey (1913) addressed the importance of interest and proposed two factors in the interest construct: identification and absorption (also, refer to Mitchell, 1993). He argued that if one recognizes and identifies himself with the learning activities, he will devote all his attention to the learning process. Hence, Dewey proposed that the better way to teach is to arouse learners' interest instead of forcing learners to work hard. Although we might all agree that interest is of greater importance and take such a concept of "interest" for granted, it is not difficult to find that the interest triggered while reading a novel and the interest that someone prefers to learn mathematics are different. The former seems to be "interestingness," and the latter seems like a characteristic due to personality. Thus, there should be a clear definition to clarify the meaning of interest. However, no serious attention of interest as an important concept in educational psychology was paid until late 1980s.

According to Hidi and Braid (1988), the role of interest during education process can be identified from researchers' study perspectives. One of these is how interest influences cognitive perfor-

mance. Another is how the "interestingness" of stimulus materials influences cognitive performance regardless of individual difference. The former, which concerns differences between individuals can be viewed as personal interest, while the latter, which does not consider individual difference can be viewed as situational interest. In general, personal interest refers to information that is of enduring personal value, activated internally and topic specific (Schraw & Lehman, 2001). In contrast, situational interest emerges in response to features in the learning environment (Linnenbrink-Garcia *et al*, 2010), and refers to information that is of temporary value and context specific (Schraw & Lehman, 2001). Thus, an initial clarification of interest can be divided into two categories: personal interest and situational interest.

Mitchell (1993) developed a conceptual framework which classified situational interest into two categories: catching and holding. Catching meant to catch attention. For example, sometimes we use group work, computers or puzzles to catch learners' attraction. Holding meant to maintain students' learning power, such as making students understand that learning is meaningful to his future life so that they will be more willing to be involved in learning actively. Following this line, we can easily infer that situational holding interest has the potential to be developed into personal interest. In fact, Hidi and Renninger (2006) proposed a more sophisticated model to describe interest development, which contains four phases: triggered situational interest, maintained situational interest, emerging individual interest and well-developed individual interest. Triggered situational interest and maintained situational interest are respectively like correspond to the aforementioned catching situational interest and holding situational interest. Emerging individual interest refers to the initiate phase of a relatively enduring predisposition to seek repeated reengagement with specific learning topic over time, while well-developed individual interest refers to a relatively enduring predisposition to reengage with specific learning topic over time. This model gives a clear map of interest development as well as a clear classification of various interest concepts.

Linnenbrink-Garcia *et al* (2010) verified the three-factor model that differentiated situational interest into (1) triggered situational interest (triggered-SI), (2) maintained situational interest concerning feeling (maintained-SI-feeling) and (3) maintained situational interest concerning value (maintained-SI-value). The situational interest in this study mainly followed the concept of Linnenbrink-Garcia *et al* (2010) to investigate the feeling and value two factors in our setting. Moreover, Rotgans and Schmidt (2011a) claimed that how situational interest is related to learning and academic achievement is still not fully understood. This also motivated our study, hence the first research question is:

Q1: Can situational interest significantly predict the learning outcome?

Course satisfaction and learning outcome

Students' rating of instruction or course satisfaction is an index of teaching effectiveness, which can be thought of as the degree to assist students achieve well (McKeachie, 1979). In general, we tend to believe that students may rate courses and instructors more highly when they expect or receive good grades. In fact, course satisfaction, which indicates how positively students perceive their learning experience, is vital to student-related outcomes (Liao & Hsieh, 2011). For example, Chang and Smith (2008) have argued that students' course satisfaction should be taken into account by instructors because attitudes are often prerequisite of success. Pulkka and Niemivirta (2013) also claimed that course satisfaction may be related to grade as a function of course characteristics or students' assessment viewpoints. Therefore, it can be inferred that course satisfaction might have a positive association to learning outcome directly or indirectly.

There has been a lot of studies investigating the relationship between evaluation scores and various measures of student learning (Beleche, Fairris & Marks, 2012; Cashin, 1988; Clayson, 2009). However, little attention on the evaluation of online courses has been paid. While online

learning processes share a number of common characteristics with face-to-face courses, the fact that they are delivered through internet means that there are new variables to assess, especially where evaluation of the entire process is concerned (Benigno & Trentin, 2000). In this study, with a new learning environment and the flipped classroom approach applied, we are wondering about the relationship between course satisfaction and students' grades in this course. Thus, the second research question is raised:

Q2: Can course satisfaction sufficiently predict the learning outcome?

Gender difference

As gender difference has generally been a crucial issue in educational studies, several topics are selected to inspect such an issue. Thus, the third question was raised and further derived to several sub-questions as follows:

Q3: Are students' perception factors and their relationships influenced by gender difference in flipped course?

The influence of situational interest on academic performance is often associated with gender (Chen & Darst, 2002). For example, Anderson, Shirey, Wilson and Fielding (1987) found boys and girls performed better in sentences that appealed to their own gender than in those appealing to the opposite gender in a sentence recall test. In addition, Thompson (1998) claimed that women have been found to enroll in online courses at a higher rate than men. Other studies also examined the extent to which interest and learning outcome differed in gender in education (Buccheri, Gürber & Brühwiler, 2011; Frenzel, Goetz, Pekrun & Watt, 2010; Shen, Chen, Scrabis & Toller, 2003). Following these examples, we are curious to see if there were gender differences in situational interest as well as in the predictive power of situational interest to learning outcome in our setting. Thus, the Q3a and Q3b are as follows:

Q3a: Are there gender differences in situational interest of our setting?

Q3b: Are there gender differences in the predicting power of situational interest to learning outcome?

Aleamoni (1999) reviewed many studies and claimed that gender difference of students' course satisfaction is negligible in a majority of studies. In this regard, recent studies present various results between gender difference and course satisfaction in education (Gonzalez-Gomez, Guardiola, Martín Rodríguez & Montero Alonso, 2012; Gulbahar & Madran, 2009; Koohang, Behling & Behling, 2008; Lu & Chiou, 2010; Naaj, Nachouki & Ankit, 2012). However, we are still curious about the gender difference for course satisfaction for our course. Therefore, Q3c and Q3d are proposed as follows:

Q3c: Are there gender differences in course satisfaction in our setting?

Q3d: Are there gender differences in the predicting power of course satisfaction to learning outcome?

Although, in general, we think female interest in mathematics is markedly lower than male interest (Frenzel *et al*, 2010), researches have confirmed that males and females perform similarly in mathematics (Lindberg, Hyde, Petersen & Linn, 2010). Other studies also present similar result in the relationship between gender difference and learning outcome in education (Awodeyi, Akpan & Udo, 2014; Kazua & Demirkolb, 2014; Samuelsson, 2010). The interest in the above sentence means the individual interest, and the learning environment is usually a traditional classroom. In a flipped learning environment, we are curious about the gender differences of the performance in this mathematics course. Thus, the Q3e rose as

Q3e: Are there gender differences in the learning outcome of this course?

Methods

Participants and procedure

In this study, high school students in Taiwan were invited to experience an online course platform, NCUx, in a flipped-classroom setting. The NCUx was a 5-week precalculus course designed for

Table 1: Grade level of the General Scholastic Ability Test

Level	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Male	1	0	1	2	0	2	0	7	10	15	20	17	13	18	16
Female	0	0	1	3	3	3	5	13	14	22	24	21	18	13	11

$n = 273$.

high school students who just received admission to universities. The goal of this online course was to bridge learning of high school and university calculus courses seamlessly. Educational institutions are considering extending the NCUx course as a core basic curriculum required to all major students in university. Students' majors cover social science and literature, engineering, and biological fields, and their required course for study is calculus. However, some of students took calculus that is not required course for graduation. Six hundred thirty-two students randomly selected from 15 senior high schools enrolled the course, and 265 students earned the credit units for completion of the course. After taking the final exam in classroom at the fifth week, 151 female and 122 male students completed the survey questionnaire. Then, all students were asked to participate in open-ended question. The open-ended question took approximately 50–60 minutes. Finally, their mathematics grades of General Scholastic Ability Test (GSAT) are distributed as shown in the following Table 1. Higher level number indicated the higher level of achievement (eg, 1 and 15 are lowest and highest respectively). According to Kolmogorov–Smirnov test, apparently two populations showed a significant deviation from normality. Therefore, we employed the Mann–Whitney test and showed a significant difference ($p < .05$) between grade levels of males and females.

Measures

The survey questionnaire contains three portions. First is the background personal information including gender, preferred learning place, major in university and so on. The second part contains self-developed situational interest and course satisfaction (two measures), which originally contains 33 items presented in a 5-point Likert scale (eg, the responses were coded as 1 [*strongly disagree*] to 5 [*strongly agree*]). The situational interest measure was devised partly based on Linnenbrink-Garcia *et al* (2010) using maintained-SI-value and maintained-SI-feeling as two main constructs. Moreover, topic interest was also included for the possibility of students who were simply attracted by the course or content. The course satisfaction measure was devised to understand the extent of satisfaction about four facets of course (ie, course design, system quality, content arrangement and online assessment). The third part is an open-ended question: "What is your feedback to this course?" The learning outcome was directly scored by final grades. The survey questionnaires were delivered in native language for the best ease of understanding and then translated to English in order to be published in the journal (see Appendix).

Data collection and analysis

To completely respond our research questions, both quantitative and qualitative data were collected. By analyzing the data from the open-ended responses, we identified five main categories of perceptions. We use these data as a supplement to explain our inference. For statistical analysis, exploratory factor analysis was first used to find the factors in both situational interest and course satisfaction measures. Then, a multivariate regression method was used to explore the relation between learning outcome and the situational interest as well as course satisfaction variables. Lastly, a *t*-test was used to test the significant level of gender differences among those variables.

Results

Students' feedback

209 students responding to the open-ended question: "What is your feedback to this course?" Some students' responses mostly expressed just appreciation or compliments to this course but did not point out which portion they felt was good. In general, most of them held positive attitudes to this course project. However, the result of the open-ended questions also revealed that many students had trouble adapting to this new learning model. We identified five categories of students' feedback as shown in the following with some representative examples. These are (1) online lecturing, (2) online assessment, (3) face-to-face instruction, (4) system quality and (5) online interaction.

Online lecturing

Forty-four participants gave feedback to online lectures. The first main point is that the content of the material is too much for them to digest. For example, one student described: "I think 8-week long is more suitable for those lectures, because I need more time to think and practice." Six participants thought that a lot of the content was familiar to them, so some novel content should be added to this course. For example, another one student mentioned: "Topics about sequences, series, and limits are just taught last semester, I feel boring to learn it again." Still, another six participants complained that they did not like online learning because of no instant interactions between students and teachers.

Online assessment

Forty participants contributed to this category. The point mainly addressed is that the design of the online assessment should be improved because they just know the scores, and they could not know the mistakes they made if they did not get full marks. Some students said, "It would be more helpful to have correct answers to check the faults. Otherwise, if I got 4 points in 5, I might need great efforts to find the wrong one." Some others claimed that the questions are too difficult for them, and they sometimes do not even know how to solve the problem even after watching the lectures.

Face-to-face instruction

Thirty-one participants gave feedback to the face-to-face instruction. Most of them give positive opinions to the instructors. Some of them like the way lecturer instructed, some of them like the patience instructors showed, and some of them like the serious attitude instructors presented. However, several students complained that classroom time was not organized well to help them solve the problems they faced online; otherwise, they could learn more.

System quality

Seven participants gave the feedback to system quality; four of them complained that system could be improved; however, they did not clearly point out specific components. Two others complained that type mathematical symbols with keyboard were difficult to them since it is necessary for some tests.

Online interaction

Four participants claimed that it is convenient for them to discuss with classmates online. Two of them suggested the interface of discussion forum could be improved. However, one questioned why he should discuss online while he could meet classmates every day. In addition, discussing mathematics is not convenient online.

Factor analysis

For these two measures, situational interest and course satisfaction, we used principal components analysis approach to extract factors. Only factors with an eigenvalue of 1.0 or more are retained for further investigation. After rotation, we chose the items with loadings greater than ±0.40 on the relevant factors and less than ±0.40 on the nonrelevant factors. All item loadings

Table 2: Factor analysis of two major measures

Category	*Situational interest*			*Course satisfaction*			
Factor	*F*	*V*	*T*	*CD*	*SQ*	*CA*	*OA*
Item (loadings)	F1 (.70) F2 (.70) F3 (.64) F4 (.63) F5 (.61) F6 (.57) F7 (.55)	V1 (.82) V2 (.68) V3 (.67) V4 (.63) V5 (.47)	E1 (.83) E2 (.83)	CD1 (.70) CD2 (.66) CD3 (.61) CD4 (.50)	SQ1 (.67) SQ2 (.65) SQ3 (.58) SQ4 (.50)	CA1 (.66) CA2 (.62) CA3 (.47)	OA1 (.65) OA2 (.64)
Eigenvalue	5.90	1.20	1.04	3.81	2.06	1.39	1.08
Cum. variance explained (%)	42.09	50.65	58.04	27.18	41.90	51.82	59.50
Cronbach's alpha	.82	.79	.86	.76	.69	.61	.69

Overall $\alpha = 0.89$ for situational interest; overall $\alpha = 0.78$ for course satisfaction.
F, feeling; V, value; T, topic interest; CD, course design; SQ, system quality; CA, content arrangement; OA, online assessment.

were greater than .40 (Hair, Black, Babin & Anderson, 2010). Table 2 shows the result. The situational interest measure contains three constructs: feeling, value and topic interest. The factor "feeling" contains items relating to personal emotions (eg, confident, fulfillment and proud) during learning process; the factor "value" contains items relating to personal beliefs to this course (eg, useful or helpful); and the factor "topic interest" represents a pure interest to the course content. The course satisfaction measure contains four constructs: course design, system quality, content arrangement and online assessment.

The reliability coefficients for three factors of the situational interest, respectively, were 0.82 (feeling), 0.79 (value) and 0.86 (topic interest). The reliability coefficients for four factors of the course satisfaction, respectively, were 0.76 (course design), 0.69 (system quality), 0.61 (content arrangement) and 0.69 (online assessment). In addition, measure of reliability with values of 0.6–0.7 deemed the lower limit of acceptability (Fornell & Larcker, 1981; Hair, 1995). The reliabilities ranged from 0.61 to 0.87 are all reasonably acceptable. The Cronbach's alpha value of the entire situational interest questionnaire is 0.89. The Cronbach's alpha value of the entire course satisfaction questionnaire is 0.78. A value above 0.7 may be an acceptable reliability coefficient, although lower thresholds are sometimes used in the literature. Given the exploratory nature of the study, reliability of the scales was deemed adequate (Hair *et al*, 2010).

Regression analysis

According to the result of factor analysis in last section, we concluded seven factors relevant to the study. For summation of the item scores of each factor, we obtained seven variables. According to Pearson correlation coefficients between factors of situational interest and the final grade (60% online assessment score + 40% final exam score), factors of situational interest were all significantly related to final grade but just at a low level (0.15~0.24). For factors of course satisfaction, only course design (coefficient = 0.33) and content arrangement (coefficient = 0.13) were significantly related to final grade. With final grade as the dependent variable, multivariate regression analysis was implemented on situational interest and course satisfaction respectively. Multivariate regression analysis approach has been widely adopted for empirically examining sets of linear causal relationships (Huang, Rauch & Liaw, 2010; Shin, Sutherland, Norris & Soloway, 2012; So & Brush, 2008). The results were shown in Table 3. In Table 3, the factor names of both

Table 3: Summary of multiple regression analysis for variables predicting final grade

Variable	β *(All)*[†]	β *(Male)*[‡]	β *(Female)*[§]
Situational interest (SI)			
Feeling	0.09	0.26*	–0.01
Value	–0.02	–0.15	0.07
Topic interest	0.20**	0.20	0.15
Course satisfaction (CS)			
Course design	0.34**	0.13	0.44**
System quality	–0.03	0.12	–0.11
Content arrangement	–0.05	0.09	–0.15
Online assessment	0.06	0.10	0.06

*$p < .05$; **$p < .01$.
[†]SI, $R^2 = 6.2\%$; CS, $R^2 = 11.4\%$. [‡]SI, $R^2 = 11.6\%$; CS, $R^2 = 9.8\%$. [§]SI, $R^2 = 3.7\%$; CS, $R^2 = 18.8\%$.

situational interest and course satisfaction were listed respectively in the first column. The corresponding standard coefficients of the regression models were shown in the second, third and fourth column respectively.

The second column was the result of all participants, the third column was the result of male participants, and the fourth column was the result of female participants. In the second column, topic interest is the only significant factor predicting final grade while situational interest is considered. For course satisfaction variables, only course design is the significant variable predicting final grade. The result showed that both of topic interest ($\beta = 0.20$, $p < .01$) and course design ($\beta = 0.34$, $p < .01$) have a positively significant influence on final grade. This relationship revealed that both well-designed course and students' interest in course content could contribute students' final grade. In third column, feeling is the only significant factor predicting final grade in situational interest, while there is no course satisfaction variable that can significantly predict final grade. The result showed that feeling ($\beta = 0.26$, $p < .05$) has a positively significant influence on final grade. This finding demonstrates that the more male students' psychological interest on emotion, the higher learning outcome of course. In the fourth column, no situational interest factors were admitted as a significant factor to predict final grade while only course design seems to be the significant predictor to final grade in course satisfaction variables. The result showed that course design ($\beta = 0.44$, $p < .01$) has a positively significant influence on final grade. This finding demonstrates that the more female students are satisfied with well-designed course, the better learning outcome will be.

Finally, considering the R^2 values, the situational interest variables ranged from 3.7% to 11.6% across different groups, while the course satisfaction variables ranged from 9.8% to 18.8%. We can see that the explaining power of these variables is mostly in a low level. Moreover, the six regression models were all significant and did not suffer the problem of multicollinearity.

Gender difference

In Table 4, mean value and standard deviations of the eight variables of male participants and female participants were shown in the second to the fifth column respectively. The average final grades of both genders were over 80 marks, which showed a good performance. Among the situational interest and course satisfaction factors, we could see that topic interest was the sole variable showing significant gender difference ($t = 2.16$, $p < .01$). The result revealed that male participants tended to gain higher mean values than female and appear to differ significantly between males and females, indicating male participants tended to gain higher appreciation on the factor of topic interest than female. On the other hand, the mean of content arrangement and online assessment was both smaller than the middle score 9 and 6 of their ranges, respectively,

Table 4: t-Test for gender difference

	Male (n = *122*)		*Female* (n = *151*)			
Variables	*M*	*SD*	*M*	*SD*	t	p
Final grade	83.70	18.44	80.26	20.38	1.44	0.15
Feeling	24.52	4.05	24.86	3.60	0.73	0.47
Value	19.18	2.72	18.88	2.75	0.90	0.37
Topic interest	7.20	1.42	6.85	1.25	2.16	0.03*
Course design	13.17	2.82	12.81	2.41	1.17	0.26
System quality	14.31	2.26	14.24	2.20	0.25	0.80
Content arrangement	8.41	2.07	8.75	1.72	1.50	0.13
Online assessment	5.93	1.41	5.92	1.39	0.03	0.97

*$p < .05$.
Range: final grade, 0~110; feeling, 7~35; value, 5~25; topic interest, 2~10; course design, 4~20; system quality, 4~20; content arrangement, 3~15; online assessment: 2~10.
t, *t* value; *p*, *p* value.

Table 5: The list of average hours spent in students' learning course

Average hours spent in course learning				
	Less than 3 hours (%)	*3–6 Hours (%)*	*6–9 Hours (%)*	*Above 9 hours (%)*
Male	47	40	11	2
Female	36	52	7	5

suggesting a negative attitude to the two factors. In addition, Table 5 showed the average time spent in this course. A Mann–Whitney test showed no significant difference between males and females in hours spent on this course.

Discussion

Students' feedback

Based on students' feedback, we found several reflections and suggestions to implement a flipped classroom with MOOC. First, if the learning material was not appropriate for students' level, the classroom time should be well designed to fill in the gap. For example, giving some brain-storming problems might be suitable for those who feel the learning content too easy while reviewing the material should be necessary for those who feel too difficult. Even if students are satisfied with the online learning material and online assessment, the classroom time should be organized to facilitate more creative thinking and learning. Lage *et al* (2000) have claimed that instructors' teaching styles should match students' learning mode. The claim here suggested that the teaching strategies should match students' level as well. Apparently, the strength of the flipped classroom model is that it is flexible, since it provides an opportunity to educators to tailor their curriculum (Bergmann & Sams, 2012; Hamdan *et al*, 2013). Instructors in flipped classrooms are enabled to make meaningful contact with students for observing, guiding, commenting and helping (Flumerfelt & Green, 2013). Therefore, instructors may fully utilize differentiated instruction strategy and more instructor–student interaction in learning activities in class to match learning tasks with students' capability to meet students' needs and maximize students' growth (Baepler *et al*, 2014; Smit & Humpert, 2012; Tomlinson *et al*, 2003).

Second, instructors should guide students the correct ideas of implementing online assessment. Most students in Taiwan are eager to get correct answers than to get correct thinking. This

phenomenon might come from the result that too many exams students should take in their learning process such that they are lazy to spend their time on brain storming thinking. Thus, students are often anxious to find correct answers rather than brain storming thinking. In this regard, the online assessment was designed not to give correct answers but just give the scores, which tended to change the habit of depending on correct answer too much. However, teachers did not play a crucial role of guiding students in thinking the appropriate strategy to have tests in this study. They agreed with students that this was a fault which should be improved. In fact, this also reflected a lack of communication between designers and instructors. With gradual appreciation of flipped classroom in Taiwan, instructors may need more time to change their instruction habits from traditional classroom as more professional educators to meet the need of the new blended learning design. Specially, instructors not only need to carefully select and evaluate what learning content to meet different character of students' need, but also need to take more efforts guiding students to the process of problem solving to assist students to consider problems more deeply in mathematics based on the design of online assessment (Hamdan *et al*, 2013). In addition, a good communication between designers and instructors may achieve well-analyzed functional requirements for supporting a synchronous assessment tool to maximize the potential of online assessment and support students' learning (Chao, Hung & Chen, 2012).

Third, keeping improvement for system quality is inevitable. Technologies play a crucial role of flipped classroom, which enhanced flipped classroom to become effective and scalable learning environment (Davies, Dean & Ball, 2013). As system quality is a crucial factor to lead to successful implement information system, course designers should interact constantly with system designers to solve the problem of the system (DeLone & McLean, 2003). For example, there should be at least an instant response team to reply the questions simultaneously.

Fourth, there should be well-designed online activities at students' online learning. In this study, the online discussion is not actively encouraged and initiated. Just as some of them said that we had met each other in school, why should we discuss online? Moreover, some students complained that discussing mathematics online is difficult because the symbols are difficult to be presented in words. Therefore, online activities should be well organized to reflect students' needs, not just enforce them to discuss online in the absence of guides (Ross & Rosenbloom, 2011). For example, online activities may need to be more design-oriented learning activities for extension of learning in class time, which may allow students the feeling of connectedness to motivate students with more active interactions in classroom learning (Kim *et al*, 2014; So & Brush, 2008).

Predicting learning outcome with student perceptions

The relationship between situational interest and learning outcome

In this study, three subfactors of situational interest (eg, feeling, value and topic interest) related to learning outcome were discussed in this section. When gender is excluded, we found that topic interest can predict final grade among the three situational interest factors, while course design can predict final grade among four satisfaction factors. Regarding this point, Hidi (1990) has discussed the role of attention as a mediating process in the relation between situational interest and text learning. Rotgans and Schmidt (2011a) mentioned that situational interest could closely predict observed achievement-related classroom behaviors, and those behaviors could significantly predict academic achievement. As indicated here, situational interest might affect learning outcome through achievement-related classroom behaviors in flipping classroom setting. Students were encouraged in achievement-related classroom behaviors with active learning in classroom so as to participate in group discussions, to engage and persist in self-directed learning, and to have the promising quality of their presentations in the classroom (Rotgans, Alwis & Schmidt, 2008; So & Brush, 2008). In turn, the results of the interest affecting learning outcome were also confirmed with elsewhere (Dewey, 1913; Heinze, Reiss & Franziska, 2005). Thus, the findings

suggest that instructors could motivate students' interest to affect their achievement in learning mathematics.

The relationship between course satisfaction and learning outcome

In this study, the four subfactors of course satisfaction (eg, course design, system quality, content arrangement and online assessment) related to learning outcome were discussed in this section. The result showed that the course design affects learning outcome. Our result of prediction from course design to learning outcome might be explained as described by Swan, Matthews, Bogle, Boles and Day (2012). Swan *et al* (2012) revealed that course design may not necessarily influence learning outcome through learning processes. Course design and learning processes may influence learning outcome directly through different perspectives. In addition, the results that course design affecting learning outcome also consist of several studies (Davies *et al*, 2013; López-Pérez, Pérez-López & Rodríguez-Ariza, 2011; Missildine *et al*, 2013). Our findings point out that instructor should pay attention to course design to affect their mathematics achievement.

Gender difference

The effect of gender difference on students' perceptions and learning outcome

Regarding the prediction from perceptions to final grades, males showed a significant feeling factor, while females showed a significant course design factor. Sun and Rueda (2012) have shown that situational interest was significantly correlated with cognitive, behavioral and emotional engagement. In particular, emotional engagement was highly correlated. Our result partly confirms this claim, as only male participants showed this phenomenon. A suspected reason was that male students may have higher mathematics interest than female students, which led male students to have more confidence in math than female students (Frenzel *et al*, 2010; Kiran & Sungar, 2012; Winheller, Hattie & Brown, 2013; Kunter, Baumert & Köller, 2007). Therefore, this finding reveals that male students' personal emotion may play crucial role to learning outcome in math and may not be affected by flipping classroom setting. Moreover, this finding reveals that male students' emotional feeling may be triggered by flipped classroom environment to affect learning outcome. The suggestion was to integrate male students' emotional feeling with some pedagogical strategies for several situational factors (Bergin, 1999; Rotgans & Schmidt, 2011b; Binti md salleh & Bin Othman, 2014).

On other hand, final grades of female participants related more to course design than to other factors. This seems to be different from our understanding. That is, females count more on feeling while males focus more on course design or system quality. However, this surprising finding reveals that females may benefit from flipped classroom approach to influence their learning performance in math. This might be due to the case of female' low competence beliefs and domain value of mathematics influenced by flipped classroom approach (Frenzel, Pekrun & Goetz, 2007a, 2007b; Xiong, Gong & Frenzel, 2011). In contrast to traditional classroom learning, female students may benefit from flipped classroom approach due to satisfaction of high degree of interactions, flexibility and many self-paced learning opportunities (Bergmann & Sams, 2012; Fischer, Schult & Hell, 2012; Gonzalez-Gomez *et al*, 2012). It was suggested that we should adopt well-organized course design, reducing females' low competence beliefs and increasing value of mathematics for female students.

Finally, although Vandecandelaere, Speybroeck, Vanlaar, De Fraine and Van Damme (2012) based on TIMSS 2003 showed that gender has a significant effect on perceived value of mathematics, the value factor here did not show a significant difference between males and females. The main reason might be that our participants are almost all high achievers, compared with TIMSS analysis. Similarly, the equivalence of perceptions in the six factors might also come from the reason that they are high achievement students mostly, even though male students may show their higher

interest in flipped mathematic course than female students (Frenzel *et al*, 2010). In addition, although the participants showed a significant gender difference in GSAT mathematics level (Table 1), males and females are nearly identically well in this course. Whether this phenomenon comes from the effects of our flipped course or just a misleading result from different statistical methods used needs to be considered and follow-up work for study should be conducted.

Conclusions

In this study, we explored the student perceptions in situational interest and course satisfaction, the gender differences in those perspectives, and the relationship with the learning outcome. We conclude with several suggestions and some reflections of our settings. We believe the experience shown here could help instructors rethink their teaching styles as well as their attitude toward flipped learning. Our findings indicated that the higher students' interest and well-organized course could affect students' mathematics achievement in flipped course (Kim *et al*, 2014; Kunter *et al*, 2007). Furthermore, male students' psychological interest on emotion in math was more than of female (Heinze *et al*, 2005; Trautwein, Ludtke, Köller, Marsh & Baumert, 2006). In contrast, females may benefit from a flipping classroom approach contributing to their learning performance in math more than male students (Bergmann & Sams, 2012; González-Gómez *et al*, 2012). Several suggestions on implementing a flipped classroom with a MOOC from students' feedback were provided for instructors' guidance. However, some limitations of the studies should be emphasized here. First is that our participants are mainly consisted of high achievement students in high schools. The gender differences as well as the course perceptions might not be generally representative of all general high school students. The second is that the survey for this study occurred after their final examination was conducted but before their grades were informed. They might therefore worry that the feedback might affect their grades. Therefore, the result should be carefully adapted to practical situation. Follow-up studies about the detailed impact of situational interest and course satisfaction should be implemented for all of these issues.

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Open data

The data from this research is available on request from any of the authors.

Ethics

Before the data were made available to the authors, all identification (eg ID, name and school) were deleted.

Conflict of interest

The authors confirm that there is no conflict of interest in the research reported here.

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Appendix

The questionnaire items of situational interest and course evaluation:

Table A1: Situational interest

Feeling	
F1	Meeting with the teacher face to face and receiving the feedbacks from teaching assistant online make me feel that this kind of learning is worthy.
F2	Taking this course makes me feel confident to the learning stage in university.
F3	Taking this course makes me witness the potential of online platform.
F4	I will have a sense of fulfillment once I know my grades for this class.
F5	I am proud of myself every time I finish the assignments.
F6	I am glad that I have the chance to take this course.
F7	If this course increases face-to-face teaching hours, I won't feel irritated.
Value	
V1	This course contributed to my knowledge for learning related courses.
V2	This course contributed to my professional development.
V3	This course is important because I can put my study into practice in the future.
V4	It is a novel experience to learn online.
V5	This course is in accordance with what I want to learn.
Topic interest	
T1	I am interested in the course content.
T2	This course attracts me.

Table A2: Course satisfaction

Course design	
CS1	It is not difficult to finish this course in five weeks.
CS2	I always have enough time to finish assignments in this course.
CS3	This course is neither too difficult nor too easy.
CS4	I am satisfied with the learning effectiveness in this course.
System quality	
SQ1	I think the replying to problems and the way to dealing with problems are effective.
SQ2	It was easy for me to become skillful at using the online platform.
SQ3	I think the online video quality is great.
SQ4	The arrangement of combining online lecture delivery and face-to-face problem solving really helps my learning.
Content arrangement	
CA1	The quizzes in the course are too many for me.(R)[a]
CA2	The tests in the course are too many for me.(R)
CA3	The video of some topics are too long for me to keep concentration. (R)
Online assessment	
OA1	The tests in the course are too difficult for me. (R)
OA2	The quizzes in the course are too difficult for me. (R)

[a](R) means reverse item. We reverse-score reverse items before doing statistical data analysis.