Academia Journal of Educational Research 8(0): 000-000, March 2020
DOI: 10.15413/ajer.2020.0201
ISSN 2315-7704

Research Paper

Evaluating learning outcomes in the implementation of flipped teaching using data envelopment analysis

Accepted 9th March, 2019

Huei-Wen Lin

Department of Banking and Finance, Aletheia University, New Taipei City, Taiwan.

ABSTRACT

This study integrated various teaching factors—based on the idea of a flipped classroom—in a financial management course. The study's aim was to establish an effective teaching implementation strategy and evaluation mechanism with respect to learning outcomes, which can serve as a reference for the future modification of teaching methods. This study implemented a teaching method in five stages and estimated the learning efficiencies of 22 students (in the teaching scenario and over two semesters). Subsequently, data envelopment analysis (DEA) was used to compare, for each student, between the learning efficiencies before and after participation in the flipped classroom—in the first and second semester, respectively—to identify the crucial external factors influencing learning efficiency. According to the results, the average overall student learning efficiency increased from 0.901 in the first semester to 0.967 in the second semester, which demonstrate that the flipped classroom approach can improve teaching effectiveness and learning outcomes. The results also showed a difference in learning efficiency between male and female students.

Key words: Flipped classroom, data envelopment analysis, learning outcome, teaching and learning.

INTRODUCTION

The literature on education in Taiwan has focused on the quantity of knowledge and skills transmitted to learners. This focus on passive reception considers only the perspective of the teacher (in particular, their professional skill, teaching techniques, and innovativeness) and not the learner. However, because teaching and learning are inseparable, rather than the one-way transmission of knowledge, teachers should focus on cultivating (in students) self-awareness, independent thinking, and the ability to apply what was learnt. For students, learning should involve self-directed study and active collaboration with more knowledgeable peers, rather than passive reception. Therefore, education should shift its focus from teachers to learners. For universities in particular, teaching responsibilities should be reconfigured to address the aspirations of learners.

Since 2016, education authorities in Taiwan have interviewed the presidents of universities and colleges. These authorities have also organized nationwide regional forums with the Legislative Yuan to consult the general public on those major education policies that have been implemented during the past decade. These interviews and forums have shown that Taiwanese universities have focused on research and neglected teaching. Most universities have focused on competing for funding, without regard to their situation, thus hindering the sustainable development of higher education in Taiwan. These problems are caused solely by a lack of research funding for undergraduate education and a lack of consensus in the teaching literature. In response to the current situation and problem in teaching, university education must focus on how they equip students with skills, especially in problem-solving. The key to teaching effectiveness lies in teachers. A community of dedicated professional should be formed to

research on effective teaching methods and reform existing ones, especially in universities and colleges, to nurture talent in the next generation.

The operation of the financial system is extremely complex. The traditional financial industry has faced multiple challenges from emerging technologies. Although new financial investment products have constantly been introduced to the market, the labor force required by the industry has been getting smaller. To aid the smooth adaptation of university graduates to highly specialized jobs in the ever-changing financial industry, university education must better integrate teaching with learning theories in introductory finance courses. Therefore, educators in business and management should focus on the establishment of an effective professional teaching model in the teaching of professional financial management. Although the literature on finance and economics in Taiwan has flourished in the past decades, the literature on teaching in professional courses remains scant. This lacuna is especially acute for practitioner-oriented studies that verify a teaching theory through its application (particularly through the combination of teaching materials and teaching methods). For the more effective transmission and application of financial knowledge, this research gap in the quality and quantity of practitioner-oriented studies (set in the classroom) must be addressed.

Experience in the classroom teaching strongly suggests that university students tend to find professional finance courses difficult. This difficulty is especially acute in mathematically intensive finance courses, primarily because students learn passively in the often-used format of a lecture. Additionally, inter-student differences in learning styles result in large variations in learning outcomes. Therefore, teaching strategies must be diversified in introductory finance courses. Such diversification, however, must accord with an understanding of differences in the learning styles of students, thus allowing such diversification to better stimulate motivation and optimize learning outcomes in accordance with student aptitudes. Scholars have advocated active learning as a remedy for poor learning outcomes (Andrews et al., 2011). The flipped classroom approach is reportedly the best method for implementing an active learning environment (Berrett, 2012; Strayer, 2012). Therefore, the university classroom (and finance courses in particular) requires an investigation into optimal teaching methods that can replace conventional teaching models.

To investigate replacements to the conventional lecture format, the main objective of this study was the establishment of both a teaching strategy and learning outcome evaluation mechanism that are applicable to university students in financial management courses. Specifically, this study integrated diversified teaching elements and applied the flipped classroom approach to a financial management course. By integrating production efficiency theory (from the field of economics) with the flipped classroom approach, the learning outcomes of participating students were evaluated. Specifically, data envelopment analysis (DEA) was used to evaluate the effects of the study's teaching approach (in addition to other factors) on learning outcomes; data on factors (as inputs) and the learning outcomes of students (as outputs) were used in the analysis. The university in which this study was conducted has identified itself as a teaching university. Therefore, practitioner-oriented studies on teaching are important. The results of this study are useful for teachers and students (especially those in finance courses), with respect to teaching and learning effectiveness. Educators can use these results to evaluate teaching performance to improve teaching quality.

LITERATURE REVIEW

The definition and development of flipped classroom theory

Technological developments have opened new areas of research for education studies. A novel teaching method, the flipped classroom approach, has replaced the conventional model of the lecture, where the student is a passive recipient of information. A flipped classroom focuses on instructional videos, group work, and hands-on practice to deliver a comprehensive learning activity where students proactively solve problems in the classroom (Berrett, 2012; Strayer, 2012). Most studies on the flipped classroom have adopted the concept of interactive learning in groups. A pioneering study was based on Piaget's 1967 student-centered learning theory (Vygotsky, 1978). The flipped classroom—based on a unique synthesis of constructivist theories—features learning activities that are informed by student questions. The theory of flipped classrooms is based on the four main aspects of learning styles, cooperative learning, problem-based learning, and active learning (Abeysekera and Dawson, 2015). Foot and Howe (1998), who introduced the concept of learning backgrounds and highlighted its connection to peer assisted learning, observed that constructivism and cooperative learning originate from Piaget's cognitive conflict theory. Smith and MacGregor (1992) stated that social interdependent relationship theory, as proposed by Lewin (1935) and Deutsch (1949), is essential to the explanation of cooperative learning.

Although existing studies on flipped classrooms differ in their conclusions, the students in flipped classrooms do not. Although students generally comment positively on this teaching method, some students are unable to adjust to the changes of a slipped classroom. DeGrazia et al. (2012) reported that students prefer courses that involve instructional videos; students in general indeed tend to passively watch instructional videos. Sappington et al. (2002) showed that although most university students do

not independently complete reading assignments, the administering of tests on preclass instructional-video content was a successful method. Other studies have shown that students prefer instructions through short instructional videos and in-class interaction as opposed to monotonous, face-to-face lectures (Toto and Nguyen, 2009; Zappe et al., 2009).

The flipped classroom is based primarily on studies of student-centered learning (Tudge and Winterhoff, 1993). However, the flipped classroom if often misunderstood as merely consisting of reading assignments outside the class and discussing them in class. Abeysekera and Dawson (2015) defined the flipped classroom as an education technique that includes group reciprocal learning activities in the classroom, in addition to teaching and self-directed learning through the use of information and computer technology outside the classroom. In a flipped classroom, class time is not used for lectures but for discussing those learning activities occurring before and during the class.

The flipped classroom approach has been applied to various types of courses. Day and Foley (2006) applied interactive learning to a computer course and divided students into an experimental and control group. Students in the experimental group watched an instructional video of a PowerPoint lecture outside class time and participated in interactive learning activities in class. Relative to their peers in the control group, students in the flipped environment obtained notably higher scores for all homework assignments. Despite its limited generalizability, these results underscore the effectiveness of a flipped classroom. Moravec et al. (2010) modified the format of an introductory biology course. Specifically, students were asked to watch an instructional video of a PowerPoint lecture and complete a work sheet before class. In class, students participated in a short 10-min lecture as well as hands-on activities of 5 to 7 min each. As a result of this modified format, students' scores on a test on the topic discussed in the instructional video watched outside of class time improved by 21%. Despite the conventional format of teacher–student interactions in this study, the flipped classroom yielded positive results. Further study is required to generalize these findings of the flipped classroom's benefits.

Instructional scaffolding theory

Instructional scaffolding theory is based on the constructivist theories. Instructional scaffolding theory argues that knowledge can only be constructed through interactions with others, whether horizontally among peers or vertically between an expert and novice (Hatano, 1993). The crux of instructional scaffolding theory is the teacher's expertise in designating each student's appropriate learning zone and providing assistance accordingly; such assistance is analogous to the scaffolding used in construction (Wood et al., 1976). Vygotsky (1978) proposed the zone of proximal development (ZPD) in learning. The ZPD determines the development of high-level psychological functions of an individual. By analyzing the relationship between learning and development, that study offered multiple conceptually based prescriptions to teaching. Specifically, Vygotsky (1978) argued that exceptional learning starts with social negotiation and ends with the obtainment of personal meaning; a temporary scaffolding is used to assist the development of a learner's ability, as well as their communication and cognition. Thus, teachers must consider both the actual and potential development of a student to understand the development of the student's learning ability. Verenikina (2003) proposed a ZPD-centered teaching idea. According to this idea, teachers must first, evaluate the development level of a student before the commencement of learning and second, design teaching activities that are ahead of the student's level of the development. In doing so, teachers spend more time interacting with students, better understand the student's needs, and are better able to establish the optimal ZPD. For students, because teacher assistance is always provided one level ahead, students are motivated to fill this gap. As a result, the teaching and learning become positive, lively, and effective. In summary, the backbone of instructional scaffolding theory is a model of cooperative learning built by both teachers and students.

Transformative learning theory

Transformative Learning Theory was proposed by Mezirow (1991). Based on the practice of adult education, the theory describes the learning process as an integration between newly acquired knowledge and existing knowledge, beliefs, and experiences (Imel, 1998). In the learning process, each step in problem-solving leads an individual to reflection—where the content of reflection depends on the perspective that they hold. However, these reflections result in transformative learning only when individuals recognize the mistake and inadequacy of their ideas and begin questioning their belief system (Mezirow, 1995). Experience-centered learning, critical reflection, and rational conversation are the three main concepts in the transformative learning theory.

Transformative learning theory has been applied to service-learning activities. According to Jacoby (1996), service-learning is defined as a form of experiential education. Through a teacher-designed community service activity and reflection process, the provider of community service learns better and the recipient of community service has their needs met. Reflection and reciprocity are the main elements of service-learning. Duckenfield and Wright (1999) described service-learning as method of learning that connects community service experiences with learning, growth, and the nurturing of civic responsibility.

Thus, the integrating of professional financial management courses with service-learning activities can help students transform their knowledge of finance through experiential learning.

Mastery learning theory

According to the educational philosophy of China's Holy Master - Confucius, teaching should accord with the aptitude of students. The model of school learning proposed by Carroll (1963) was based on the same idea. According to Carroll (1963), teaching methods, learning time, and learning opportunities must be adapted to the individual characteristics of students. The model proposed that a student's achievement of mastery is a function of their extent of school learning and time spent learning. Mathematically expressed, extent of mastery = *f* (actual time spent on learning/time required for learning). Specifically, the time spent learning depends on the perseverance and learning opportunities of the learner, and the time required for learning is related to the aptitude and comprehension ability of the student as well as the quality of teaching (Carroll, 1989). Bloom (1968), agreeing with Carroll's five main factors influencing the extent of mastery, modified Carroll's model of school learning into a more practicable mastery learning strategy. An application of the group-based teaching method revealed that a uniform application with respect to teaching method and learning time resulted in great differences in the learning outcomes of students. However, a non-uniform application, tailored to each student, resulted in better learning outcomes.

Carroll's variables have been foundational to other studies. With regard to learning time and opportunities, Anderson (1976) reported a strong relationship between learning achievement and the time a student is willing to spend on active learning. Gettinger (1985) showed that insufficient time spent on effortful learning negatively affects retention in memory. Arlin (1984) noted first, if learning time is constant, individual differences affect learning achievements, and second, when students must achieve a given level of mastery, individual differences affect the requisite learning time. Smith et al. (2005) demonstrated that extra learning time and learning opportunities (in addition to regular class sessions) constitute a considerable help to students with lower achievements. Gandara and Rumberger (2007) added extra teaching time in English instruction, resulting in increased learning opportunities and decreased differences in learning outcomes between students; extra time had a significantly positive influence on learning outcomes.

As for learning aptitude, Guskey (1997) reported that aptitude is the primary predictor of learning speed. That is, aptitude only predicts the time taken by a student to achieve a certain level of mastery. Moreover, that study noted that quality of teaching and sufficient learning time enable most students to achieve mastery; the relationship between aptitude and learning achievement was inconsequential.

Comprehension ability refers to a student's cognition of what the material is (and means) in general and the student's ability to understand learning assignments and follow teaching procedures in particular. In addition, the quality of teaching is a crucial factor influencing student learning achievement (Bloom, 1968). Guskey (2007) advised teachers to vary their teaching methods to meet the needs of various students. Holdzkom and Brandt (1995) established two evaluation dimensions—presentation of teaching activities and feedback during teaching—based on the teaching quality–related subset of mastery learning theory. Spiggle (2003) determined that in mathematics courses, the adequate presentation of teaching activities positively affects learning achievement. Feedback during teaching refers to teachers giving timely (verbal, written, and encouraging) feedback, which greatly motivates learners to continue learning (Chang, 1994) and is positively related to student learning outcomes (Wilkerson et al., 2000). Mastery learning theory has been applied to education in the previous decades, strongly suggesting that mastery learning positively affects learning outcomes (Guskey, 2007; Kazu et al., 2005).

METHODS

Research scope

This practitioner-oriented study applied the flipped classroom approach to a finance course. This finance course was a compulsory year-long course, and this study used various activities in the teaching process, integrated lectures with practical activities, and leveraged resources (within and without the university) in teaching. A financial transaction simulation system was introduced in the second semester. As for the study's method of evaluation, in the final score, the midterm and final exam scores weighed lesser and performance in each learning stage weighed more. After the authors observed the participation of students in each learning activity, students were asked to complete a questionnaire regarding their personal performance and active learning ability. The questionnaire results were the data used to further evaluate learning outcomes.

Participants

Participants of this study are the students who took this finance course. Because this course is a compulsory year-long course, the teaching and learning process was evaluated in five stages. Students are free to leave the course and new students are free to join during the two

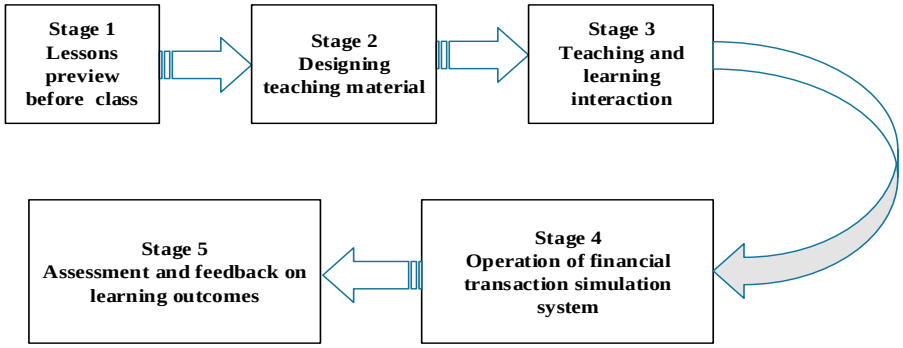

Figure 1: Research procedure to explore flipped teaching.

semesters. To ensure consistency in the data (on both semesters) for more effective comparisons using the DEA, 22 students from the course were selected for cross-semester evaluation and analysis.

Research procedure

Implementation procedure

This study applied the diversified stage teaching method to evaluate the learning efficiency of students in the classroom. A different teaching factor is integrated in each stage, where hands-on activities are used for teaching. The research procedure comprised five stages as shown in Figure 1.

Evaluation of teaching effectiveness and quantitative analysis tools

A two-stage DEA was conducted based on the data of students' learning effort and involvement (input aspect) and learning outcomes (output aspect), allowing for the in-depth observation of the learning efficiency of students in a financial management course after the implementation of the flipped classroom approach. In addition, the relationship between learning efficiency and environmental variables was determined.

(1). Learning effort (input) variable setting and assessment:

a). Learning motivation: The level of self-regulated learning motivation of a student under the flipped classroom approach. The self-regulated learning scale established by Santhanam et al. (2008) was used in this study. This scale comprises a questionnaire of six items, such as "I can set financial management learning goals and study schedules" and "I actively search for information related to the course or the homework." A five-point Likert scale was used to rate items in this scale, thereby assessing learning motivation.
b). Weekly input time for the preparation and review of class material: The average hours a student spent weekly on preparing and actively reviewing class material were calculated.
c). The level of proactivity in the classroom: Each lecture was three hours long. The lecturer recorded the number of times a student participated in interactive class discussion.
d). Attendance: How often a student attended class throughout the semester.

(2). Learning outcome (output) variable setting and assessment:

a). Weighted scores of tests, midterm exam, and final exam: Scores were used to evaluate whether students have acquired the requisite knowledge. Scores have been a crucial indicator of learning outcomes (Chandra and Lloyd, 2008; Santhanam et al., 2008). In this study, the final score was calculated according to the lecturer-stipulated weights of each teaching activity.
b). Learning satisfaction: Learning satisfaction is a crucial variable in assessing learning outcome in a learning environment (Alavi et al., 2002; Chou and Liu, 2005; Zhang et al., 2006). A five-point Likert scale was used to assess how satisfied students were with their overall learning performance.
c). Self-perceived learning outcomes: This item refers to the self-assessment of students regarding their extent of mastery of and attention paid to course material after learning with the flipped classroom approach. The assessment concept of Marcolin et al. (2000) was adopted in the questionnaire design, which included five items, such as "I care about learning outcomes in this financial management course" and "I feel encouraged when my financial management test scores improve, and worsening scores are a call to action." The questionnaire used a Likertfive-point scale to assess the average improvement in the students' interest in learning.

(3). Environmental variables for learning efficiency:

Environmental variables, such as the participant's gender, participation in student associations in the department,

having of a part-time job, and rental accommodation were chosen based on previous studies. The environment of the teaching scenario and a student's experience in taking courses were also included as variables. The influence of these environmental variables on the learning efficiency was determined in this study.

(4). Analysis method: Two-stage DEA:

After evaluating the efficiency of each student before and after taking this course, this study used a two-stage method developed by Coelli et al. (2005). This method allowed for the identification of those environmental variables that affect learning efficiency. In the first stage, the standard DEA was applied to estimate decision-making units (DMUs)(that is, the learning behavior of students).In the second stage, a Tobit regression was used to estimate the significance and direction of influence of each environmental variable (e.g., gender, a student's year of study, place of residence, and teaching scenario) on learning efficiency using the efficiency value obtained in stage one as the dependent variable.

a). Efficiency estimation in stage-one DEA: The concept of production efficiency was developed from the analysis of the frontier production function, first conceptualized by Farrell (1957). Under the condition of constant returns to scale (CRS) with no presupposed production function or estimated function parameter, all input factors determine the efficiency frontier. Subsequently, the efficiency frontier can be used to measure the technical efficiency (TE) of the producer. Charnes et al. (1978) proposed the DEA, which was developed based on ideas in linear programing. They expanded the TE indicator to be applicable to multiple (rather than single) production, thus enabling the evaluation of relative efficiency between DMUs. This study adopted the model proposed by Charnes et al. (1978) and assumed that the learning output of each student is a CRS. Specifically, the class has N students, and each student has K and M types of learning input and learning output, respectively. The output-oriented model is then:

$$Max_{\theta,\lambda}\theta$$
$$\text{s.t. } x_i \geq X\lambda,\ Y\lambda \geq \theta y_i,\ \lambda \geq 0, \qquad (1)$$

where x_i is the K × 1 input matrix of student i, X is the K × N input matrix, y_i is the M × 1 output matrix of student i, Y is the M × N output matrix, λ is the N × 1 weight matrix, θ is the amplifying ratio required to achieve efficiency frontier output when the input is a constant, and $1/\theta$ refers to the efficiency value between 0 and 1.

b). Stage-two Tobit regression model estimation: In this stage, the influence of each environmental variable on the learning efficiency of students was estimated. The efficiency assessment function is:

$$TE = Z'\delta + \nu, \qquad (2)$$

where $0 \leq TE \leq 1$is the technical efficiency; δ is the parameter vector of dimension $1 \times k$, where higher valuesrepresent higher efficiency; Z is the environmental variable vector of dimension k ×1; and ν is a random disturbance, where it is assumed that $\nu \sim i.i.d.N(0, \sigma_\nu^2)$. Because $0 \leq TE \leq 1$, data truncation may occur. The Tobit regression model is often adopted to perform the estimation and determine those environmental variables with considerable effects on student learning efficiency.

(5). Data collection: A self-reported inventory was designed according to the teaching material, lecturing method, and level of student adaptation in the flipped classroom. After the implementation of each teaching-activity stage, students were asked to complete the inventory and their test scores were also recorded. The output data from the learner were also collected for subsequent evaluations of learning outcomes.

RESULTS

Teaching process and outcomes

The first stage in the teaching process was preparation before class. Students were tasked with getting acquainted with the course and formulating questions; the cloud-based immediate interactive system, ZUVIO, was used to conduct preclass tests to understand the conceptual structure that students have established with regard to course content. These tests enabled researchers to understand the prior financial knowledge had by students. The second stage comprised lecturer explanations of the flipped classroom strategy and the handing out of assignments, including homework and tests, to be finished during the course of the semester. The third stage focused on improving student concentration in class, where the ZUVIO system was used to obtain real-time student feedback. Through enhanced teacher–student interaction, students that fall behind are identified so that the lecturer can adjust the teaching content and level of difficulty. Because repeated practice is essential, according to the mastery learning theory, students become familiar with the course content through repeated practice on questions and exercises. In the fourth stage, the financial transaction simulation system was introduced for students to put theory to practice. The fifth stage focused on the feedback and evaluation of learning outcomes through a posttest to verify whether students have internalized the professional knowledge acquired in class. Students were asked to complete a questionnaire and their self-evaluation was measured. DEA was used to estimate the learning efficiency of students and identify those factors and environmental variables that are critical

Table 1: The descriptive statistics of students' input and output items in the first semester.

	Output variables		Input variables				
	Weighted final scores	Learning satisfaction	Self-perceived learning outcomes	proactivity in the classroom	Attendance	Learning motivation	Weekly input time for the preparation and review of class material
Mean	77.44	2.11	2.06	7.32	41.32	1.62	0.26
S. E	4.13	0.18	0.14	0.60	1.14	0.13	0.04
Media	76.56	2.00	1.79	7.00	43.00	1.43	0.20
Mode	--	2.00	1.63	7.00	45.00	--	--
S.D.	19.37	0.84	0.64	2.80	5.33	0.59	0.17
Variance	375.19	0.70	0.41	7.85	28.42	0.35	0.03
Kurtosis	-0.76	-0.26	-1.26	2.32	4.36	-0.63	0.29
Skewness	-0.26	0.71	0.26	0.54	-2.01	0.61	1.00
Range	66.44	3.00	2.17	14.00	21.00	2.11	0.60
Min.	42.06	1.00	1.00	1.00	24.00	0.81	0.07
Max.	108.50	4.00	3.17	15.00	45.00	2.92	0.68
Sum	1703.63	46.45	45.27	161.00	909.00	35.70	5.69
number	22.00	22.00	22.00	22.00	22.00	22.00	22.00

to learning efficiency, thus serving as a reference for the future modification of teaching methods. At the end of the semester, students were asked to review their strengths and weaknesses in personal performance, time management in learning, and ability to practically apply classroom knowledge. The results of this review serve as a reference for future adjustments to methods of implementing the flipped classroom.

The implementation of a flipped classroom includes the establishment of student learning files for the conduct of qualitative and quantitative evaluations of learning outcomes. The qualitative evaluation involves the student's formulation of questions, ability to learn independently, management of knowledge and skills, and evaluation of the process. Qualitative evaluations focus on student performance through experimental records, raw data, activity records, surveys, interviews, records of learning experiences, and student reflections. As for the quantitative analysis, this study introduced production economic theory to the conduct of DEA. The descriptive statistics of each (input and output) variable are presented in Tables 1 and 2.

This study further used a paired *t*-test on the data on students in both semesters. The *t* test was used to observe, for each (input and output) variable, the difference between semesters (Table 3).No statistical significance was noted for any of the three output variables. As for the four input variables, proactivity in raising questions in class significantly decreased in the second semester ($t = 5.477^{***}$), which might be due to students being familiar with the course or being eager to participate in active learning. Learning motivation in the second semester was higher than that in the first semester ($t = -2.170^{**}$), which might be due to the interest of students being stimulated by the introduction of the financial transaction simulation system (as an output) in the second semester.

Learning efficiency analysis

Because students are less able to control the output variables, this study adopted the input-oriented DEA model. Moreover, in contrast to manufacturing, undesirable output, such as noise or pollution, can be neglected in the teaching scenario. Thus, the strong disposability hypothesis (that is, where opportunity costs are ignored) can be used to assess the learning production efficiency of students. The DEAP 2.1 analytical tool was adopted in this study. Based on Equation (1), average learning efficiency of the 22 students, learning efficiency of each student in both semesters, and the slack movement between input and output were estimated (Tables 4 and 5). With regard to learning efficiency, those of the 22 students in the first stages of the first (three outputs and four inputs) and second semesters (four outputs and four inputs) were included in the estimation. According to Table 4, the mean DEA-estimated student learning efficiency in the first semester was 0.966; seven students exhibited low learning efficiency. According to Table 5, the overall mean efficiency in the second

Table 2: The descriptive statistics of students' input and output items in the second semester.

	Output variables			Input variables				
	Transaction simulation	Weighted final scores	Learning satisfaction	Self-perceived learning outcomes	Proactivity in the classroom	Attendance	Learning motivation	Weekly input time for the preparation and review of class material
Mean	-0.16	68.35	2.25	2.02	3.75	39.09	1.8	0.26
S.E.	0.03	6.98	0.18	0.13	0.58	1.7	0.13	0.04
Media	-0.11	81.07	2.17	2	3.75	42	1.79	0.21
Mode	--	--	2	2	0.01	45	1.25	0.22
S.D.	0.12	32.73	0.84	0.63	2.72	7.97	0.61	0.2
Variance	0.01	1070.94	0.7	0.4	7.41	63.52	0.37	0.04
Kurtosis	-0.2	-1.25	-0.52	-0.54	-1.23	0.31	-1.02	0.66
Skewness	-0.94	-0.6	0.22	0.13	-0.09	-1.29	0.09	1.3
Range	0.39	96.25	3	2.4	8	24	2.04	0.69
Min.	-0.41	10.7	1	0.95	0	21	0.79	0.03
Max.	-0.02	106.95	4	3.35	8	45	2.83	0.72
Sum	-3.51	1503.77	49.42	44.5	82.54	860	39.63	5.81
number	22	22	22	22	22	22	22	22

Table 3: Comparison of input and output variables between the first and the second semester.

	Output variables		Input variables				
	Weighted final scores	Learning satisfaction	Self-perceived learning outcomes	proactivity in the classroom	Attendance	Learning motivation	Weekly input time for the preparation and review of class material
Mean difference	9.084	-0.135	0.035	3.566	2.227	-0.178	-0.005
T-value	1.748	-0.938	0.522	5.477***	1.458	-2.1702**	-0.126
P(T<=t)	0.095	0.359	0.607	0.000	0.160	0.042	0.901
df	21	21	21	21	21	21	21

***p<0.01;**p<0.05.

semester increased to 0.997; only two students failed to satisfy the efficiency benchmark. The results showed that in the second semester, the learning efficiency of these 22 students improved because of the implementation of the flipped classroom approach.

Tables 4 and 5 also detail the analysis of slack movement for each (input and output) variable. The analysis showed that with respect to the output, if the learning input does not increase, the slack movement of the final score output was 0 for 20 students in the first semester, meaning that for these students, student output had no further room for improvement. As for learning satisfaction, 18 and 21 students in the first and second semesters, respectively had a slack movement of 0 in learning satisfaction output, which indicates that input–output disposition was excellent. As for self-perceived learning outcomes, 22 students had excellent input–output disposition in the first semester, and one student had room for improvement in self-perceived learning outcomes in the second semester.

With respect to the input, and assuming no decrease in

Table 4: Slack movement for each input and output variable and students' DEA efficiency values in the first semester.

Student No.	Efficiency value	Weighted final scores	Learning satisfaction	Self-perceived learning outcomes	proactivity in the classroom	Attendance	Learning motivation	Weekly input time for the preparation and review of class material
1	1	0	0	0	0	0	0	0
2	0.821	15.053	0.275	0	0	0	0	0
3	0.878	0	1.634	0	0.989	0	0	0.129
4	1	0	0	0	0	0	0	0
5	0.716	9.177	0	0	0	0	0	0
6	1	0	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0
14	0.987	0	0	0	0	0	0	0
15	0.875	0	0.478	0	0	0	0	0
16	1	0	0	0	0	0	0	0
17	1	0	0	0	0	0	0	0
18	0.980	0	0	0	0	0	0	0
19	1	0	0	0	0	0	0	0
20	1	0	0	0	0	0	0	0
21	1	0	0	0	0	0	0	0
22	0.986	0	0.448	0	0	0	0	0.476
mean	0.966							

Table 5: Slack movement for each input and output variable and students' DEA efficiency values in the second semester.

Student No.	Efficiency value	Transaction simulation	Weighted final scores	Learning satisfaction	Self-perceived learning outcomes	proactivity in the classroom	Attendance	Learning motivation	Weekly input time for the preparation and review of class material
1	1	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0
5	0.959	-0.068	0	0.782	0	0	0.448	0	0
6	0.981	-0.061	0	0	0.658	0	0	0	0
7	1	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	0

Table 5: cont

14	1	0	0	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0
16	1	0	0	0	0	0	0	0	0
17	1	0	0	0	0	0	0	0	0
18	1	0	0	0	0	0	0	0	0
19	1	0	0	0	0	0	0	0	0
20	1	0	0	0	0	0	0	0	0
21	1	0	0	0	0	0	0	0	0
22	1	0	0	0	0	0	0	0	0
Average	0.997								

learning output, in the first semester, one student could reduce their input for proactivity in class, and two students could reduce their input for the preparation and review of class material; in the second semester, only one student could reduce their input for attendance. The results showed that the implementation of a flipped classroom resulted in excellent input–output disposition for all 22 students in both semesters. Learning efficiency in the second semester was also slightly better than that in the first semester.

Upon completion of the first stage that is the efficiency analysis, Tobit regression was used in the second stage to evaluate the influence of environmental variables on learning efficiency (for both semesters). The Tobit results are shown in Tables 6 and 7. The results obtained by a Tobit censored regression model showed that male students demonstrated better learning efficiency than their female peers in both semesters. In the first (but not second) semester, students who did not live at home had a significantly higher learning efficiency than those who lived at home.

Reflection of the teacher

Gaps between teaching and learning are inevitable in the classroom. Conventional teaching methods are a teacher-centered teaching process, where teachers lecture by writing on a blackboard and students memorize the content by taking notes. In such a learning process, the primary function of the teacher is to subjectively determine what and how students should learn. By contrast, students in the traditional classroom are less interested in learning *per se* and more interested in obtaining good grades; these students are less motivated to improve their professional competences, acquire knowledge from the content, and form relationships between the concepts taught in class. The one-way nature of conventional teaching methods makes students passive receivers of knowledge and hinders their deeper understanding of the content. This results in students being unable to acquire core professional competences after completing the course. Therefore, novel teaching techniques, such as the flipped classroom, must be applied to improve teaching quality and learning effectiveness.

Because the teacher's method of communication is critical in the classroom, media must be appropriately used in the conduct of teaching and experiential learning. Multimedia-related teaching techniques have been extensively applied to improve the learning environment (Liao, 2007; Mayer, 2001; Waxman et al., 2003). Alavi and Leinder (2001) reported that the rapid development of teaching and learning models involves technology as the medium. This study attempted to expand the elements of flipped classrooms based on this rapid development. Specifically, to flip the conventional one-way method of lecturing, in addition to integrating multimedia and information technology with class activities, visits to financial facilities and a financial transaction simulation system were included in the course. In addition, this study introduced production economic theory to establish an objective mechanism for evaluating the learning outcome of students in a flipped classroom environment.

The lecturer in this study had more than 20 years of experience in teaching financial management. For the university in which this study was conducted, financial management is a compulsory professional course for second-year students in the Department of Finance. The conventional classroom where teachers lecture and students listen has failed to retain the attention of the next generation of students. Students have become increasingly passive in learning, and their learning efficiency has become low. The lack of learning motivation is evident in the classroom, where most students sleep, use their phones, and play mobile games. Thus, professional education is difficult, resulting in low learning achievement in students and students to give up on learning. Considering this problem, this study demonstrates that the combination of theory and practice in the flipped classroom benefits both teaching and learning in the nurture of practical experience, learning of business knowledge, and honing of professional competences. The employment of flipped teaching contributes to achieving more with less in both teaching and learning.

The research results suggest that learning motivation

Table 6: The Tobit regression on the effect of environmental variables to learning efficiency in the first semester.

	Coef.	Std. Err.	t-value	P-value>|t|	95% Conf. Interval	
Intercept	0.9151	0.0262	34.80***	.000	0.8598	0.9703
Gender	0.0776	0.0304	2.55**	.020	0.0136	0.1416
participation in student associations	-0.0559	0.0330	-1.69	.108	-0.1253	0.0135
Part-time job	0.0339	0.0302	1.12	.277	-0.0296	0.0974
rental accommodation	0.0596	0.0279	2.14**	.046	0.0011	0.1183
Number of obs	22					
LR $\chi^2(4)$	9.55					
Prob>χ^2	0.0487					
Log likelihood	27.2038					
Pseudo R^2	-0.2129					
Sigma	0.0617	0.0097			0.0413	0.0820

***p<0.01; **p<0.05.

Table 7: The Tobit regression on the effect of environmental variables to learning efficiency in the second semester.

	Coef.	Std. Err.	t-value	P-value>|t|	95% Conf. Interval	
Intercept	0.9927	0.0034	288.78***	.000	0.9855	0.9999
Gender	0.0090	0.0040	2.27**	0.036	0.0007	0.0174
participation in student associations	-0.0090	0.0043	-2.08	0.052	-0.0180	0.0001
Part-time job	0.0068	0.0040	1.71	0.104	-0.0015	0.0151
rental accommodation	0.0021	0.0036	0.57	0.576	-0.0056	0.0097
Number of obs	22					
LR $\chi^2(4)$	7.96					
Prob>χ^2	0.0929					
Log likelihood	69.7043					
Pseudo R^2	-0.0606					
Sigma	0.0081	0.0013			0.0054	0.0107

***p<0.01; **p<0.05.

must be improved if classroom learning atmosphere is to be improved. To improve learning motivation, learning efficiency, and teaching and learning quality, more diverse learning activities—such as service-learning activities, recording digital learning content to assist with preclass learning, and teaching activities where students promote basic business and finance knowledge in elementary schools—are planned in future iterations of the course. By preparing for such activities, students can deepen their knowledge and pay it forward to the teaching scenario, thus increasing their motivation of learning. Therefore, activity-oriented learning is necessary and must be deepened and sustained in the teaching scenario.

Student feedback

The technologically advanced teaching scenario has become increasingly popular. Various information technologies have been introduced to the classroom, and teaching assistance systems have been developed as a result. For example, the application of the platform ZUVIOi n the teaching scenario has enabled students to interact with each other using their mobile phones. Students easily adapt to this platform, allowing them to track classroom discussion in real-time. This platform can thus aid the implementation of the flipped classroom. With this platform, students can easily prepare for and review class material, and teachers can observe student reactions and obtain immediate feedback, thus remedying the problems of a lack of teacher–student communication and student–student interaction in conventional teaching scenarios (in addition to making teaching activities less dull and rigid).

In addition, students in this study also experienced the operation of an actual financial market. Through the introduction of the stock transaction simulation system, students are provided with a simulated experience of actual market transactions after learning about financial theories. Through such an experience, their learning horizons are expanded and the learning outcome of applying theory to

practice is fulfilled.

In the Student Online Teaching Evaluation results, the overall satisfaction levels of students in the first and second semesters were 4.61 and 4.64 out of 5 points, respectively. Moreover, a student remarked that "the teacher took us to visit the stock market and planned a simulation of stock transactions for us, which was really interesting."

CONCLUSION AND SUGGESTIONS

In addition to diversifying teaching elements, this study gathered and quantitatively analyzed data to demonstrate the influence of the flipped classroom approach on student learning efficiency, in a financial management course. The learning efficiency of each student was determined through an evaluation of student-learning input and output. This method of determination allows for the quick identification of first, students who are lagging behind and second, those environmental factors (specific to each student) influencing a student's learning efficiency. Thus, novel flipped teaching methods help students with low levels of learning achievement. After the diversified teaching method is applied, learning efficiency indicators can be adjusted according to student reflections, feedback, and questionnaire responses. This study was able to observe and compare between the learning efficiency of each student, thus improving real-time counseling and remedies to learning gaps in the classroom.

This study's results can be published through public events organized by the university or conferences organized by the teaching department. If shared with teachers of relevant courses, the experiences documented in this study can reduce cognitive gaps, inspire teaching strategies that better fulfill student needs, and stimulate discussion on the potential applications of this study's results. This study established a teaching model suitable for students with low learning motivation and minimal prior knowledge. It also tested the model's effectiveness with respect to student learning outcomes during its implementation. This study's results can, in being shared with colleagues, be comprehensively used to improve overall student learning outcomes in finance-related courses. The teaching model may be implemented in schools to effectively improve teaching quality and—in accordance with the ultimate goal of education—nurture well-rounded students.

REFERENCES

Abeysekera L, Dawson P (2015). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. High. Educ. Res. Dev. 34(1): 1-14.

Alavi M, Marakas GM Yoo Y (2002).A comparative study of distributed learning environments on learning outcomes. Inf. Syst. Res. 13(4): 404-415.

Anderson LW (1976). An empirical investigation of individual differences in time to learn.J. Educ. Psychol. 68(2): 226-233.

Andrews T, Leonard M, Colgrove C, Kalinowski S (2011). Active learning not associated with student learning in a random sample of college biology courses. Life Sci. Educ. 10(4): 394-405.

Arlin M (1984).Time variability in mastery learning. Am. Educ. Res. 21(1): 103-120.

Berrett D (2012). How 'flipping' the classroom can improve the traditional lecture. The Chronicle of Higher Education. Retrieved from http://chronicle.com/article/How-Flipping-the Classroom/130857/

Bloom BS (1968).Learning for mastery. Evaluation Comment 1(2): 1-5.

Carroll JB (1963). A model of school learning. Teach. Coll. Rec. 64(8): 723-733.

Carroll JB (1989). The Carroll model: A 25-year retrospective and prospective view. Educ. Res. 18(1): 26-31.

Chandra V, Lloyd M (2008). The methodological nettle: ICT and student achievement. Br. J. Educ. Technol. 39(6): 1087-1098.

Charnes A, Cooper WW, Rhodes EL (CCR) (1978). Measuring the efficiency of decision making units. Eur. J. Operat. Res. 2: 429-444.

Chou SW, Liu CH (2005). Learning effectiveness in a web-based virtual learning environment: A learner control perspective. J. Comput. Assist. Learn. 21(1): 65-76.

Coelli TJ, Rao DSP, O'Donnell CJ, Battese GE (2005). An introduction to efficiency and productivity analysis (2nded.). Kluwer Academic Publishers, Massachusetts.

Day JA, Foley JD (2006).Evaluating a web lecture intervention in a human-computer interaction course. IEEE Trans. Educ. 49(4): 420-431.

DeGrazia JL, Falconer JL, Nicodemus G, Medlin W (2012). Incorporating screencasts into chemical engineering courses.In Proceedings of the ASEE Annual Conference & Exposition.

Deutsch M (1949). A theory of cooperation and competition. Human Relations *2*(2): 129-152.

Duckenfield M, Wright J (1999). Pocket guide to service learning. Clemson, SC: National Dropout Prevention Center.

Foot H, Howe C (1998).The psychoeducational basis of peer-assisted learning.In K. J. Topping and S. W. Ehly (Ed.), Peer-assisted learning Lawrence Erlbaum Associates. pp. 27-43.

Gandara P, Rumberger R (2007). Resource needs for California's English learners: Getting down to facts. Institute for Research on Education Policy and Practice, Stanford University.

Gettinger M (1985). Time allocated and time spent relative to time needed for learning as determinants of achievement. J. Educ. Psychol. 77(1): 3-11.

Guskey TR (1997). Implementing mastery learning (2nded). CA: Wadeswoth Publishing Company.

Guskey TR (2007). Closing achievement gaps: Revisiting Benjamin S. Bloom's "Learning for Mastery". J. Adv. Acad. 19(1): 8-31.

Hatano G (1993). Time to merge Vygotskian and constructivist conceptions of knowledge acquisition. In E. A. Forman, N. Minick, & C. A. Stone (Eds.), Contexts for learning: Sociocultural dynamics in children's development New York: Oxford University Press. pp 153-166.

Holdzkom D, Brandt RM (1995).From accountability to professional empowerment in North Carolina. In D. L. Duke (Ed.), Teacher evaluation policy: From accountability to professional development. Albany, NY: State University of New York Press.

Imel S (1998).Transformative learning in adulthood. ERIC Document Reproduction Service No. ED200.

Jacoby B (1996). Service learning in today's higher education. San Francisco, CA: Jossey-Boss.

Kazu IY, Kazu H, Ozdemir O (2005). The effects of mastery learning model on the success of the students who attended "Usage of basic information technologies" course. Educ. Technol. Soc. 8(4): 233-243.

Lewin K (1935). Dynamic theory of personality. McGraw-Hill Book Co. D. K. Adams and K. E. Zener, Trans.

Liao YKC (2007). Effects of computer-assisted instruction on students' achievement in Taiwan: A meta-analysis. Comput. Educ. 48(2): 216-233.

Marcolin BL, Compeau DR, Munro MC, Huff SL (2000). Assessing user competence: Conceptualization and measurement. Inf. Syst. Res. 11(1): 37-60.

Mayer RE (2001). Multimedia learning. Cambridge England: Cambridge University Press.

Mezirow J (1991). Transformative dimensions of adult learning. San

Francisco, CA: Jossey-Bass.
Mezirow J (1995). Transformative theory of adult learning. In M. R. Welton (Ed.), In defense of the lifeworld-critical perspectives on adult learning. New York: State university of New York Press.
Moravec M, Williams A, Aguilar-Roca N, O'Dowd DK (2010). Learn before lecture: a strategy that improves learning outcomes in a large introductory biology class. CBE-Life Sci. Educ. 9(4): 473-481.
Santhanam R, Sasidharan S, Webster J (2008).Using self-regulatory learning to enhance e-learning-based information technology training. Inf. Syst. Res. 19(1): 26-47.
Sappington J, Kinsey K, Munsayac K (2002). Two studies of reading compliance among college students. Teach. Psychol. 29(4): 272-274.
Smith BA, Roderick M, Degener SC (2005).Extended learning time and student accountability: Assessing outcomes and options for elementary and middle grades. Educ. Admin. Q. 41(2): 159-236.
Smith BL, MacGregor JT (1992). What is collaborative learning? In M. Maher, A. M. Godsell and V. Tinto Ed., Collaborative learning: A sourcebook for higher education. National Center on Postsecondary Teaching, Learning and Assessment. pp. 10-30.
Strayer J (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. Learn. Environ. Res. 15(2): 171-193.
Toto R, Nguyen H (2009). Flipping the work design in an industrial engineering course.In Frontiers in Education Conference, 2009. FIE 2009. 39th IEEE, pp. 1-4, IEEE.
Tudge JRH, Winterhoff PA (1993). Vygotsky, Piaget, and Bandura: perspectives on the relations between the social world and cognitive development. Hum. Dev. 36(2): 61-81.
Verenikina I (2003). Understanding scaffolding and the ZPD in educational research. Retrieved from University of Wollongong Research Online http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1695&context=edupapers
Vygotsky LS (1978). Mind and society: The development of higher mental processes. Cambrigdge, MA, Harvard University Press.
Waxman HC, Lin MF, Michko HG (2003).A meta-analysis of the effectiveness of teaching and learning with technology on student outcomes. Learning Point Associates. Retrieved from http://www.ncrel.org/tech/effects2/waxman.pdf
Wilkerson DJ, Manatt RP, Rogers MA, Maughan R (2000). Validation of student, principal, and self-ratings in 360 degree feedback for teacher evaluation. J. Personnel Eval. Educ. 14(2): 179-192.
Wood D, Bruner JS, Ross G (1976). The role of tutoring in problem solving. J. Child Psychol. Psychiatr. 17(2): 89-100.
Zappe S, Lieicht R, Messner J, Litzinger T, Lee HW (2009). "Flipping" the classroom to explore active learning in a large undergraduate course.In Proceedings of American Society for Engineering Education Annual Conference & Exposition.
Zhang D, Zhou L, Briggs RO, Nunamaker JJF (2006). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. Inf. Manag. 43(1): 15-27.