Using transactional distances to explore student satisfaction with group collaboration in the flipped classroom

William Swart*

Department of Marketing and Supply Chain Management,
East Carolina University,
Greenville, NC 27858, USA
Email: swartw@ecu.edu
*Corresponding author

Niva Wengrowicz

Department of Education in Science and Technology,
Faculty of Industrial Engineering and Management,
Technion – Israel Institute of Technology,
Haifa, Israel
Email: nivawen@technion.ac.il

Karl L. Wuensch

Department of Psychology,
East Carolina University,
Greenville, NC 27858, USA
Email: wuenschk@ecu.edu

Abstract: In the 'flipped' classroom, students use online materials to learn what is traditionally learned by attending lectures, and class time is used for interactive group learning (IGL). IGL differentiates the flipped class from a traditional class and is touted as what makes the flipped class reflective of how higher education will change. In this paper, we use transactional distance (TD) and relative proximity theory (RPT) to hypothesise collaboration factors that could model student satisfaction in a flipped class. An instrument based on these factors was administered to a total of 84 students enrolled in two sections of a flipped operations management course over two semesters and EFA, SEM and CFA analyses determined it to be valid and reliable. Multiple regressions were used to determine which factors were statistically significant unique predictors of student satisfaction in the flipped classroom. The findings of the research imply that neither instructors nor students should be left to 'sink or swim' when first exposed to the flipped classroom. Instead, instructors should be incentivised to develop the skills required to be an effective learning, or cognitive, coach and students should be instructed in teaming skills as part of the flipped classroom experience.

Keywords: flipped learning; group collaborative learning; problem-based learning; PBL; instructional design; transactional distance; structural equations modelling; operations management.

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Biographical notes: William Swart is a Professor of Marketing and Supply Chain Management at East Carolina University. He received his BS in Industrial Engineering from Clemson University and his PhD in Operations Research from the Georgia Institute of Technology. He has held leadership positions in the industry, including Corporate Vice President, and in the academia, including Provost and Vice Chancellor for Academic Affairs. He is the recipient of a NASA/JFK Group Achievement Award, the Institute of Industrial Engineers (IIE) Operations Research Practice Award, and the Achievement in Operations Research Medal from the Institute for Operations Researchand Management Science (INFORMS).

Niva Wengrowicz received her PhD degree from Bar Ilan University and was a Postdoctoral Fellow at the Department of Education in Science and Technology at the Technion – Israel Institute of technology. She is an Adjunct Lecturer at the Faculty of Industrial Engineering and Management, at the Technion and served as a Visiting Scholar in the System Design and Management Program at the Massachusetts Institute of Technology. Her current research focuses alternative assessment at higher education programs in technology-enhanced learning environments. She has published articles in several journals including *Computers & Education*, *American Journal of Distance Education*, *Knowledge-Based Systems*, *Systems Engineering*, etc.

Karl L. Wuensch is a Full Professor in the Department of Psychology at East Carolina University. In addition to teaching three of the four graduate courses in statistics and research design offered by the department, he also teaches a couple of undergraduate courses each year. He has been recognised as a Teacher/Scholar by the university and has received the Board of Governors' Award for Excellence in Teaching, the highest teaching award in the University of North Carolina system. He has published 79 articles in scholarly journals and eight chapters in books.

1 Introduction

In the 'flipped' classroom, students use online materials to learn what is traditionally learned by attending lectures and class time is used for interactive group learning (IGL). In his book 'College (Un)bound)', Selingo (2013) indicates that the "flipped classroom reflects how higher education will change as a result of the opportunity that rapidly evolving instructional technologies are allowing for merging online classes with face-to-face classes to provide a hybrid model that is capable of improving quality and reducing costs".

One source of increased costs at universities is the focus on increased enrolment which generates demand for additional classroom space (Hall et al., 2010). Baepler et al. (2014) investigated the potential of the flipped classroom to reduce costs by investigating the time a class requires a physical classroom. Their findings indicated that through the use of the flipped class, the time that a class required the use of a physical classroom was reduced by 66% without undermining the student learning experience or student learning outcomes. Their study involved three sections of a general chemistry class attended three times a week in a theatre style classroom holding 350 students. They concluded that this goal is achievable with the construction of or remodelling of existing classrooms into specially designed, smaller, active learning classrooms to support flipped learning.

In this paper, we focus on the role of the IGL activities that are at the heart of the flipped class in causing student satisfaction.

1.1 Flipped learning

In order to avoid possible confusion, we will define the term '*flipped classroom*' as having two distinct, but inextricably linked components that distinguish the pedagogical approach from the physical facility/location in which it is implemented. The pedagogical approach will be referred to herein as '*flipped learning*' while the physical location in which the IGL activities takes place will be referred to as the '*IGL classroom*'.

Selingo's (2013) predictions about the future of higher education are reflected in the literature. In their survey of the published research about the flipped classroom, Bishop and Verlegen (2013) state that "There is considerable buzz in academic circles at all levels, focused around the flipped classroom". They list 83 articles as well as 39 blog posts, news articles, and five websites dedicated to the flipped classroom and six web resources for flipped classroom teachers. With interest continuing to grow, researchers at George Mason University with support of Pearson (http://home.pearsonhighered.com/) undertook a comprehensive review of research relevant to the flipped classroom. The research cited 44 sources and resulted in a white paper titled "A Review of Flipped Learning" (Hamdan et al., 2013).

Both of the above reviews of the research agreed that flipped learning may not work for all instructors and students. They also agreed that there is a need for more and better quantitative and qualitative research to identify how the potential of flipped learning can be maximised. For example, Bishop and Verlegen (2013) state that of the 83 studies on the flipped classroom they found only one that examined student performance throughout the semester. But, it was very specific rather than being based on established principles to guide adaptation.

The concept of flipping the classroom is not new. What is new is that professors across a broad range of disciplines are adopting the idea and a growing number of research studies show that students who are more active in their learning perform better (Selingo, 2013). In the remainder of this paper, we adopt the Bishop and Verleger (2013) definition of the flipped classroom "as a new pedagogical method, employing asynchronous video lectures and practice problems as homework as well as group-based problem solving activities in the classroom. It represents a unique combination of learning theories once thought to be incompatible: active, collaborative and context-based learning activities founded upon a constructivist and student-centered ideology and passive, individual and content-based instructional lectures derived from direct instruction methods founded upon teacher and content-centered principles. Thus, the flipped classroom consists of two distinct parts: interactive group learning activities *inside* the classroom and direct computer-based individual instruction *outside* the classroom". More recently, Bergmann and Sams (2014) have noted that too much of the discussion about the out of class component of flipped learning has focused on videos. Instead, they note, they now prefer to use the term 'learning object' when talking about the flipped classroom. A learning object can include videos, but it also can be other resources such as online simulations, books, and periodicals. However, research has shown that video-lectures are as effective as in-person lectures at conveying basic information (Bishop and Verlegen, 2013; Hamdan et al., 2013). Furthermore, Herreid and Schiller (2013) cite five sources that show that watching instructional video podcasts have a positive impact on *student attitudes*, three that show a positive impact on *student behaviour*, and four that show a positive impact on *student performance*.

1.2 Interactive group learning

Technology-enhanced learning elements such as developing instructional videos tend to pique the interest of instructors when they first hear about the flipped classroom. However, as with face-to face instruction, many students experience the ‘illusion of understanding’ when what is required for completing the homework seems straightforward while watching an expert do the task. But, then they face difficulties when they try to put what they observed into practice on their own. Thus, while students may acquire the basic content by watching the videos, the most central part of the flipped classroom is what happens in class (Wallace et al., 2014).

We use the term ‘IGL’ as an umbrella to span the spectrum of active learning approaches that may be used *inside* the flipped classroom, preferably one designed specifically to accommodate such activities. Recent surveys (Prince, 2004; Bishop and Verleger, 2013; Davidson et al., 2014) indicate that the in-class part of the flipped classroom can encompass a spectrum of learning theories including cooperative learning (Stahl, 1994), collaborative learning (Johnson et al., 1998), team-based learning (Michaelsen et al., 2014; Haidet et al., 2014), and problem-based learning (PBL) (Woods et al., 2000). These theories fall under the category of active learning (Prince, 2004) and all have group collaboration and PBL as central ingredients. However, the manner in which instructors choose to implement such problem-based collaboration may depend on problem type, form of interaction, knowledge focus, forms of facilitation, forms of assessment, and learning emphasis. The various possible groupings of collaborative PBL activities based on these factors used by any one instructor in any one class has been referred to as ‘constellations’ (Savin-Baden, 2014) and serve to illustrate that no two classes, whether employing lecture or flipped learning pedagogies, are identical (Hamdan et al., 2013).

1.2.1 IGL classrooms

Traditional classrooms are inhibitors of IGL. Rows of seats facing a lectern and a blackboard (or computer screen) are contrary to the constructivist conceptions of learning that underlie IGL. Constructivists assume that knowledge is individually constructed and socially co-constructed by learners based on their experiences that provide interpretable experiences and facilitate knowledge construction (Jonassen, 1999). Consequently, having an appropriate learning space (classroom) that facilitates and supports IGL is a key ingredient to successful flipped learning (Janz et al., 2012; Baepler et al., 2014).

A number of authors, including Heick (2013), Lippman (2013), Janz et al. (2012), and Villano (2010), have offered guidelines for building collaborative learning spaces. For example, while Lippman (2013) posits some fundamental questions that administrators and educators should discuss among themselves before engaging in any new building project, Villano (2010) provides pictures as well as seven tips for building collaborative learning spaces. These tips are:

- involve faculty in the design process
- gauge student input
- invest in flexible furniture
- create technological redundancy
- assess acoustical features
- do not forget low-tech
- train, train, train.

1.3 Transactional distance

This research was conducted in the first of a number of planned conversions of existing classrooms to IGL classrooms at the College of Business of a large Southeastern University in the USA. Since it was the first time in which flipped learning was implemented in such a room at that university, it was particularly important to understand what drives student satisfaction in such flipped classrooms. Such understanding would guide improvements to future IGL classroom designs and the manner in which flipped learning was implemented. To obtain this understanding, an instrument that is based on sound educational theory was required. We selected transactional distance (TD) as the theoretical basis for our instrument because it is recognised as one of the major theories about student learning.

Moore (1973, 1993, 2013) defined TD as "a psychological and communication space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner" implying that if learning outcomes in any course are to be maximised, TDs need to be minimised.

Zhang (2003) expanded Moore's definition of TD to be "The cognitive, psychological, social, cultural, behavioral and/or physical distance between learners and the other elements of their learning environments that prohibit students' active engagement with learning". In Zhang's work, the barriers to students' active engagement with learning in the course environment are measured via a dedicated questionnaire, referred to as the scale of TD, developed for this purpose. It was originally intended to explain student learning at a distance, but its application has expanded. Using Zhang's Scale of TD with slight modifications, Rabinovich (2009) studied TD in synchronous web-extended classrooms in which live on-campus classes are delivered simultaneously to both in-class students on campus and remote students on the web who attend synchronously via virtual classroom web collaboration software. Horzum (2011) developed a scale to measure TD in blended environments. In his study, a scale consisting of 38 items and five sub-factors was used to measure perception of TD in such environments. More recently, Zhang's scale of TD was used to determine the relative proximity of specific web-based, hybrid, and face to face courses to 'ideal' (Swart et al., 2014).

The IGL activities are at the core of flipped learning. These activities create TDs that are results of the group dynamics that may be influenced by factors other than those originally postulated by Moore (1973, 1993, 2013) and later modified by Zhang (2003). Wengrowicz et al. (2014) used elements of both Moore's and Zhang's work to define Collaboration-TD as the pedagogical, psychological, collaboration-cultural, and communication barriers that can lead to misunderstanding between collaborating students in collaborative PBL environments. They developed an instrument, referred to as Coll-TD, to measure TDs in collaborative project-based virtual learning environments.

1.4 Student satisfaction

We chose to use student satisfaction as the focus of our study because direct links have been found between both student satisfaction and student learning and between student satisfaction and student retention. While student learning is the primary concern of instructors, student retention is arguably of primary interest to administrators dealing with difficult budget realities (Hall et al., 2010).

Zhang (2003) studied the relationship between two different perceptions of student learning (I have learned a great deal in this course, I have made tremendous progress towards my goal in the subject area of this course) and one perception of student satisfaction (Overall, I am extremely satisfied with this course). Her results indicated highly statistically significant correlations between all three ($p < 0.01$). Similar results were reported with entirely different data in a recent study by Swart et al. (2014). Lo (2010) also found a statistically significant relationship ($p < 0.05$) between three satisfaction factors (instructor performance, student's own commitment to learning, and course policies) and perceived student learning. Although we consider students perceiving that they are learning the material positive, we are also cognisant of studies (Bacon, 2011; Clayson, 2009) that have found little or no correlation between indirect measures of learning (student perception) and direct measures of learning (grades on exams). One study (Steenhuis et al., 2011) that used an alternative teaching strategy (simulations) as a means of teaching concepts found that student performance on the simulation was not necessarily indicative of a student's performance on examinations designed to test what was to be learned during the simulation. Our anecdotal experience was that student average and median grades improved in the flipped classroom over that experienced in the traditional classroom in previous (to the advent of the flipped classroom) semesters and that grades below a 'C' became rare.

The link between student satisfaction and retention (persistence) was conclusively established in a study across 65 four-year institutions with 27,816 student participants (Schreiner, 2009). The findings were that student satisfaction indicators added significantly to the ability of predicting student retention and that satisfaction varies by class. For first year students, retention is best predicted by satisfaction with the campus climate. For sophomores, retention is best predicted by a combination of GPA, gender balance on campus, and campus climate. For juniors, retention is best predicted by a combination of GPA, global satisfaction and satisfaction with the campus climate. For seniors, retention seemed to be a moot point since their satisfaction mattered little to their persistence at this point in their career.

1.5 Research objectives

The research reported in this paper was motivated by an administrative decision to encourage innovation in teaching and learning by faculty and students through the remodelling of traditional classrooms into IGL classrooms. Some faculty, including us, saw this as an opportunity to implement flipped learning in the newly remodelled classrooms because it provided an opportunity to enable significant learning (Vygotsky, 1980). Furthermore, it develops collaboration skills in students. These are fundamental to business operations and are critical skills for success as a manager (Bedwell and Salas, 2014; Lobato et al., 2010).

Since the implementation of flipped learning in an IGL classroom is an imprecise science at best, it became important to develop quantitative measures of the impact of flipped learning on student satisfaction so that appropriate and relevant improvements could be made in both the pedagogy and the IGL classroom design prior to the resourcing of additional IGL classrooms. In particular, since the IGL classrooms specifically facilitated IGL, our focus was to develop quantitative measures that would describe what specific aspects of IGL impacted student satisfaction and by how much. More specifically, the objectives of this paper are to:

1 define the TD factors associated with the IGL component of a flipped classroom

2 develop a reliable and valid instrument to measure these factors.

The purpose of these objectives was to determine which TD factors and are significant predictors of student satisfaction and the relative contribution of each.

2 Method

This research was conducted over a period of two semesters with students enrolled in a required undergraduate operations management course (OMGT 3223 – Business Decision Modelling) at a large university in the Southeastern United States. The design of both the IGL classroom and the flipped learning pedagogy followed appropriate and relevant results cited in the literature.

2.1 Model

This is a quantitative study based on a close-ended attitude scale questionnaire. We modified the Coll-TD instrument developed by Wengrowicz et al. (2014) to account for the specific types of collaboration designed into our implementation of the flipped classroom. The new instrument, referred to as Coll-TD/F, was administered to 84 students and the quantitative data was statistically analysed using SEM and CFA to ascertain the reliability and validity of the instrument. Multiple regression was then used to determine which of the Coll-TD/F factors served as predictors of student satisfaction.

2.2 Participants

A total of 84 undergraduate students enrolled in two sections of OMGT 3223 in the fall semesters of 2013 and 2014 participated in the study. There were a total of 24 female students and 43 students worked full time. Table 1 provides a breakdown of the participants.

2.3 Implementation

The first step in implementation of this research was to physically convert an existing classroom into an IGL classroom. The second step was to transform the mode of instruction from the traditional pedagogy to the flipped pedagogy. In this section, we describe in detail each of these steps.

Figure 1 College of business IGL classroom (see online version for colours)

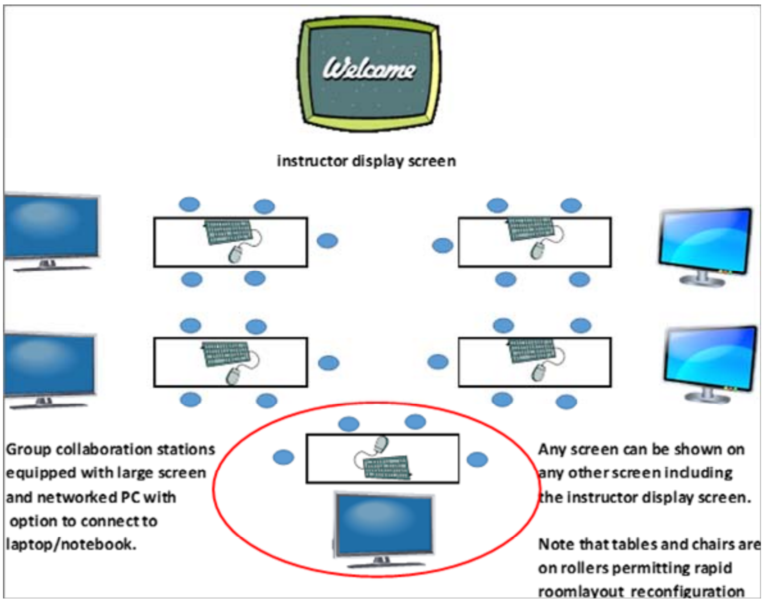
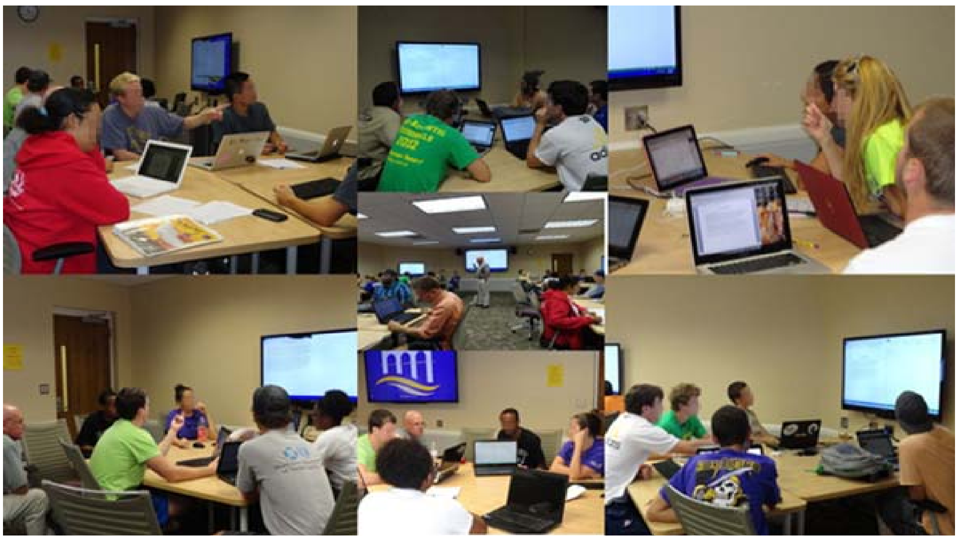


Figure 2 The IGL classroom in action (see online version for colours)



2.3.1 Implementing an IGL classroom

The Dean of the College of Business had a history of actively encouraging innovative teaching/learning approaches and instinctually understood Vygotsky's (1980) theory of the zone of proximal development that says that learners can acquire knowledge more rapidly when working with others who are more expert in a given task. This is facilitated by flowing, fluid, and flexible learning spaces (Lippman, 2013). When he initiated the development of the first IGL classroom, he organised a number of feedback/brainstorming sessions that included university architects and planners, IT professionals, faculty and students. These inputs, as well as knowledge of what was done at other institutions such as Winona State University (Janz et al., 2012) resulted in the College of Business' (and university's) first IGL classroom which is diagrammed in Figure 1 and pictured 'in action' in Figure 2.

The furniture in the IGL classroom is free standing, and both chairs and tables are on rollers, permitting rapid reconfiguration of the learning space to accommodate new group structure, or to move from a collaborative workstation mode to a traditional lecture format where all tables and chairs are aligned facing in the same direction (a configuration often used during exams).

The classroom has seven large screens and each has a dedicated networked computer. Students have electrical outlets to charge their laptops (required for business students) and any laptop can be connected to the large screen. The instructor has the ability to manage the technology so that all screens show any screen the instructor wishes to exhibit. This feature is particularly useful when the instructor wishes to share information with the entire class, or when one group is making, for example, a Power Point presentation.

Low tech was not forgotten. The IGL room has two white boards visible to the entire class. Student teams can move their furniture around the whiteboards if/when they wish to use them as they collaborate. Faculty can use them to post announcements, explain material to the class, or to tutor a single or select group of students.

The IGL classroom as shown has all of the features that were deemed relevant and appropriate for a business school environment. It can accommodate almost any imaginable group activity. It is ideally suited for the implementation of flipped learning by instructors wishing to adopt that mode of learning in their classes. IGL classrooms are equipped with sophisticated collaboration hardware and software, and frequent seminars are offered to train faculty in their appropriate use.

2.3.2 Implementing flipped learning

One of the authors was assigned to teach two sections of a required undergraduate business course, OMGT 3223 (business decision modelling) in the IGL classroom. This course followed the norm of quantitative courses in business schools by being considered by students to be among the most challenging and least favourite in the curriculum (Zanakis and Valenzi, 1997). The authors were aware of the buzz (Bishop and Verleger, 2013) about the flipped classroom. So, they seized the opportunity to implement flipped learning in the IGL classroom hoping to make the course more satisfying to students.

There is no 'how to' list for implementing the flipped classroom (Hamdan et al., 2013): but, a design framework and nine design principles which we adopted and implemented when relevant and appropriate were proposed by Kim et al. (2014). In addition, successfully implementing flipped learning goes well beyond simply recording a video and letting students do homework in class (Findlay and Mombourquette, 2014). To 'flip' OMGT 3223, the instructor had to:

1 develop and effectively use appropriate materials

2 commit to letting go of traditional teaching practices

3 secure buy-in from students for the approach so they understand what their responsibilities will be and commit to the new learning process.

Adopting the flipped learning paradigm means the days of preparing lecture notes, going to class and delivering the lecture, answering a few questions, and then assigning homework are ended. Instead, the daily corresponding responsibilities of the instructor and the students associated with flipped learning are listed summarised below:

a Implementing the out of class component

  Instructor:

  1 Establish daily learning objectives.
  2 Have the daily lecture available on appropriate audio/visual media.
  3 Prepare IGL activity to accomplish daily learning objectives.
  4 Prepare daily quiz to test that *each* individual in each group has accomplished learning objectives.

  Students: Study the daily lecture prior to coming to class.

b Implementing the In-class component

  Instructor: make announcements and comments about the day's material.

  Students: ask questions (if any).

  Instructor: provide daily interactive group learning activity (usually a problem) to groups.

  Students: collaborate to complete daily interactive group activity. Ask for coaching from instructor (as necessary). The work is usually shown on large screen.

  Instructor: provide coaching (as necessary).

  Instructor: coach/teach by walking around (observe group activities and intervene when appropriate to point out mistakes, etc.).

  *Instructor/*students: students and instructor agree that objectives of the interactive group learning activity have been achieved.

  Students: take a daily individual quiz to demonstrate that each individual has achieved that day's learning objectives.

The above steps illustrate that our IGL activities form a constellation of activities (Savin-Baden, 2014) that include collaborative learning, team-based learning, and PBL. These activities include collaboration to solve daily in-class problems as well as collaboration to solve take home exam problems (Michaelsen et al., 2014). Furthermore, teams are allowed to morph with each other so that there can be learning facilitated by team members as well as by communication between teams. However, our approach appears to differ from most other forms of IGL in that team activities are not graded. Instead, each student is graded based on what they have learned as a result of the IGL activities by taking an *individual* in-class quiz or exam. As Vygotsky's (1980) theory of the zone of proximal development states, learners can acquire knowledge more rapidly when working with others who are more expert in a given task. Thus, our last step in implementing the in-class component is intended to make sure that each student, in addition to participating in the IGL activity, also has individually acquired the skills, knowledge, and abilities specified in that day's learning objectives.

Group collaboration in OMGT 3223 extends to exams. The course has four two-part exams. Each exam includes a take home set of problems on which students may collaborate. Such collaboration usually involves developing a number of spreadsheets for the assigned problem cases (problems) and is designed to be a continuation of the collaborative learning processes that students have learned to use in-class. The in-class individual exams consist of questions requiring an understanding of the spreadsheets to be answered. This is like any traditional exam in which the purpose is to assess whether the student has mastered the material as an individual.

2.3.2.1 The role of the instructor

The sequence of in-class responsibilities listed above make it clear that the role of the instructor in flipped learning is substantially different than in a traditional lecture class. We found that students come to class ready to start work on their daily IGL activity. When asked at the beginning of the class if they have any questions, the typical response is "we'll see once we start on the day's in-class activity". This response transforms the classroom into a place where just-in-time learning (JITL) is experienced. JITL provides opportunity for students to learn at the moment of greatest relevance, when they are faced with the specific need to know. JITL also creates the opportunity for the instructor to become a coach to the student as well as his/her team in the process of learning. Being an effective learning, or cognitive, coach, not unlike being an effective athletic coach, requires that the instructor be flexible and is able to resort to the most effective manner of helping the student and their team in the process of learning how to solve the problem (Bolton, 1999; Wallace et al., 2014). They must be able to motivate the learner to put out intense effort, and they provide expert feedback that is very timely (Selingo, 2013). In our case, we embraced the opportunity to change our approach. Unfortunately, not all professors are willing to change their approach to teaching and cling to tradition in spite of being provided with great opportunities to experiment, such as the IGL classroom (Selingo, 2013).

2.4 Instruments

2.4.1 Designing a valid and reliable instrument

Several researchers have developed instruments to measure TD (Zhang, 2003; Rabinovich, 2009; Horzum, 2011). However, we were able to find only one documented study that focused on group collaborative learning. Wengrowicz et al. (2014) developed and validated the Coll-TD instrument. This instrument is an online questionnaire for measuring the TD perceptions of students who participated and collaborated via visualisation-based environments as part of the VISIONAIR project. This project, sponsored by the European Union, was aimed at creating an infrastructure for conducting state-of-the-art research in visualisation in virtual group collaborative environments (Wengrowicz et al., 2014). Their research used project-based learning (PBL), a teaching method which is characterised by authentic investigation, collaboration among peers, the use of technology to support the process of inquiry, and delivery of an end product (Wengrowicz et al., 2014).

The Coll-TD questionnaire that was developed for the VISIONAIR project measures student's subjective feelings regarding the following six Coll-TD factors that are made up of four main factors (*Comm; Under; Collab-Att; and Satisfaction*), two of which were split between attitudes toward the peers and instructor (the numbers in parentheses are the number of questions composing each factor):

1 *Comm-Peer:* communication between peers (7)

2 *Comm-Inst:* communication between students and instructor (7)

3 *Under-Peer:* understanding between peers (6)

4 *Under-Inst*: understanding between students and instructor (7)

5 *Collab-Att:* student's attitude toward collaborative learning (5)

6 *Satisfaction*: student satisfaction with the course structure, the instructor, their peers, and their ability to use their skills in the course (8).

The Coll-TD questionnaire content was validated by three experts in educational technologies. The researchers (Wengrowicz et al., 2014) reported a high value of combined Cronbach α reliability (0.89) with a high level of inter-correlation between factors. These results have indicated internal construct validity of this instrument. In addition, comparison between groups as well as correlations of the TD factors and other student outcomes has indicated more construct and content validity evidence. As a whole, these reliability and validity results provide ample assurances that this tool can be trusted and adapted outside their immediate context of study.

2.4.2 Developing the flipped classroom group collaboration TD questionnaire

The flipped learning IGL approach used in OMGT 3223 is different from the collaboration scenario used for the VISIONAIR study. The main difference in our approach lies in the fact that collaboration takes place at two levels:

1 during each of the in-class meetings, at which time the instructor is present and acts as a learning, or cognitive, coach in the specially designed IGL classroom

2 during the exams, when groups do not have access to the instructor, they collaborate as a group to solve the take home exam problems prior to taking the individual in class exam.

To account for those differences, a new instrument had to be developed.

In the new instrument, the Coll-TD factor *Com-Peer* was replaced by two separate sub-factors: C*om-Peer-H* which describes the student's subjective feeling regarding their ability to communicate with their peers and their peers with them while working on the take home exams; and, C*om-Peer-IC* which describes the student's subjective feeling regarding their ability to communicate with their peers and their peers with them while working on the in-class collaborative problems. Similarly, the Coll-TD factor *Under-Peer* was replaced by two separate sub-factors: *Under-Peer-H* which describes the student's subjective feelings regarding their ability to explain themselves using a technology-based learning environment and their ability to know whether others understood them while working on the take home exams; and, *Under-Peer-IC* which describes the student's subjective feelings regarding their ability to explain themselves using a technology-based learning environment and their ability to know whether others understood them while working on the in-class collaborative problems.

For each of the above new sub-factors, an appropriate number of questions were developed. These replicated the original factor's questions and modified them to account for the different location of each sub-factor (home vs. in-class). The new questionnaire, referred to as Coll-TD/F, was developed for the IGL component of flipped learning. The eight collaborative TD factors for the flipped classroom are made up of four main-factors (*Comm; Under; Collab-Att; and Satisfaction*), two different human reference points for learning (instructor; peers), and two different collaborative learning locations (home; in-class) The 46 closed end questions corresponding to these factors are summarised in Appendix. The complete questionnaire also contained questions pertaining to student demographics, such as student gender (female/male), student section (Fall 2013/Spring 2014) and student work (no/part-time job/full-time job), as well as their perceptions about the hybrid classroom, group size, and relative contribution of individual group members to the various collaborative assignments.

3 Findings

In this section, we will describe the changes we made for adjusting an existing measurement instrument to our flipped pedagogy environment. We also explore in detail the validation process of this instrument including exploratory factor analyses (EFA) with varimax rotation and confirmatory factor analysis (CFA) using Structural Equation Modelling (SEM). We then use the results of Stepwise Linear Regression to determine which TD factors can serve as predictors of student satisfaction, including a discussion of the meaning and possible implications of these findings.

3.1 Validating the Coll-TD/F instrument

The Coll-TD/F questionnaire developed above was administered to both sections during both semesters and 84 valid responses were collected. Demographic details of the respondents by section are listed in Table 1. To determine whether the responses of both sections could be combined into one group we conducted a one way MANOVA in which the dependent variables were the dimensions defined by the Coll-TD/F instrument and the independent variable was which semester the student took the course. The results indicated that there was no significant difference in the Coll-TD/F dimensions between the two semesters, $F(8,75) = 1.53$, $p>.05$, $\eta^2 = .14$.

Table 1 Distribution of female and working students by course section

	N	*Female*		*Working*	
		n	*%*	*n*	*%*
SEC1	22	8	36.4	12	54.5
SEC2	23	6	26.1	10	43.5
SEC3	19	6	31.6	11	57.9
SEC4	20	4	20.0	10	50.0
Total	*84*	*24*	*28.6*	*43*	*51.2*

Students were asked to respond to each of the 46 questions listed in Appendix on a five point Likert scale (1 = strongly disagree, 5 = strongly agree). The student responses for each question under each Coll-TD/Ffactor were averaged. A high score is considered good and implies a low TD. The lower the TD, the less of a barrier that factor is to learning.

The data was analysed using SPSS and its add-on module – AMOS as well as R. The internal consistency coefficient was calculated for the 46 items of the Coll-TD/Fquestionnaire as well as for each one of the eight factors individually. The results are exhibited in Table 2. Both Cronbach's α and McDonald's ω were used too estimate reliability. Zinbarg et al. (2005) concluded that Cronbach's α is a lower bound to reliability. They suggested calculating the McDonald's ω in addition in cases of multidimensional scale with unequal general factor loadings. Both α and ω had the value of 0.98, indicating a high degree of reliability for the Coll-TD/F questionnaire.

Table 2 Flipped classroom Coll-TD/F factors and internal consistency coefficients

TD factor	*Description*	*# of questions in questionnaire*	*Cronbach's α*	*McDonald's ω*
Com-Peer-IC	Communication between peers during in-class collaboration	5	0.94	.94
Com-Peer-H	Communication between peers during take home exam collaboration	5	0.91	.91
Com-Inst	Communication between students and instructor	8	0.93	.93
Under-Peer-IC	Understanding between peers during in-class collaboration	5	0.93	.93
Under-Peer-H	Understanding between peers during take home exam collaboration	5	0.95	.95
Under-Inst	Understanding between students and instructor	5	0.93	.93
Collab-Att	Student's feeling toward collaborative learning	5	0.89	.90
Satisfaction	Student satisfaction with course structure, the instructor	8	0.92	.92
All factors	All questions	46	0.98	.98

Table 3 EFA findings for the main factor-Comm

Com sub-factor I: Com-Peer, explained common variance – 40.66%		
	I	*II*
Q11_3	.865	.244
Q11_1	.865	.289
Q8_2	.860	.292
Q11_2	.852	.276
Q8_3	.835	.228
Q8_4	.826	.353
Q8_1	.809	.302
Q11_4	.806	.341
Q9	.724	.406
Q6	.589	.252
Com sub-factor II: Com-Inst, explained common variance – 31.12%		
	I	*II*
Q5_2	.249	.850
Q5_3	.265	.843
Q5_5	.280	.784
Q5_7	.309	.771
Q3	.156	.766
Q5_6	.381	.752
Q5_1	.366	.749
Q5_4	.439	.576

Note: Without limiting the number of sub-factors

Table 4 EFA findings for the main factor-*Under*

Under sub-factor I: Under-Peer, explained common variance – 43.94%		
	I	*II*
Q13_2	.879	.274
Q13_3	.860	.209
Q13_1	.817	.360
Q13_4	.814	.325
Q13_5	.806	.422
Q12_2	.733	.425
Q12_4	.697	.500
Q12_1	.694	.564
Q12_3	.684	.428
Q12_5	.664	.616

Note: Without limiting the number of sub-factors

Table 4 EFA findings for the main factor-*Under* (continued)

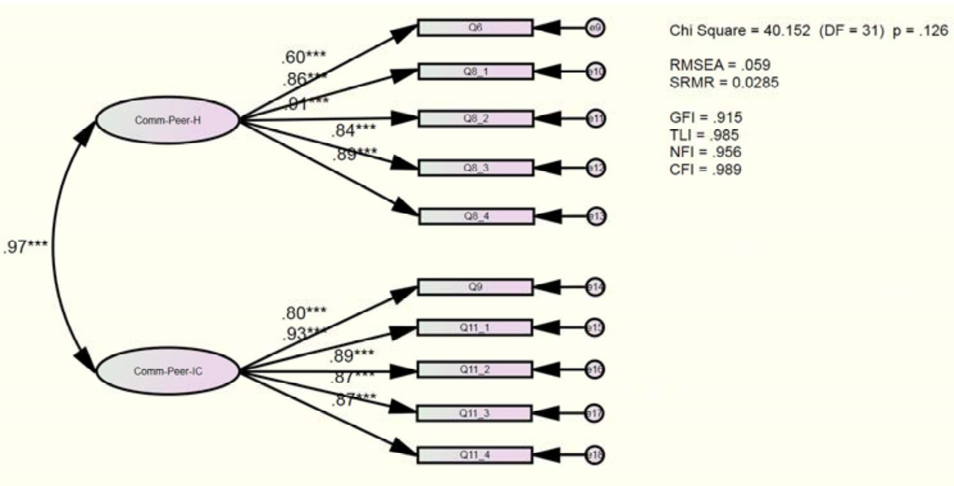
Com sub-factor II: Under-Inst, explained common variance – 33.80%		
	I	*II*
Q12_7	.278	.854
Q12_6	.298	.848
Q12_9	.298	.840
Q12_10	.401	.749
Q12_8	.518	.714
Q12_7	.278	.854
Q12_6	.298	.848
Q12_9	.298	.840

Note: Without limiting the number of sub-factors

EFA with Varimax rotation (without limiting the number of factors) were performed for the two main Coll-TD/F factors – *comm*and *under* – that were changed in this study in order to examine their construct validity after the adjustment of our research tool to flipped learning. The analysis of the *Comm* factor indicated two distinct content worlds that match the original Coll-TD questionnaire dimensions: *Com-Inst* and *Com-Peer* and the cumulative percentage of explained variance was 71.78%. Table 3 presents these EFA findings.

The analysis of the *Under* factor also indicated two distinct content worlds that match the original Coll-TD questionnaire dimensions: *Under-Inst* and *Under-Peer* and the cumulative percentage of explained variance was 77.74%. Table 4 presents these EFA findings.

Figure 3 *Com-peer* measurement model validation – CFA findings (see online version for colours)

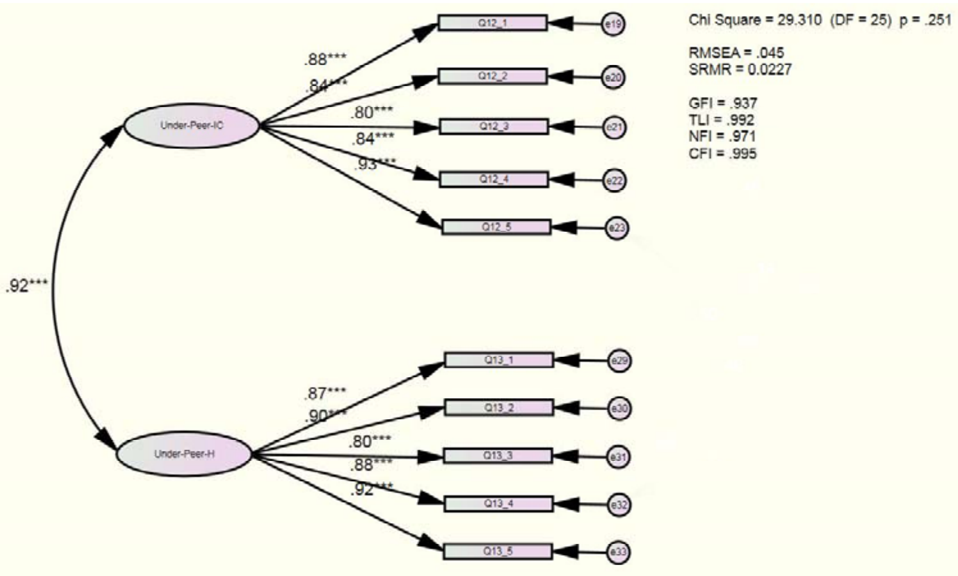


Following the EFA, we conducted CFA in order to validate our measurement model. The questions of the *Com-Peer* factor were grouped into two distinct content domains: *Com-Peer-IC* and *Com-Peer-H*. This measurement model was constructed by using SPSS-AMOS with which we conducted the CFA.

The results are presented in Figure 3 and indicate a good fit ($\chi^2(31) = 40.15$; p = .13; RMSEA = .06; SRMR = .03; GFI = .91; TLI = .98; NFI = .96; CFI = .99) between the model and the observed data (Schreiber et al., 2006).For each subscale, composite reliability (CR) exceeded .90, well above the benchmark of .70 (Fornell and Larcker, 1981). Validity was assessed by calculating, for each subscale, the average variance extracted (AVE: .69 for *Com-Peer-H,* .76 *for Com-Peer-IC*), average shared variance (ASV: .94 for both subscales), and maximum shared variance (MSV: .94 for both subscales). The standardised loadings of all items were equal to or greater than .60, the MSV and ASV both exceeded the AVE (Hair et al., 2010), and the AVE for each subscale exceeded .65, well above the benchmark of .50 for establishing convergent validity (Fornell and Larcker, 1981).

Similarly, the measurement model of the *Under-Peer* factor that was divided into two distinct content domains – *Under-Peer-H*and *Under-Peer-IC* – is presented in Figure 4 and also indicates a good fit ($\chi^2(25) = 29.31$; p = .25; RMSEA = .04; SRMR = .02; GFI = .94; TLI = .99; NFI = .97; CFI = .99) between the model and the observed data (Schreiber et al., 2006). For each subscale, CR exceeded .90. AVE was .77 for *Under-Peer-H*, and.74 for *Under-Peer-IC*; ASV was .85 for both subscales, and MSV was .85 for both subscales. The standardised loadings of all items were equal to or greater than .80, the MSV and ASV both exceeded the AVE, and the AVE for each subscale exceeded .65.

Figure 4 *Under-peer* measurement model validation – CFA findings (see online version for colours)



These EFA and CFA results provide solid evidence for the Coll-TD/F construct validity while supporting our measurement model with an emphasis on the factors that were adjusted to the flipped learning.

4 Predictors of student satisfaction

The purpose of this study and its Coll-TD/F instrument definition and validation was to enable us to determine which of the seven Coll-TD/F factors and student demographics are significant predictors of student satisfaction, which is the eighth Coll-TD/Ffactor, and to evaluate the relative contribution of each.

Satisfaction was significantly correlated (p < .001) with each of the other seven subscales, with values of Pearson r ranging from .616 to .880. Stepwise multiple regressions were used to create a reduced model for predicting satisfaction.

The independent variables included personal attributes (*gender, section, work)* and the seven out of eight Coll-TD/Ffactors (*Comm-Inst, Comm-Peer-H, Comm-Peer-IC, Under-Inst, Under-Peer-H, Under-Peer-IC, Collab-Att*). The findings of the regression are presented in Table 5.

Table 5 Stepwise regression results for predicting student satisfaction in the flipped classroom

	Step I				*Step II*				*Step III*			
	b	*Std. err.*	*B*	*t*	*b*	*Std. err.*	*B*	*t*	*b*	*Std. err.*	*B*	*t*
Comm-Inst	0.85	0.05	0.88	16.77***	0.53	0.07	0.55	7.77***	0.51	0.07	0.53	7.71***
Under-Inst					0.42	0.07	0.42	5.96***	0.36	0.07	0.36	4.91***
Collab-Att									0.14	0.05	0.14	2.57**
R	0.88***				0.92***				0.93***			
R^2	0.78				0.84				0.86			
F	281.78***				217.89***				157.52***			
df-regression	1				2				3			
df-residual	82				81				80			

Notes: **p < 0.5; ***p < .001

The results presented in Table 5show the results from the stepwise linear regression. In the third and last step, the factor representing the student's collaboration attitude (*Collab-Att*) was entered after the previous two (*Comm-Inst,Under-Inst*).The percent of explained variance was 86% and the regression equation reached statistical significance, $F(3,80) = 157.5$, $p < .001$. According to the standardised regression coefficients (β), the factor *Comm-Inst*β = .53, $p < .001$ and the factor *Under-Inst*β = .36, $p < .001$ made positive and significant unique contributions to explaining the variance in satisfaction. As with the two previous factors, the student's collaboration attitude (*Collab-Att*) factor also made a positive and significant unique contribution to explaining the satisfaction variance $\beta = .14$, $p < .001$. It should be noted that the failure of the remaining subscales to enter the stepwise model is due to their being redundant with those which did enter. As noted earlier, every one of the subscales was significantly correlated with satisfaction.

The results of the stepwise regression shown in Table 5 indicate that one unit of improvement in *Comm-Inst* will increase student satisfaction, on the average, by 0.51 units, one unit of improvement in *Under-Inst* will increase student satisfaction, on the average, by 0.36 units, and one unit of improvement in *Collab-Att* will increase student satisfaction, on the average, by 0.14 units. Thus, of the seven Coll-TD/F factors, only three had sufficiently large unique associations with satisfaction to make it into the stepwise model: *Comm-Inst*, *Under-Inst*, and *Collab-Att*. The first two refer specifically to the communication and understanding between the student groups and the instructor while the third refers to the attitude the student has toward learning in a collaborative learning environment such as the flipped classroom.

5 Discussion

Having *Comm-Inst* and *Under-Inst* emerge as statistically significant unique predictors of student satisfaction appears to reaffirm the importance of the instructor as one of the unifying themes, or pillars, upon which successful flipped classrooms are built (Hamdan et al., 2013). The fact that these two factors did emerge as statistically significant unique predictors of student satisfaction may be explained by how we implemented flipped learning. During the in-class sessions, student teams grapple with a non-trivial problem that requires that they understand the material covered in the video lecture that they were supposed to have viewed in preparation for the in-class session. Getting started on the problem is the first hurdle that they face. Once they have started, it is not uncommon for students to reach what they perceive as a dead end. Both the start-up phase of the in-class activities as well as being extricated from a dead end approach often prompts student teams to call for help from the instructor who, in flipped learning, functions as a combination of roaming learning coach and consultant (Selingo, 2013; Bolton, 1999). The OMGT 3223 classes that were the subject of this study had either five or six teams. When several of these teams compete for access to the instructor at the same time, frustration sets in for those teams that must wait. When a team gains access to the instructor, they often just want to know what to do next and are not inclined to want to listen to why. When the instructor tries to explain the reasons behind what they should do next, frustration can also set in. The need for instructor's prompt feedback and guidance in flipped classes was one of the major conclusions of another flipped classroom study (Kim et al., 2014). Being able to support students' different needs while managing the competing demands of student teams for time and having them listen to what to do next as well as to the why is one of the major challenges faced by an instructor in the flipped classroom.

Having *Collab-Att*emerge as a statistically significant unique predictor of student satisfaction was not particularly surprising. This factor addresses the student's perception of the new learning culture inherent in the flipped classroom which is characterised by a deliberate shift from a teacher-centred classroom to a student centred approach. Students who liked the collaborative learning experience were more satisfied with the course. The result is important, in that it appears to support the notion that learning culture is one of the unifying themes, or pillars, upon which successful flipped classrooms are built (Hamdan et al., 2013). The importance of learning culture in attaining satisfaction in flipped classrooms has been demonstrated also in Chen et al. (2014) study. Their findings, which reinforce our *Collab-Att* findings, indicated that the achievements and course satisfaction of students who still had difficulty adopting new approaches because of their traditional passive learning habits were significantly low.

We were surprised that no form of peer to peer collaboration, whether communication between peers (*Comm-Peer-IC*, *Comm-Peer-H*) or understanding between peers (*Under-Peer-IC, Under-Peer-H*) was a statistically significant unique predictor of student satisfaction with the in class component of flipped learning. Our data indicated that there was high correlation between the in-class and take home exam factors: The two variables *Comm-Peer-IC* and *Comm-Peer-H*) were strongly correlated with satisfaction ($r = .71$ and $.68$, respectively) and very highly related to each other, $r = 0.91$ ($p < 0.01$).The intercorrelation between these two predictors doubtlessly contributed to the redundancy that prevented them from entering the stepwise model. Likewise, *Under-Peer-IC* and*Under-Peer-H*were well correlated with satisfaction ($r = .76$ and $.62$) and highly correlated with each other, $r = 0.85$ ($p < 0.01$).

Although we understood the statistical explanation that these factors did not enter the stepwise model due to simple redundancy, we wanted to explain the results since they were surprising to us. It would appear to us that good peer-peer relationships in class would extend to out of class and vice versa. We concluded that the in-class factors for both of these did not emerge as significant because we observed that when a student team gets ‘stuck’, their immediate response is to seek help from the instructor. It is possible that they saw the role of the instructor as getting them out of trouble instead of placing greater reliance on their peers to work collaboratively through the tough spots. An observed behaviour during the take home exams was that the groups tended to divide the problem among themselves so that each individual or pair of individuals took responsibility for a particular problem and then shared the results with the other group members, thus circumventing the essence of teamwork and true collaboration (Lobato et al., 2010). Hence, peer communication and understanding did not take place to the extent anticipated by the instructor.

The above discussed insignificant peer-related predictors to satisfaction as well as significant instructor –related predictors are consistent with the findings of Kim et al. (2014) which emphasise the instructor’s role as an initiator and facilitator for building a good community and collaborative learning culture.

6 Conclusions

This research has identified three success factors (Lee-Post, 2007), that are statistically significant and unique predictors of student satisfaction. These factors can be viewed as teacher centric and student-centric processes that can be managed in a similar manner as described Vanteddu and Somarajan (2012) by instructors seeking to continuously improve student satisfaction in their courses. Whereas the latter focused their efforts on the continuous improvement of objective measures of student learning, we propose that the a system to continuously improve student satisfaction will simultaneously produce more satisfied students which will help instructors better manage the learning of their students and yield greater student persistence which will help administrators in their efforts to increase retention (and institutional revenues).

Although the results of this one study cannot be considered as conclusive for all cases, the results obtained reinforce Hamdan et al.’s (2013) finding that two of the ‘pillars’ for creating a successful flipped classroom are the instructor and the learning culture. They also reinforce Bolton (1999) and Selingo's (2013) findings that flipped classroom instructors must have more skills than just delivering content. They must also be able to be effective learning coaches that initiate, facilitate and encourage a collaborative learning culture. They must be able to determine when and how to shift direct instruction from the entire class to individual groups and how to maximise the face-to-face time between teachers and students. During class time, instructors must continually observe their students, provide them with feedback relevant in the moment, encourage them to work together, share their opinions and continually assess their work. Hence, providing instructors who will be adopting the flipped classroom for the first time with focused and structured training will help to assure a positive experience for faculty and students alike.

As Wengrowicz (2014) concluded, the way to instil pedagogical change in technology-based environments is through redefining the instructor's role and assisting them to obtain the required skills to be effective in the new environment. Educational technology is a major engine of change and instructors must assume the role of change agents. Their success in this acquired new role will depend on their ability to make productive use of these technologies by developing appropriate pedagogies for students to achieve valid learning goals.

The results indicate that the student's attitude toward problem-based collaborative learning environment is significantly correlated with student satisfaction. One of the benefits of context-based collaborative learning is to prepare students for the emphasis given to teamwork in the real world. Bolton (1999) reports that 72% of business school instructors at her university assign students to project teams in at least one of their classes. However, 81% of faculty gave modest, limited, or no support to students assigned to teams. Her findings indicate that 94% of faculty were at least somewhat satisfied with student teams in their class, compared to only 64% of the students. From this, we can conclude that providing students with in-class team building training can provide significant improvement in student satisfaction. This training can only come at the expense of taking time away from students' learning content. However, Bolton (1999) reports success in achieving significant improvements in student satisfaction from team building activities that require less than five hours of in-class time spread out over the entire semester.

The flipped classroom has been touted as an exciting new topic in technology-based educational research. Our research indicates that the success of the IGL component of the flipped classroom, as measured by perceived student satisfaction and learning, does not depend on the TDs between students. Instead, it is solely dependent on the TDs between the students and the instructor *and* the attitude of students toward IGL activities. Consequently, instructors must have the desire and be given the opportunity to understand and embrace active learning pedagogies that will allow them to become effective 'learning (or cognitive) coaches'. Similarly, students should be taught how to effectively collaborate in teams as they become exposed to the growing trend toward active learning. With proper preparation of faculty and students, the flipped classroom can deliver on its many promises.

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Appendix

Coll-TD/F factors and questions

QUESTION #	COMMUNICATION WITH THE INSTRUCTOR *Comm-Inst*
Q3	As compared to a traditional lecture course, I had more interaction with the instructor in this course
Q5_1	I have enough ways to communicate with the instructor
Q5_2	The communication with the instructor significantly contributed to my learning in this class
Q5_3	It is easy to communicate with the instructor in class
Q5_4	It is easy to communicate with the instructor over the internet
Q5_7	The frequency of communication with the instructor reflects my needs in this course
Q5_5	The classroom layout enabled the instructor to be available to the group
Q5_6	The classroom layout allowed the instructor to monitor our progress on the in class collaboration problems
	COMMUNICATIONS WITH PEERS DURING TAKE HOME EXAMS ***Com-Peer-H***
Q6	I communicated with group members as part of our collaboration while working on the TAKE HOME exams
Q8_1	Our team members have enough ways to communicate with each other
Q8_2	The communication between us significantly contributed to the quality of our submission
Q8_3	The frequency of communication between us reflects our need for completing the take home exams
Q8_4	It is easy to collaborate given the available resources (internet, study rooms, etc.)
	COMMUNICATION WITH PEERS IN CLASS ***Com-Peer-IC***
Q9	I communicate with group members as part of our collaboration while working on the daily IN CLASS group activities
Q11_1	Our team members have enough ways to communicate with each other
Q11_2	The communication between us significantly contributed to the quality of our submission
Q11_3	The frequency of communication between us reflects our need for completing the in class group problems
Q11_4	It is easy to collaborate given the available resources in the hybrid classroom
	UNDERSTANDING WITH PEERS IN CLASS ***Under-Peer-IC***
Q12_1	I could explain myself to my peers while working together on the IN CLASS group activities
Q12_2	After giving an explanation to my peers while working on the IN CLASS group activities, I knew whether they understood me
Q12_3	After giving an explanation while working on the IN CLASS group activities, I knew whether there was someone who did not understand me
Q12_4	My peers were able to explain themselves while working together on the IN CLASS group activities
Q12_5	My peers were able to identify whether I really understood their explanations during the IN CLASS group activities
	UNDERSTANDING WITH INSTRUCTOR IN CLASS ***Under-Instr***
Q12_6	The instructor was able to answer questions, teach, and explain the course content during the IN CLASS group activities
Q12_7	The instructor was able to identify whether I really understood his explanation during the IN CLASS group activities
Q12_8	I could explain myself to the instructor when it was required during the IN CLASS group activities
Q12_9	After giving an explanation to the instructor during the IN CLASS group activities, I knew whether he understood me
Q12_10	After giving an explanation to the instructor during IN CLASS group activities, I knew whether he didn't understand me
	UNDERSTANDING WITH PEERS TAKE HOME ***Under-Peer-H***
Q13_1	I could explain myself to my peers while working together on the TAKE HOME EXAMS
Q13_2	After giving an explanation to my peers while working on the TAKE HOME EXAMS, I knew whether they understood me
Q13_3	After giving an explanation while working on the TAKE HOME EXAMS, I knew whether there was someone who did not understand me
Q13_4	My peers were able to explain themselves while working together on the TAKE HOME EXAMS
Q13_5	My peers were able to identify whether I really understood their explanations during the TAKE HOME EXAMS
	COLLABORATION ***Collab-Att***
Q14_1	I prefer to work in a group
Q14_2	Working together yields higher quality results than working individually
Q14_3	Collaborative group work enables deeper learning compared to individual work
Q14_4	I learned from some of my peers while working on our assignments
Q14_5	I believe that my contribution to our peer collaboration was significant
	SATISFACTION ***Satisfaction***
Q26_1	I am satisfied with the special structure of the course
Q26_2	I am satisfied with the special layout of the Bate 3012
Q26_3	I am satisfied with my team's IN CLASS collaborative work
Q26_4	I am satisfied with my team's TAKE HOME EXAM collaborative work
Q26_5	I am satisfied with my peers
Q26_6	I am satisfied with the course teaching methods
Q26_7	I am satisfied with the course instructor
Q26_8	I am satisfied with the way my learning is being evaluated in this course