Flipped Learning: An Empirical Study on the Inhibitors of Disruptive Innovation

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Approved by

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Abstract

Many researchers have been highly expecting the change in the traditional education market to flipped learning. Although much previous research has investigated the benefits of flipped learning, expected disruption of teaching and learning practices has not yet come to fruition. Transforming from traditional educating systems to flipped learning mismatches the object of teaching and learning. Moreover, the diffusion of flipped learning is slow in progress and there are some underlying inhibitors of disruptive innovation. This paper aims to explain why flipped learning has not been speedily diffused in terms of disruptive innovation. We will empirically study the main factors – path dependency, perceived efficiency, and perceived risk – that might hinder the diffusion of flipped learning. Also, we will analyze these inhibitors through the survey conducted on students in the university setting. Our findings suggest that students who perceive risk of flipped learning would be path dependent on the traditional lecture, however, students would adopt flipped learning when they perceive its efficiency. Overall, our study would contribute to providing directions of the future education market.

Keywords: disruptive innovation, flipped learning, path dependency, perceived efficiency, perceived risk

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1. Introduction

Many researchers have been highly expecting the change in the traditional education market to flipped learning. The emergence of the Internet and advanced technology has suggested new directions for higher education. Also, increasing tuition fee and free online courses are giving pressure to change the traditional lecture (Bishop & Verleger, 2013). A mismatch between the purpose of teaching and the actual demands in learning has been identified (Blin & Munro, 2008). The teaching practices are required to transform from the traditional lecture style to flipped learning.

Flipped learning strategy restructures the traditional way and allows students to learn the course content outside the classroom for a deeper level of engagement inside the classroom (Strayer, 2012). Lage et al. (2000) simply defines it as “events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa”. Bishop and Verleger (2013) restricted and developed the definition of flipped learning as an educational technique that consists of interactive group learning activities inside and direct individual instruction outside the classroom. We redefine flipped learning as an education that students could gain knowledge through distributed materials and assimilate knowledge through discussions in class. Students could match their learning styles and instructor’s teaching styles (Fry & Kolb, 1979) in the way they learn better by asking questions and helping each other.

Flipped learning is a new educating method that supplements the traditional lecture as it is expected to transform and disrupt the traditional educating practices by integrating innovative instructional strategy (Missildine et al., 2013; Blin & Munro, 2008). It provides a successful new model for teaching and active learning that could be applied to solving the real-world problems (Herreid & Schiller, 2013). Also, flipped learning had a positive effect on students as they enjoyed the lecture and perceived the teaching practices to be more effective and innovative (Zappe et al., 2009). In fact, students spend more time on the course as instructors cover more materials in the flipped learning format than the traditional lecture format. Students were able to demonstrate better performance in individual and group problem solving, quickly adopt the format, and show greater satisfaction (Mason et al., 2013). According to Alvarez (2012), “the flip approach holds the golden key for students because instructors can control and eliminate learning obstacles, and it allows them to present their best and share resources”. Most instructors that use the flipped learning model universally agree that it makes the difference in the way they integrate instructional videos into an overall approach (Tucker, 2012).

Although much previous research has investigated the benefits of flipped learning, expected disruption of teaching and learning practices has not yet come to fruition (Selwyn, 2007; Keller, 2005; Kirkup and Kirkwood, 2005; Tearle, 2003). Transforming from traditional educating practices to flipped learning mismatches the object of teaching and learning as the instructors are lack of proper competencies through explicit training and development program. Moreover, the diffusion of flipped learning is slow in progress due to the doubts about the efficacy of the flipped learning in the scholarly community (Heilesen & Josephsen, 2008). There are some underlying inhibitors of disruptive innovation (Assink, 2006). It was argued that disruption results from the uses made of technology and not from technology itself, and that augmentation must be more than simple remediation for success (Bolter, Grusin, & Grusin, 2000).

This paper aims to explain the reason behind the diffusion of flipped learning in terms of disruptive innovation. The main factors – path dependency, perceived efficiency, and perceived risk – that inhibit the diffusion of flipped learning will be studied. Furthermore, these inhibitors will be analyzed through the survey in the university setting.

2. Theoretical Background and Hypotheses

Flipped Learning

Simply, in the flipped learning model, what is usually done in class and what is usually done as homework is flipped (Herreid & Schiller, 2013). Lage et al. (2000) defines it as the learning events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa. Flipped learning is described as restructuring the traditional way and allowing students to learn the course content outside the classroom for a deeper level of the actual engagement inside the classroom (Strayer, 2012). It could free the class time for more active and problem-based learning activities (Mason et al., 2013). Bishop and Verleger (2013) restricted and developed the definition of flipped learning as an educational technique that consists of interactive group learning activities inside and direct individual instruction outside the classroom. As a new educational method, it delivers video lectures and practice problems to be done at home, and group activities to be actively done in class.

Bergmann and Sams (2010, 2012, 2013) have conceptualized flipped learning as “which is traditionally done in class is now done at home, and which is traditionally done as homework is now completed in class” and implemented the flipped learning model. The concept implies that students watch the recorded lectures outside the classroom, so this may be effective in differentiating students’

learning styles. As students watch the lecture at home and then practice what they have learned in the classroom, they perceive flipped learning as more about how to effectively use in-class time. When instructors implement flipped learning, they mostly begin the lecture with a discussion time to guide and interact with each student. The instructors adopt more of a tutorial role rather than being the presenters of information in the class. The flipped learning model could be successfully implemented only when it is personalized for each of the instructor's teaching styles.

Sams and Bergmann also founded the "Flipped Learning Network" and specified flipped learning as an educational approach where direct instruction is moved from the group to individual learning environment. Ultimately, the learning environment becomes dynamic and interactive where the students apply concepts, actively solve problems, and creatively engage in group interactions with the instructor. Students could watch video lectures as many times as they want to understand the contents and participate in class by answering questions, working on group projects, and deeply exploring the contents.

Therefore, we redefine flipped learning as an education that students could gain knowledge through distributed materials and assimilate knowledge through discussions in class. Students could match their learning styles and instructor's teaching styles (Fry & Kolb, 1979) in the way they learn better by asking questions and helping each other. In fact, flipped learning puts more emphasis on design and problem solving than the traditional education, and improves students' understanding about the course topic (Mason et al., 2013).

Advantages and Disadvantages of Flipped Learning

Implementing flipped learning provides several advantages to both the students and instructors. It provides flexibility with completely restructured and student-centered time, so that students could actively participate in the learning process (Bergmann & Sams, 2010, 2012, 2013). Students could apply their knowledge by solving problems and gaining a deeper understanding about the subject since they have watched the lecture before coming to class (Roehl et al., 2013). This helps students to interact with each other, clear up misconceptions, and gather exact information. Flipped learning also gives instructors the flexibility to meet their students' learning needs. It provides better insight into students' level of interest, achievement, and engagement in learning. Moreover, the instructors could customize and update the course materials to the students right away (Fulton, 2012).

In addition to flexible learning environment, flipped learning creates an opportunity for students to obtain knowledge at their own pace regardless of time and place. Students are more actively engaged

in learning (Herreid & Schiller, 2013) due to free access to the course materials in several different formats and multiple instructors' expertise (Mason et al., 2013; Fulton, 2012). Instructors also flip professional development through other's lectures and learn from each other.

Although there are several advantages in adopting flipped learning, it may not be applied to all the lectures (Roehl et al., 2013). Also, there are some discrepancies regarding the appropriateness of flipped learning model (Mason et al., 2013). Students might resist in doing assignments since they perceive them as extra work (Stone, 2012). Then, they may participate in class without being prepared in advance (Herreid & Schiller, 2013). Strayer (2007) found that students also take uncomfortable responsibility for learning on their own.

For instructors, implementing flipped learning can be time consuming as it requires much work and planning prior to the class (Mason et al., 2013). The instructors should prepare for the lecture and reorganize the course materials in order to have students study for the in-class activities (Stone, 2012; Herreid & Schiller, 2013). However, the instructors argued that it is difficult to find and use video lectures and that preparation requires a significant amount of time and effort (Herreid & Schiller, 2013).

Diffusion of Innovation

According to Rogers (2003), diffusion of new ideas is "the process by which an innovation is communicated through certain channels over time among the members of a social system". The characteristics of innovations – relative advantage, compatibility, complexity, trialability, and observability – that are perceived by individuals of a social system help determine their different rate of adoption. Thus, innovations perceived by individuals with greater relative advantage, compatibility, trialability, observability, and with less complexity would have more rapid rate of adoption than other innovations.

Disruptive Innovation

Based on several definitions of disruptive innovation, Assink (2006) defined it as "a successfully exploited new product, process, or concept that significantly transforms the demand of an existing market, disrupts its former key players, and creates whole new business practices". Two types of disruptive innovation provide customers with less performance but lower prices and greater convenience in the existing marketplace (Christensen et al., 2003). Type I disruption provides

customers a relatively simple product or service to experience what they could not have done due to lack of money or skills. They could compete against non-consumption and establish a whole new market. Type II disruption involves targeting the over-served customers by deploying a lower-cost business model that serves less demanding customers.

Christensen, Aaron, and Clark (2003) argued that disruptive innovation changes the landscape of the education market as many learners have the opportunity to obtain much information. Disruptive business model would improve the underserved and non-consuming quality of innovation. Moreover, learning and teaching through disruption would increase social and economic welfare as people learn at all education levels.

However, there are internal and external inhibitors that hinder disruptive innovation capabilities (Assink, 2006). The nature of the inhibitors would describe the impact they have on the diffusion of flipped learning. The main factors expected to have an effect on the students' intention to adopt flipped learning are path dependency, perceived efficiency, and perceived risk (Figure 1).

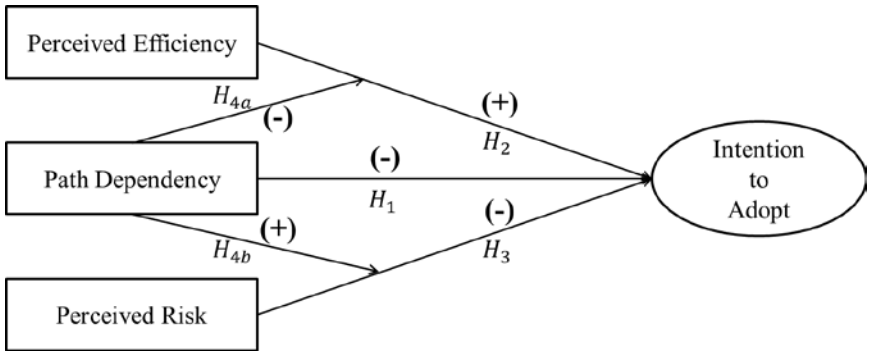


Figure 1. Research Model

Path Dependency

Path dependency is defined as a process where the behavior pattern is based on the prior experiences and cumulative knowledge (Saarenketo et al., 2004). In the knowledge-based view, path dependency drives the exploitation of knowledge and expansion (Hutzschenreuter & Volberda, 2007). In the view of technology adoption, the concept of path dependency is related to the migration across the education market. In this point of view, the incentive of adopting new technology is a function of related experience with prior technology (Zhu et al., 2006). Based on the idea, path dependency studies how students' prior experiences and knowledge affect the adoption of flipped learning.

Students who are more likely to be path dependent on the traditional lecture style have the tendency to not adopt flipped learning, thus we propose:

Hypothesis 1. Path dependency will negatively influence the intention to adopt flipped learning.

Perceived Efficiency

Technology Acceptance Model (TAM), which is the extended version of Theory of Reasoned Action (TRA), identifies the effect of perceived usefulness and perceived ease-of-use on the user attitude towards technology (Davis, 1986). Here, attitude is described as the degree to which the user is interested in the system. Students' attitude toward flipped learning system will directly affect their intention to adopt flipped learning. Students would perceive flipped learning lecture to be more efficient than the traditional lecture when they are interested in the key advantages of flipped learning. Thus, we propose:

Hypothesis 2. Perceived efficiency will positively influence the intention to adopt flipped learning.

Perceived Risk

A mismatch exists even when flipped learning may not be far different from the traditional lecture. The most noticeable mismatch is identified among the students and instructors (Scanlon & Issroff, 2005) regarding the expected quality of flipped learning. Also, a mismatch between the object of the lecture and the actual demand of the students is identified (Blin & Munro, 2008). A mismatch between the instructor's competency and student needs are likely to happen as well (Heilesen & Josephsen, 2008). These gaps would have students perceive uncertainty and risk of the flipped learning lecture, and thus prefer the traditional lecture. Therefore, we propose:

Hypothesis 3. Perceived risk will negatively influence the intention to adopt flipped learning.

Moderating effect of path dependency

Students are path dependent on the traditional lecture style due to its familiarity, comfortability, and less requirement of participating in class (Fitzegarld, 2008). For this reason, flipped learning should be accompanied by the traditional lecture style. If flipped learning just replaces the traditional lecture with no supplements (Missildine et al., 2013), the students would refuse to adopt it even though it has

some advantages. Moreover, students might realize the uncertainty and risk of flipped learning, so they are likely to become path dependent on the traditional lecture. Therefore, we hypothesized as follows:

Hypothesis 4a. Path dependency will negatively moderate the relationship between perceived efficiency and the intention to adopt flipped learning.

Hypothesis 4b. Path dependency will positively moderate the relationship between perceived risk and the intention to adopt flipped learning.

3. Methods

Sample and Data Collection

A survey, targeting the students at UNIST, was conducted to collect data for the study. Survey questionnaires were distributed to 351 students, 199 through online and 152 through offline. Among 351 responses, 34 responses including doubtful and missing values were eliminated, thus leading to ultimate sample size of 317 students. 63.1% of the students were male and 36.9% were female. Students aged from 17 to 20 years were 25.2%, 21 to 25 years were 68.1%, and 26 to 30 years were 6.6%, with the average age of 22 years (SD=2.48). The students majored in various types of departments, the highest percentage of students majored in business administration (34.1%), general studies (12.6%), energy and chemical engineering (12.3%), mechanical and nuclear engineering (11.7%), life sciences (7.3%), design and human engineering (6.0%), natural science (5.4%), electrical and computer engineering (4.7%), materials science and engineering (3.2%), and urban and environmental engineering (2.8%) departments. Most students had attended approximately one to three flipped learning lectures (38.5%) and four to six lectures (35.3%). Detailed information of the descriptive statistics is shown in Table 1.

Table 1. Descriptive Statistics of Demographic Variables

Measures	Items	Frequency	Percentage
Gender	Male	200	63.1%
	Female	117	36.9%
Age	17-20 years	80	25.2%
	21-25 years	216	68.1%
	26-30 years	21	6.6%
Department	General Studies	40	12.6%
	Mechanical and Nuclear Engineering	37	11.7%
	Urban and Environmental Engineering	9	2.8%
	Design and Human Engineering	19	6.0%
	Materials Science and Engineering	10	3.2%
	Energy and Chemical Engineering	39	12.3%
	Electrical and Computer Engineering	15	4.7%
	Life Sciences	23	7.3%
	Natural Science	17	5.4%
	Business Administration	108	34.1%
The Number of Flipped Learning Lectures	0 lecture	12	3.8%
	1 to 3 lecture(s)	122	38.5%
	4 to 6 lectures	112	35.3%
	7 to 9 lectures	34	10.7%
	more than 10 lectures	37	11.7%

Measures

The questionnaire items include path dependency, perceived efficiency, perceived risk, and intention to adoption. From the conceptual model of disruptive innovation inhibitors (Assink, 2006), adoption barrier was introduced to generate the questionnaire items for intention to adoption and path dependency, mindset barrier for perceived efficiency, and risk barrier for perceived risk each. Then, we modified the questionnaires in terms of the flipped learning context. All questionnaires were translated into Korean for the survey and back to English in order to recheck the accuracy of translation. A 5-point Likert scale was used for all questionnaires where 1=strongly disagree to

5=strongly agree. The items for perceived efficiency and intention to adoption were reverse coded as their large values indicated small values of each construct (DeCoster & Claypool, 2004). We tested reliability through SPSS and Cronbach's alpha coefficient for each factor showed acceptable reliability values (Table 2).

Table 2. Cronbach's Alpha

Path Dependency	Perceived Efficiency	Perceived Risk	Intention to Adopt
.725	.679	.554	.906

By using LISREL, we performed confirmatory factor analysis (CFA) to examine the validity of factor model with several fit indices. The chi-square statistic was used to evaluate the adequacy of the model fit. The ratio of chi-square divided by the degree of freedom should be smaller than three (Carmines & McIver, 1981) and the value for our model was 2.3 ($\chi^2/df = 2.3$; where $\chi^2=66.97$, $df=29$), thus indicating an acceptable model fit. Root Mean Square Error of Approximation (RMSEA) value should be under .08 for a better fit (Browne & Cudeck, 1993) and our model (RMSEA = .066) was indicated to be acceptable. The value of Comparative Fit Index (CFI), Goodness of Fit Index (GFI), and Adjusted Goodness of Fit Index (AGFI) are acceptable only when the value is over .90 (Bagozzi & Yi, 1988). These three indices met the acceptable fit level with the value of CFI = .98, GFI = .96, and AGFI = .92.

Control variables

Control variables that may influence the intention to flipped learning adoption were included. We controlled for two demographic variables in order to examine the relationship between the independent variables (path dependency, perceived efficiency, and perceived risk) and dependent variable (intention to adopt) through linear regression analysis. Gender was measured as 1 = male and 2 = female. The number of flipped learning lectures students had attended was measured as 2 = 1~3 lectures, 5 = 4~6 lectures, 8 = 7~9 lectures, and 10 = more than 10 lectures.

4. Results

Correlations between the intention to adopt flipped learning and other variables are shown in Table 3. Path dependency is negatively correlated to the intentions to adopt flipped learning ($r=-.347$, $p<0.01$). Also, both perceived efficiency and perceived risk have positive correlations with the intentions to adopt flipped learning ($r=.929$, $p<0.01$ for perceived efficiency; $r=.146$, $p<0.01$ for perceived risk). Correlations between path dependency and perceived efficiency is negative ($r=-.283$, $p<0.01$), whereas path dependency and perceived risk is positive ($r=.195$, $p<0.01$).

Table 3. Correlation of the Variables

Variable	Mean	Standard Deviation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Intention to Adopt	0	1	1							
(2) Gender	1.37	.48	.041	1						
(3) Age	22.39	2.48	.036	-.020	1					
(4) Department	6.38	3.42	.058	-.001	.469**	1				
(5) FL Lecture	4.55	2.86	.001	.085	.021	.063	1			
(6) Path Dependency	0	1	-.347**	-.004	-.066	-.058	.036	1		
(7) Perceived Efficiency	0	1	.929**	.026	.003	.026	.024	-.283**	1	
(8) Perceived Risk	0	1	.146**	.063	-.041	.040	.043	.195**	.236**	1

N=317; **p<0.01 (two-tailed significance level)

We have performed linear regression analysis (Table 4) with SPSS to analyze the proposed hypotheses. Before doing so, we centered the variables through LISREL before using them as the interaction terms of the moderating effect (Model 3). Model 3 included two moderating variables by multiplying, path dependency and perceived efficiency, and path dependency and perceived risk, respectively. Model 2 included the independent variables of path dependency, perceived efficiency, and perceived risk, and Model 1 contained control variables of gender and the number of flipped learning lectures.

Table 4. Linear Regression Analysis Results

Variable	Model 1	Model 2	Model 3
Gender	.042	.022	.019
FL Lecture	-.002	-.018	-.017
Path Dependency		-.074**	-.066**
Perceived Efficiency		.921***	.933***
Perceived Risk		-.057**	-.047*
Path Dependency×Perceived Efficiency			.003
Path Dependency×Perceived Risk			.059**
F	.271	430.071***	314.305***
R^2	.002	.874	.877
Adjusted R^2	-.005	.872	.874
R^2 Change	.002	.872	.003

N=317; * p<0.1, **p<0.01, ***p<0.001 (two-tailed significance level)

We were able to identify how data fits the statistical model from the F and R^2 value, thus only the first model did not fit to the data. Also, control variables had no significant effect across all the models. Model 2 indicated negatively significant coefficients of path dependency (β=-.074, $p<0.01$) and perceived risk (β=-.057, $p<0.01$) for the intention to adopt flipped learning. These support both hypothesis 1 and 3 because negative relationship was anticipated. Also, perceived efficiency had positively significant coefficient for the intention to adopt flipped learning (β=.921, $p<0.001$), supporting hypothesis 2. By adding the moderators in Model 3, R^2 change has increased with the significance level of .019 ($p<0.1$). Therefore, the moderating effects of path dependency on the relationship between perceived efficiency and the intention to adopt flipped learning, as well as perceived risk and the intention to adopt flipped learning, were examined. The interaction of path dependency and perceived efficiency (Figure 2) showed a positive, but no significant effect on the intention to adopt flipped learning, so it does not support hypothesis 4a. The interaction for path dependency and perceived risk (Figure 3) showed a positively significant influence on the intention to adopt flipped learning (β=.059, $p<0.01$). This implies that the students who perceive risk tend to be path dependent on the traditional lecture, so they are more likely to not adopt flipped learning. Thus, hypothesis 4b is supported.

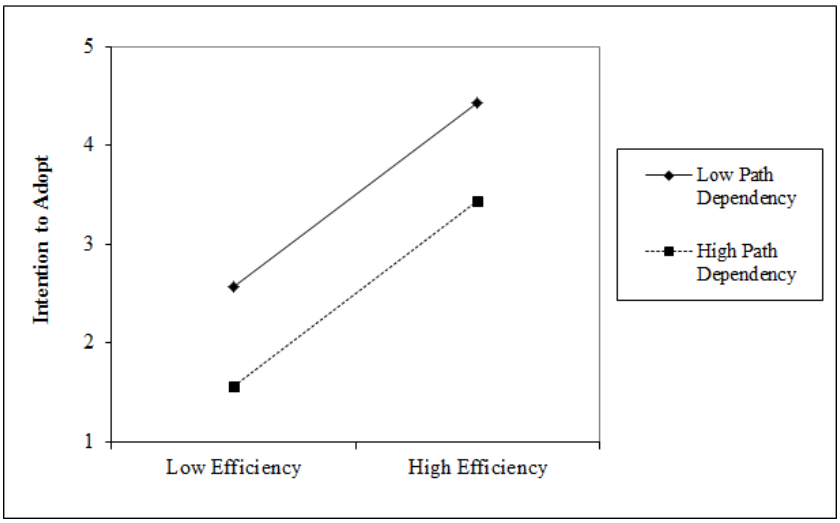


Figure 2. Interaction (Path Dependency×Perceived Efficiency)

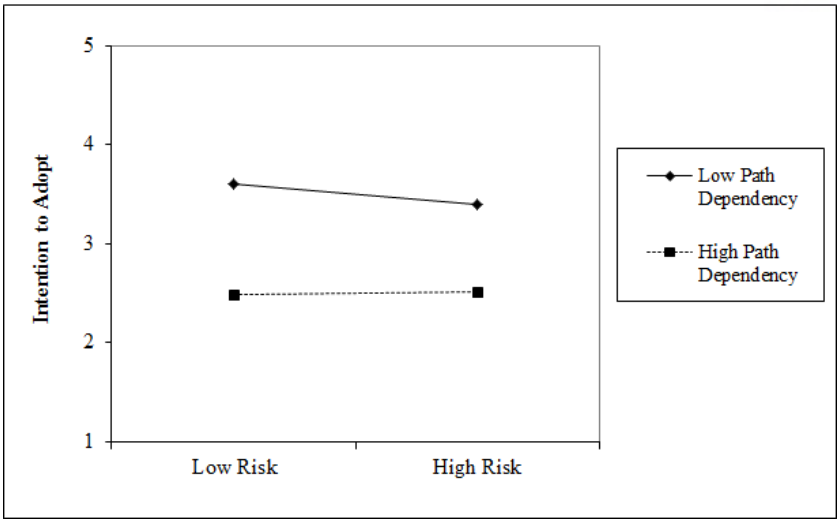


Figure 3. Interaction (Path Dependency×Perceived Risk)

All the results for the hypotheses test are summarized in Table 5.

Table 5. Hypotheses Test Results

	Hypotheses	Supported?
H_1	Path dependency will negatively influence the intention to adopt flipped learning.	yes
H_2	Perceived efficiency will positively influence the intention to adopt flipped learning.	yes
H_3	Perceived risk will negatively influence the intention to adopt flipped learning.	yes
H_{4a}	Path dependency will negatively moderate the relationship between perceived efficiency and the intention to adopt flipped learning.	no
H_{4b}	Path dependency will positively moderate the relationship between perceived risk and the intention to adopt flipped learning.	yes

5. Discussion

Due to the expectation in the education market to change from traditional lecture format to flipped learning, previous research have investigated on the advantages of flipped learning. However, the expected disruption in the educating practices has not yet come to fruition. Our study seeks to find the inhibitors – path dependency, perceived efficiency, and perceived risk – behind the diffusion of flipped learning in terms of disruptive innovation.

We have hypothesized that path dependency and perceived risk will have negative influence on the intention to adopt flipped learning, and perceived efficiency will have a positive effect. The results provided intriguing evidences. There was a negative influence for each path dependency and perceived risk on the intention to adopt flipped learning as we have expected. On the other hand, the influence of perceived efficiency on the intention to adopt flipped learning showed a positive direction. To conclude, the evidences imply that students who perceived risk would not prefer to adopt flipped learning. Also, they would not adopt flipped learning when they are path dependent on the traditional lecture. However, students would adopt flipped learning when they perceived its efficiency.

In order to examine the interactions among path dependency, perceived efficiency, and perceived risk, we further examined the moderating role of path dependency. The interaction between path dependency and perceived efficiency did not support hypothesis 4a. On the other hand, the interaction between path dependency and perceived risk resulted in the same direction as our expectation, thus supported hypothesis 4b. Although hypothesis 4b was supported to have positively moderating effect, it seems to strengthen the negative relationship between perceived risk and the intention to adoption. In other words, path dependency seems to have a moderating impact of strengthening the slope's direction.

In terms of perceived risk, the survey items measured course satisfaction according to the professor or teaching assistant's ability and the course's characteristics. Thus, high risk indicates the difference of course satisfaction between the traditional lecture and flipped learning, and low risk indicates less difference. When students perceive low risk of flipped learning, they do not realize the difference between the traditional lecture and flipped learning because they are just not interested in the educational method.

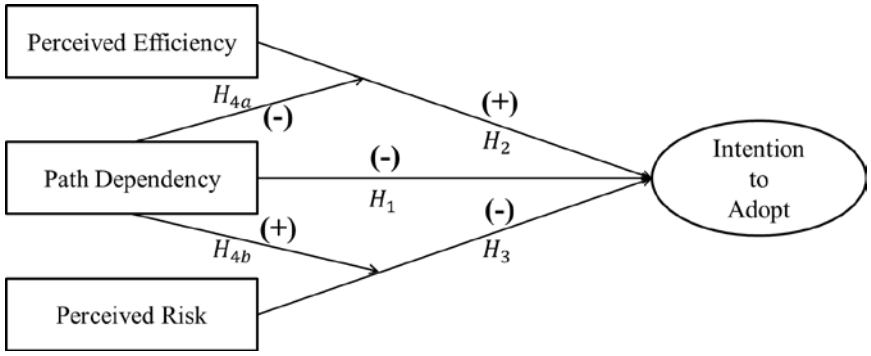
There are several limitations to this study. First, the samples were obtained from the university setting only at UNIST. We were not able to generalize the results regarding other universities. Further research should be conducted on more universities where flipped learning lecture format is adopted. Second, the appropriateness of flipped learning differs for the course types and levels (Mason et al., 2013) as well as the departments where individual students belong to. We have assessed all the

variables on the individual level. For a better result, however, individual responses should be aggregated to the department level so that researchers will be able to investigate the variance between each department groups. Finally, the measurement items of perceived risk may not be sufficient enough to measure the students' satisfaction towards flipped learning. Although the same education format is delivered to students, they receive it in a different way (Sams & Bergmann, 2013), thus the degree to which students perceive risk will vary. More questionnaire items that measure risk regarding students' competency should be included in the future research.

Strategy for better adoption of flipped learning is to guide the students with much information so that they would understand how flipped learning is effective and helpful. According to Stone (2012), students need to be informed about the flipped learning structure of the course before the semester begins. Also, they should be informed about the outcome of their efforts at the end of the semester so that they could compare it with the traditional lecture style. When the traditional lectures are supplemented by flipped learning, it would integrate innovative educating strategies and the lecture would become more productive (Missildine et al., 2013; Berret, 2012).

APPENDIX A

Research Model



APPENDIX B

Descriptive Statistics of Demographic Variables

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APPENDIX C

Cronbach's Alpha

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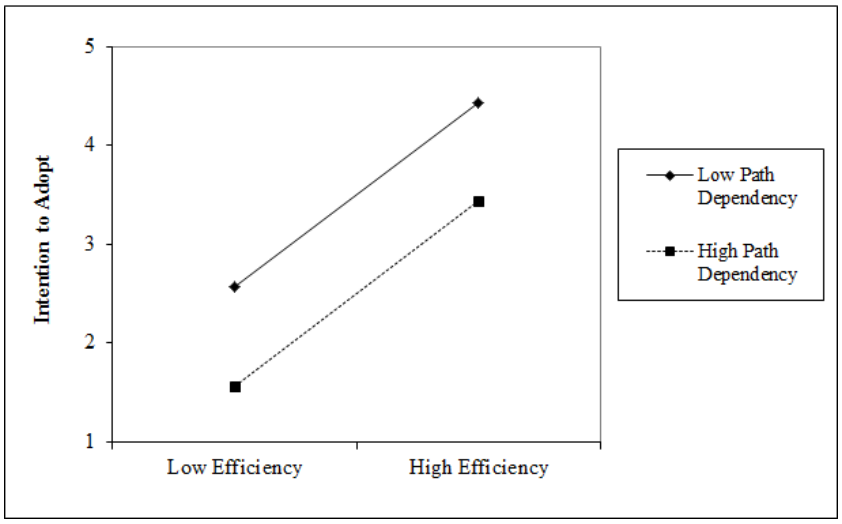
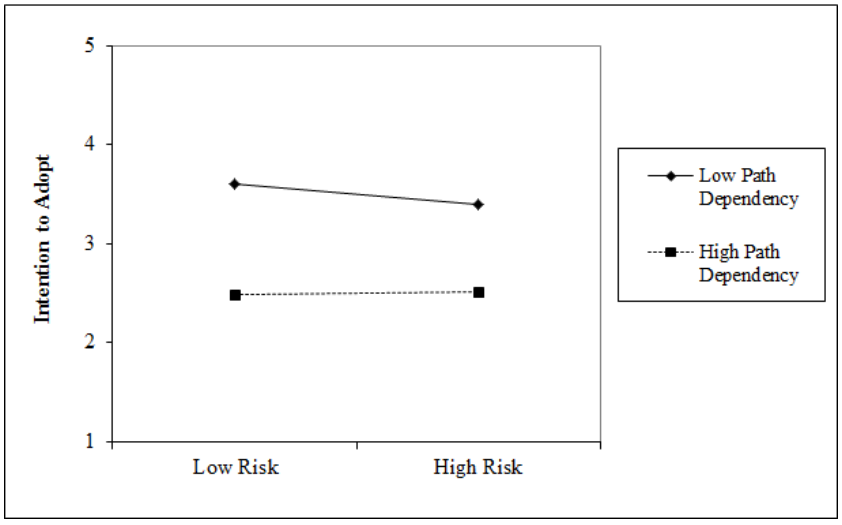
APPENDIX F

Interaction (Path Dependency×Perceived Efficiency)



APPENDIX G

Interaction (Path Dependency×Perceived Risk)



APPENDIX H

Hypotheses Test Results

	Hypotheses	Supported?
$\mathbf{H_1}$	Path dependency will negatively influence the intention to adopt flipped learning.	yes
$\mathbf{H_2}$	Perceived efficiency will positively influence the intention to adopt flipped learning.	yes
$\mathbf{H_3}$	Perceived risk will negatively influence the intention to adopt flipped learning.	yes
$\mathbf{H_{4a}}$	Path dependency will negatively moderate the relationship between perceived efficiency and the intention to adopt flipped learning.	no
$\mathbf{H_{4b}}$	Path dependency will positively moderate the relationship between perceived risk and the intention to adopt flipped learning.	yes

APPENDIX I

Survey Items

Items of intention to adopt flipped learning, path dependency, perceived efficiency, and perceived risk

Instruction: Please respond to the following items. (1 = strongly disagree; 5 = strongly agree)
Intention to Adopt
I think negatively of flipped learning.
If there are flipped learning and traditional lecture styles, I would choose the traditional lecture style as much as possible.
I would recommend the traditional lecture rather than the flipped learning lecture to colleagues.
Path Dependency
Flipped learning – not the traditional lecture style that consists of offline discussion and lecture – is unfamiliar.
Although flipped learning is better than the traditional lecture style, I do not prefer flipped learning as it is unfamiliar to me.
I prefer flipped learning more than the traditional lecture style.
Perceived Efficiency
Compared to the traditional lecture style, flipped learning is not helpful in acquiring knowledge and understanding information.
Compared to the traditional lecture style, the amount of knowledge I have obtained from the flipped learning lecture is small relative to the effort I have put for class preparation.
(Students who attended flipped learning lecture only) I think I earned a bad grade in the flipped learning lecture.
Perceived Risk
Compared to the traditional lecture style, course satisfaction of flipped learning differs in accordance with the professor or teaching assistant's ability.
Compared to the traditional lecture style, course satisfaction of flipped learning differs in accordance with the course's characteristics.

Note: All items are measure on 5-point scale (1 = to a very small extent to 5 = to a very large extent).

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감사의 글

UNIST에 입학한 2009년을 시작으로 대학원을 졸업하기까지 어느덧 7년 가까이 울산에서 머물렀습니다. 제3의 고향이 되어버린 울산에서 지내며 제가 더 성장하고 성숙해지기까지 큰 힘이 되어주셨던 분들께 감사의 인사를 전하고자 합니다.

우선, 4년이 훌쩍 넘은 긴 시간동안 부족한 저를 지도해주신 우한균 교수님께 진심으로 감사드립니다. 교수님의 가르침 덕분에 제 스스로를 돌아보며 반성하는 시간을 가지고 자신감도 가질 수 있게 되었어요. 존경합니다! 그리고 아낌없는 조언으로 논문이 잘 마무리되기까지 신경 써주신 정윤혁 교수님, 김영춘 교수님, 좋은 강의를 해주신 UNIST 경영학부 교수님들 모두 감사드립니다. UNIST 진학부터 저의 진로에 관심 가져주시고 응원해주신 송숙정 선생님께도 감사의 말씀을 전하고 싶습니다.

엄마처럼 날 케어해준 gu엉니, 5년째 나의 멘토가 되어주는 반쪽 뽀삐, 같은 길을 걸어오며 든든했던 정버미, 쿵짝이 아주 잘 맞는 제2슨, 뒤늦게 친해져서 아쉬운 감성래퍼 도슨생. 고맙다는 말을 수없이 해도 부족한 우랩 식구들! 땡큐 >.< 말하지 않아도 다 알아주는 마이펭, 센스쟁이 용느, 그리고 재간둥이 숭이. 너희 덕분에 매순간 즐겁고 힘이 났다 ^_^ 잘 통하는 밍디, 내 일도 자기 일처럼 도와준 써지, 지친 하루를 같이 마무리하며 다음날도 으쌰으쌰할 수 있게 해준 my fan 수혀니, 오랜 세월 묵묵히 지켜봐주며 응원해준 핑키&깝, 그리고 언제나 반가운 종허니오빠, 힘솔이. 데이터 수집에 큰 도움을 준 UNIST 학부생들, 특히 UNIS, 지구방위대 (고생많았던 조쮼&진주회장님), EPIDEMIC, U-Turn, NEST 학생들, 대학원생들까지도 모두모두 고마워요♡ 내가 징징대도 다 받아주는 10년지기 꼬비, 먼곳에서 나보다 더 외롭고 힘들텐데도 챙겨주는 영쥐, 연락 자주 안해서 매번 미안하지만 그래도 평생함께할 쫑으니, 그리고 오랜만에 봐도 마치 어제 본 것처럼 편한 사대부고 이과팸들. 늘 보9싶5하는 내 맘 알제?

마지막으로, 항상 믿고 지켜보며 저에게 아낌없는 사랑과 응원을 보내주신 우리 엄빠 감사해요! 애교쟁이 내 동생이지만 가끔은 언니 같은 우리 뚜라니와 나의 기쁨조 또형제까지도 다들 사랑하고 더 잘할게요♥

앞으로 언제 어디서나 더 노력하는 제자, 선후배, 그리고 친구가 되겠습니다. 감사합니다!

2015년 7월 16일