

# Students' Attitudes toward Using Innovative Information Technology for Learning Based on Theory of Planned Behavior

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**Abstract**—The main purpose of this study was to explore how IT is integrated into teaching and learning in German bachelor curriculum, and explore the university students' attitude toward the use of integration innovative information technology for learning in Germany. The data was collected by document collection and questionnaires. Multiple Regression Analysis was used to determine the three variables of behavioral intention. The results show that both attitude and subject norm are good predictors of IT for students' learning intention. Finally, results indicated TRA predicts the use innovative IT for learning intention well, though the impact of the TRA is greater than TPB.

**Index Terms**—Instruction with information technology, bachelor curriculum, innovative instruction, high education, theory of planned behavior.

## I. INTRODUCTION

Communication and information technology have become a key part of today's teaching and learning strategy is increasingly becoming a mainstream concern in higher education. Recommendations for the transformation of schools and for innovative teaching practices have been expressed in many countries—such as Japan, the USA, and various European countries[1] [2]. [3] reported the widespread implementation of virtual learning environments and e-learning within higher education institutions in the UK come with enticing promises in the following areas: improvements in quality, flexibility and effectiveness of teaching and learning, increased opportunities for lifelong learning, scope for reduced costs and participation in the global knowledge economy. Integrating IT into instruction has become a global educational objective. Furthermore, a large body of research has focused on the effects of technology on students' achievement, self-concept, and attitudes towards E-learning [4]. Fewer studies have attempted to look at how teachers can integrate innovative information technology into engineering education in universities [5] [6]. However, it is also important to understand how students think about innovative information technology for learning during the teaching process. It is also important to understand behavior intentions. [7] pointed out that being a learner in an eLearning environment is very different from being a learner in a face-to-face setting. Thus, discovering students' attitudes and ways of thinking can be useful to instructors for instructional design and

serve as a method of utilizing integrated IT in university curricula [8].

The main purpose of this study was to clarify the relationship between attitude, subjective norm, and perceived behavior control with the intention of use of innovative information technology for learning by German students. Investigation was carried out through questionnaires and document collection. The research findings will assist university instructors and curriculum developers to facilitate the development and application of IT in university curricula. The two specific purposes arising from the above goal are listed as follows:

- (1) To explore whether or not there are significant differences between background information variables (gender, age, and academic degree) and dependent variables (attitude, subjective norm, perceived behavioral control and behavioral intention).
- (2) To explore the relationships among independent variables (attitude, subjective norm, and perceived behavioral control) used in examining the prediction of behavioral intention of students' use of innovative information technology for learning.

## II. LITERATURE REVIEW

The theory of planned behavior (TPB) (see figure 1) is a theory about the link between attitudes, belief and behavior. TPB helps us to understand how we can change the behavior of people, and predict deliberate behavior, because behavior can be deliberated and planned [9] [10] [11]. The theory of planned behavior was proposed by Icek Ajzen in 1985 in his article, "From Intentions to Actions: A Theory of Planned Behavior." TPB has its roots in the theory of reasoned action (TRA) which was brought forward by Martin Fishbein and Icek Ajzen in 1975. In order to clarify the relationship between attitude and behavior, the theory of reasoned action (TRA) can be employed to account for complete volitional behavior in a broad range of settings. In the TRA model, an individual's behavior in question is the dependent variable of interest. Individual behavior is posited to be immediately affected by the intention to perform the behavior, which in turn is determined jointly by attitude and subjective norm [12]. According to the theory of reasoned action, if people evaluate performance of a suggested behavior as positive, and if they think peers

want to perform the behavior, they are more likely to perform the behavior themselves [12]. A high correlation of attitude toward behavior and subjective norms to behavioral intention has been confirmed in many studies [13] [14]. In addition, according to TPB, human action is guided by three kinds of considerations, as follows:

1. Behavioral Beliefs (beliefs about the likely consequences of a behavior)
2. Normative Beliefs (beliefs about the normative expectations of others)
3. Control Beliefs (beliefs about the presence of factors that may facilitate or impede performance of a behavior) [15].

Briefly, the TPB [9] [16] has three main conceptual independent determinants of intention (See figure 1). The first predictor is attitude toward behavior which refers to the degree to which people have a favorable or unfavorable evaluation of the behavior [10]. The second predictor is a social factor termed subjective norm, which refers to the perceived social pressure to perform or not to perform a type of behavior [10]. The third predictor is the degree of perceived ease of performing or perceived difficulty of performing a behavior [9].

Based on the TRA and TPB we can understand that university students can be affected by their attitudes and beliefs when they utilize IT in their learning. Thus, researchers have tried to explore the behavior of Germany university students in adopting innovative IT for learning. This study uses the theory of planned behavior (TPB), a well-known behavior research model from social psychology, as its theoretical foundation.

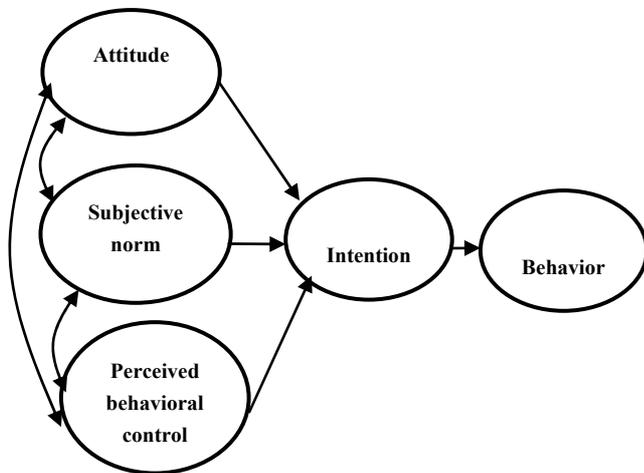


Figure 1. Figure 1 Theory of planned behavior model [11]

### III. INTEGRATION OF INFORMATION TECHNOLOGY INTO INNOVATIVE INSTRUCTION IN TU ILMENAU

The Ilmenau Technical University has more than 100 years of history, and it is primarily famous as a university for sciences, technology and engineering. The University had 6252 students enrolled in degree courses and 525 academic staff in the winter semester of 2008/2009. The combination at Ilmenau of a friendly, personal academic setting with pleasant social conditions has long been a trademark of this TU. The university has a high

reputation, both for its academic content and for the facilities offered to students. The university is famous also for its effective use of IT to assist student performance and to promote students’ specialized abilities. Over recent decades, the university has earned national and international recognition for its academic and research achievements. More than 100 research sections exist at present and they are concentrating more and more on forward-looking studies and research, such as energy-saving and other alternative technology, information and communication technology that can improve social organization, and the sort of business theory and practice that will be less damaging to the environment and the natural world. The Remote Engineering Application Laboratory is an example of how TU Ilmenau integrates innovative IT into instruction and research. The lab is described as follows.

The instructional concept of remote lab, designed and developed by “Integrated Hardware and Software System Group” at the Technical University of Ilmenau in Germany, deals with the design of complex digital control systems which promote students’ learning in engineering education. [17] pointed out that learning the design of control systems requires not only deep theory but also practical experience gained through laboratory work. The goal of the Remote Engineering Application Laboratory is to examine and implement new techniques for the development of a training system based on finite state machines (FSM). As for its contribution, the lab presents means and methods required to provide a tool available web wide for a large user base which is independent from an operating system. Figure 2 shows the instructional application of a remote engineering laboratory during the 2008 International Summer School in Advanced Remote Technologies at Ilmenau University of Technology in Germany. The instructor can operate the remote system and connect the real laboratory. The remote lab is connected from Germany to Sweden by instructors. Students can learn through flexible and individualized learning. The lab is also convenient for students to access any time, any place.

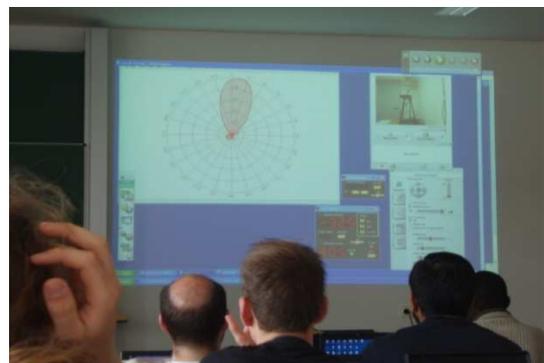


Figure 2 Instructional application of remote engineering laboratory  
Source: 2008 international summer school in advanced remote technologies at Ilmenau University of Technology in Germany (Date: 2008.7.13-7.26)

Figure 3 is the client-server architecture of the remote lab. The system is divided into two parts, one is the remote hardware model and the other is the local virtual model. Students can login to the remote system and input data to operate the remote real machine, and they can get feedback from remote system as to whether or not that operated it successfully. In addition, the system also provides an assessment strategy and feedback in time.

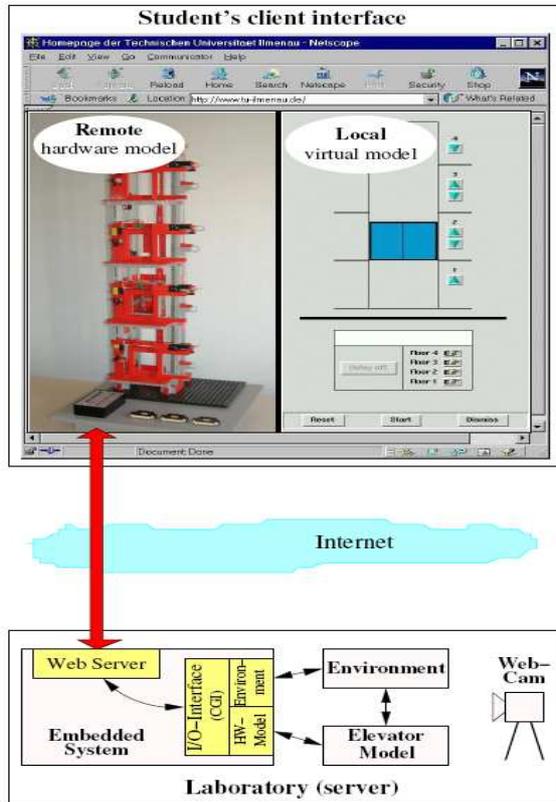


Figure 3 Client-server architecture of the remote lab [17]

IV. RESEARCH METHODOLOGY

This study was conducted to examine the relationship between attitude, subjective norm, and perceived behavior control among German university students using information technology for learning. Analysis of data using a one-way ANOVA test determined the differences that emerge between the background information variables and the intention to use IT for learning. The rejection level of the hypotheses was set at  $\alpha = .05$ . The relationships among independent variables (attitude, subjective norm, and perceived behavioral control) were used in examining the prediction of behavioral intention of students' use of innovative information technology for learning. The research framework of how background information variables affect dependent variables is presented in Figure 2.

A. Research hypotheses:

The study was designed to test the following hypotheses:

H1: There is significant difference between background information variables (gender, age, and academic degree) and dependent variables (attitude, subjective norm, perceived behavioral control and behavioral intention).

Furthermore, the research framework of the independent variable compared to the dependent variable is shown in figure 4.

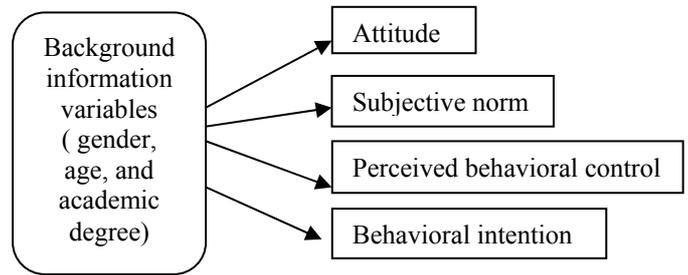


Figure 4 Research framework of the independent variable compared to the dependent variable

H2: There is a significant relationship among independent variables (attitude, subjective norm, and perceived behavioral control) which can be used in examining the prediction of behavioral intention of students' use of innovative IT for learning.

A regression analysis was run by using the following model: **Intention = Attitude + Subject Norm + Perceived Behavioral Control**

B. Research Sample and Selection of Subjects

The formal survey subjects are focus on the Technical University of Ilmenau students who are enrolled in different academic degree programs, including diploma, bachelor, master, and doctorate students. 270 volunteers accepted the survey and filled out the online questionnaire. Since 1 questionnaire was incomplete, a total of 269 usable surveys were used.

C. Research Instrument

The main questionnaire items were a revised version of the content of attitudes shown in [18] towards the use of instructional technology questionnaires. The questionnaire contained three parts: Part I of the survey instrument consisted of 28 questions. Each construct was evaluated using a 5-point Likert-type scale as follows: "5"-strongly agree; "4"-agree; "3"- neutral; "2"- disagree; "1"- strongly disagree. Part II of the survey instrument consisted of the background information: gender, age, country, and academic degree.

IV. FINDINGS AND DISCUSSIONS

In this formal survey, there are 170 males and 99 females. Over 60% of the respondents are male. There are 102(37.9%) students from 15-20 years old, 130(48.3%) students from 21-25 years old, 28 students from 26-30 years old, and 9 students over 31 years old in this survey. Thus, almost all students are 15-25 years old. Only 9 of respondents are international exchange students. All others come from Germany. There are 63(23.4%) diploma students, 135(50.2%) bachelor students, 59(21.9) master students and 12(4.5%) doctoral student.

*A. Relationship of gender variables toward dependent variables*

Researchers took the analysis method of independent samples t-test to test the relationship of gender variables toward dependent variables. In regard to the gender issues, there is no significant difference between male and female students in terms of attitude ( $t = 1.340$ ,  $df = 267$ ,  $p = .181 > .05$ ), subjective norm ( $t = .667$ ,  $df = 267$ ,  $p = .505 > .05$ ), and intention ( $t = .011$ ,  $df = 267$ ,  $p = .991 > .05$ ). According to the perceived behavioral control ( $t = 2.580$ ,  $df = 267$ ,  $p = .010 < .05$ ). Thus, there was a statistically significant difference between gender and perceived behavioral control. The mean of males' (16.21) perceived behavioral control variable is higher than females (15.16).

*B. Relationship of different ages variables toward dependent variables*

TABLE I.  
ANOVA ANALYSIS BETWEEN DIFFERENT AGES

		Sum of Squares	df	Mean Square	F	Sig.
Attitude toward the behavior	Between Groups	598.16	3.00	199.39	4.16	0.01*
	Within Groups	12698.40	265.00	47.92		
	Total	13296.57	268.00			
Subjective norm	Between Groups	46.72	3.00	15.57	1.97	0.12
	Within Groups	2099.39	265.00	7.92		
	Total	2146.11	268.00			
Perceive behavioral control	Between Groups	94.31	3.00	31.44	3.04	0.03*
	Within Groups	2742.48	265.00	10.35		
	Total	2836.79	268.00			
Intention to use IT for learning	Between Groups	261.16	3.00	87.05	4.22	0.01*
	Within Groups	5464.14	265.00	20.62		
	Total	5725.30	268.00			

\*. The mean difference is significant at the 0.05 level.

In order to know whether there is significant difference or not between different ages and dependent variables, researchers employed the analysis method of one way ANOVA (Analysis of Variance). As shown in the table 3, we can see the ANOVA analysis between different ages and four variables; these results were shown as follows.

According to the attitude toward the behavior variable, the F value is significantly different ( $F = 4.16$ ;  $P < .05$ ).

For the perceived behavioral control variable, the F value is significantly different ( $F = 3.04$ ;  $P < .05$ ), and as for the intention to use IT for learning variable, the F value is significantly different ( $F = 4.22$ ;  $P < .05$ ). Thus we have to reject the null hypothesis. Based on these results, there is a significant difference between different ages and attitude toward the behavior. Researchers continue to analyze which differences exist by using the statistical method of posteriori comparison. In addition, according to the subjective norm variable, the F value is not significantly different ( $F = 1.97$ ;  $P > .05$ ). Thus, we have to accept the null hypothesis. There is no significant difference between different ages and the subjective norm.

According to the Scheffé analysis method, we can observe three variables (Subjective norm, Perceive behavioral control, Intention to use IT for learning) from the results of posteriori comparison. The variable of perceived behavioral control and the variable of intention to use IT for learning are not significantly different among different age groups. As for the variable of attitude toward the behavior, there is a significant difference between the age group of 26-30 and the age group of 15-20. 26-30 years old students score higher in attitude toward the behavior than 15-20 years old students.

*C. Relationship of different academic degrees variables toward dependent variables*

TABLE II.  
ANOVA ANALYSIS BETWEEN DIFFERENT ACADEMIC DEGREES

		Sum of Squares	df	Mean Square	F	Sig.
Attitude toward the behavior	Between Groups	56.36	3.00	18.79	0.38	0.77
	Within Groups	13240.20	265.00	49.96		
	Total	13296.57	268.00			
Subjective norm	Between Groups	67.98	3.00	22.66	2.89	0.04*
	Within Groups	2078.13	265.00	7.84		
	Total	2146.11	268.00			
Perceive behavioral control	Between Groups	9.77	3.00	3.26	0.31	0.82
	Within Groups	2827.01	265.00	10.67		
	Total	2836.79	268.00			
Intention to use IT for learning	Between Groups	132.57	3.00	44.19	2.09	0.10
	Within Groups	5464.14	265.00	20.62		
	Total	5725.30	268.00			

Within Groups	5592.73	265.00	21.10
Total	5725.30	268.00	

\*. The mean difference is significant at the 0.05 level.

In order to know whether there is significantly different or not between different academic degrees and the dependent variable, researchers have employed the analysis method of one way ANOVA (Analysis of Variance). As shown in table 2, we can observe the ANOVA analysis results between different academic degrees and four variables. These results are shown as follows.

According to the attitude toward the behavior variable, the F value is not significantly different ( $F = 0.38; P > .05$ ). For the perceived behavioral control variable, the F value is not significantly different ( $F = 0.31; P > .05$ ), and as for the intention to use IT for learning variable, the F value is not significantly different ( $F = 2.09; P > .05$ ). Thus, we have to accept the null hypothesis. There is no significant difference between different academic degrees and attitude toward the behavior. According to the subjective norm variable, the F value is significantly different ( $F = 2.89; P < .05$ ). Thus, we have to reject the null hypothesis. Based on the results, there is a significant difference between different academic degrees and the subjective norm. Researchers continue to analyze which differences exist by way of the statistical method of posteriori comparison.

As for the subjective norm results of posteriori comparison, there is a significant difference between the bachelor group and the diploma group. Bachelor students have a higher subjective norm than diploma students.

*D. Relationship of independent variables used in examining the prediction of dependent variables*

TABLE III.

**Model Summary**

Model	R	R Squared	Adjusted R Squared	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.412 <sup>a</sup>	0.17	0.17	4.22	0.17	54.66	1.00	267.00	0.00
2	.453 <sup>b</sup>	0.21	0.20	4.14	0.04	11.79	1.00	266.00	0.00

- a. Predictors: (Constant), Subjective norm
- b. Predictors: (Constant), Subjective norm, Attitude toward the behavior
- c. Dependent Variable: Intention to use IT for learning

In this study, only attitude toward the behavior and subjective norm can predict intention to use IT for learning (see table 3). This regression model was able to

explain a significant degree of variation in responses with  $F = 54.66$  and a level of significance of  $p = .00$ . In addition, the correlations between the independent variables (attitude toward the behavior, subjective norm, and perceived behavioral control) and dependent variable (intention to use IT for learning) were also examined. Subjective norm and attitude toward the behavior most highly correlated with Intention (.412 and .362 respectively), while perceived behavioral control was less correlated with Intention (.297).

Previous research has explored less of the relationships between students' background information variables and dependent variables. Gender, age, and academic degree are described as followings.

*A. Gender*

The findings of this study reveal no significant difference between gender and the three dependent variables (attitude towards the behavior, subjective norm and behavioral intention). However, there was a statistically significant difference between gender and perceived behavioral control. The males' perceived behavioral control is higher than females'. In general, male rational thought is higher than female; on the contrary, the perceptual of females thought is higher than males. This differs from findings in other studies. There is a statistically significant relationship between the attitudes of the students and gender. Women are more positive than men [19].

*B. Age*

The variables of subjective norm, perceived behavioral control and the variable of intention to use IT for learning are not significantly different among different age groups. Yet, for the variable of attitude toward the behavior, there is a significant difference between the age group of 26-30 and the age group of 15-20. 26-30 years old students score higher in attitude toward the behavior than 15-20 years old students. 15-20 years old students have the lowest mean attitude toward the behavior, which refers to the fact that this group of students have just entered university and most do not have a lot of experience with integrated IT learning.

Moreover, the group of 21-25 years old students has the lowest mean of subjective norm, perceived behavior control, and intention to use IT for learning. The group of over 31 year old students has the highest mean of subjective norm, perceived behavior control and intention to use IT for learning. Researchers point out that as students have more access to high education, their attitude toward use of information technology in learning gradually increases.

*C. Academic degree*

Researchers compared different academic degrees with dependent variables and discussed the findings. There is no significant difference between academic degrees and attitude, perceived behavioral control, and intention to use IT for learning. However, there is a significant difference between different academic degrees and the subjective norm. According to the findings of this study, bachelor students have higher subjective norm than diploma students. Bachelor students have the highest means of

subject norm compared to the other three degrees. Since this group students is the youngest students among the research sample in the new German education system, results show they have higher attitude in regard to the subjective norm.

Doctorate students have the highest means among attitude toward the behavior, perceived behavior control and intention to use IT for learning. This corresponds very closely with the results of different ages discussed by research mentioned in the preceding paragraph. Students over 31 years old also have the highest mean of perceived behavior control and intention to use IT for learning. Most students over 31 years old are doctoral students. To sum up, doctorate students have better active learning and self-control ability compared to other degree students. Furthermore, the findings point that students with higher degrees have higher attitudes toward perceived behavior control. Diploma students have the lowest mean of subject norm, perceived behavior control, and intention to use IT for learning. From the above findings, it is inferred that the learning attitudes of students is easily reduced with the increase of learning time.

## V. CONCLUSIONS

Base on the findings of this study, attitude [4], subjective norm [20], and perceived behavioral control variables are the related to students' behavioral intention [21]. In addition, attitude toward the behavior and subjective norm can be predicted by the intention to use IT for learning. This has been confirmed in prior studies [14] [12] [22]. The results indicate that TRA is well suited to predict learning intention used in innovative IT, though the impact of TRA is more robust than TPB. The findings also indicate that attitude and subjective norm have the largest effect on intention

## ACKNOWLEDGMENT

The authors greatly appreciate the financial support provided by Taiwan's National Science Council of the Republic of China under contract No. NSC-096-2917-I-017-101 and also the kind assistance of the Integrated HW/SW Systems Group at Ilmenau University of Technology, Germany.

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