Mining Student's Belief based on E-learning System Readiness

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***Abstract*—** E-learning system implementation in higher education has become ubiquitous to enrich teaching and learning experience. Understanding student's belief based on their readiness for such technology is considered vital. The aim of this study is to investigate the students' willingness for an e-learning system as emerging learning technology, based on the Technology Readiness Index (TRI) dimensions- innovation, optimism, discomfort and insecurity- of Parsuraman, We analyze the most influential factor on students readiness. Using data mining technique as a clustering students beliefs based on TRI dimensions provides a meaningful explanation of their e-learning system readiness. A survey questionnaire was conducted to collect data from 400 participants. To analyze the collected data, Confirmatory Factor Analysis (CFA) and Measurement Model have been deployed. We used Classification approach with two-step cluster technique to validate the research model. Our results show a match of four out of the five TRI segments and despite their optimism the students show their reticence concerning e-learning system readiness.

***Keywords*—**Data mining E-learning, Technology Readiness Index, Measurement Model, Two-step cluster.

I. Introduction

NOwdays, higher educational institutions have a significant tendency towards the use of the Internet for delivering their courses, both on campus and at a distance. The Internet as a core of this system plays a dual role by being a place for the distribution of didactic materials and a tool of communication between users engaged in the educational activity to support and simplify the processes of learning [5,21]. The E-learning system viewed as web-based education is becoming an increasingly widespread approach in higher education institutions all over the world. Particularly, Blended Learning (BL), is a more used technique incorporating the robustness of face-to-face and technology-enhanced learning ([12],[18]). BL is ever more being considered as one of the most important drivers for education reform today [19]. Globally, higher education institutions have invested significant resources in e-learning system.

Since the adoption of e-learning system is ever increasing rapidly worldwide, universities in the Gulf region are at the threshold of implementation of such system. Specifically, in Saudi Arabia Umm al-qura University has recently implemented a Desire To Learn (D2L) as Learning Management System (LMS). Such system supports both distance and traditional learning and encourages academics to use e-learning system by providing a multi-levels training for teachers as well for students for a continuous education development. This new paradigm transfers education from teacher-centered to student-centered [14]. The use of an e-learning system was not viewed only as an individual activity, but it is also communal, that is collaborative and cooperative nature between teacher and the students themselves [22]. Even so, it is obvious that such a change does not take place overnight ([13],[3]). In fact, having an e-learning system on campus will not automatically lead to its use and the benefit of such system will not be maximized unless learners start using it [25]. Consequently, the availability of a technological infrastructure is not enough to predict the readiness or no for the use of e-learning system as a new emerged technology, either on the side of the teachers or on that of the students.

The current research is based on the Technology Readiness Index (TRI) scales of Parasuraman and Rockbridge Associates Inc (1999), as theoretical framework. We aim at assessing the readiness of students use of e-learning system technology in higher education. Such models have been the object of research scrutiny since the publication of the original studies TRI by Parasuraman [16] and Parasuraman and Colby [17]. TRI model test results can be generalized for contexts such as insurance services, and industrial equipment [26]. Before undertake data mining technique such clustering confirmatory factorial analysis (CFA) was used to validate the instrument and the results obtained had indicated that TRI lead to differentiate between users and non-users of such new technological products or services, and may help to predict adoption of these products or services [20].

To the best of our knowledge, TRI has not been tested yet in Saudi Arabian universities, despite its worldwide use especially in the business world.

This research was carried out for the case of users and non-users of e-learning system in three stages:

Stage 1: we first analyze the correspondence between TRI dimensions to assess the state of technology readiness of Umm al-qura university students. To perform this stage, we carried out a CFA, with results pointing to differences in terms of optimism and insecurity between users and non-users of e-learning system;

Stage 1: next, we evaluate the main influence factor that might help understanding the increase or the suppression of

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the technology readiness among the surveyed students. Along this stage, we carried out a statistical analysis using correlation with real observations to reach the most accurate estimation for the dominant factor.

Stage 3: we finally validate the results of the first and second stages by mining students into different groups to explain the tendency beliefs of students in their readiness about e-learning system. To validate the research results, we conducted a clustering approach using two-step cluster technique.

The remainder of this paper approaches the following subjects: section II introduces the TRI by presenting the literature review, the hypothesis and the segmentation of the technology readiness dimensions. In section III we present the research model upon which we based our research arguments pertaining to the most influencing factor that affect students readiness for e-learning system technology. The methodology proposed for conducting the current study is presented in Section IV. The analysis and the results of the survey are presented in section V and finally section VI is devoted to a synthesis of the concluding remarks of the study.

II. Technology Readiness Index

A. Literature Review

The current state-of the art shows that the combination between positive and negative beliefs concerning technology underlies the field of technology readiness [5], [15] and [17]. The expression "Technology Readiness Index" (TRI) was first introduced in the beginning of the new millennium by Parasuraman and was published in the Journal of Service Research [16]. Parasurman propose to measure the "*people's propensity to embrace and use new technologies for accomplishing goals in home life and at work*" (Parasuraman, 2000, p. 308). Since then, the TRI has become a widely accepted metric for studying the behavior process behind the adoption of technological products and services. Nevertheless, TRI gives an idea about a person's beliefs and not person's ability using new technology [27]. As multiple-item scale, the TRI consisted of a 36 questions devoted to measuring "technology readiness". The 36-item scale was composed of four component dimensions of beliefs related to technology that influences a personal's level of technology readiness. These beliefs assign a person's willingness to interact with new technology [17]. Among these four dimensions, two are contributors to technology adoption, which are:

- **Optimism** It describes the expecting from the positive pertinence of technology.
- **Innovativeness** It is about the authority of using technology.

The two others are called inhibitors of technology adoption, which are:

- **Discomfort** It is the doubt about the guarantee that concerns ordinary people experience with technology.
- **Insecurity** It is the risk that people may have with technology-based transactions.

As contributors, optimism and innovativeness are the locomotive of technology readiness. In fact, a high score measured on these dimensions will generally enlarge the technology readiness. In contrast, discomfort and insecurity prevent or delay, people's natural tendency to use new technology. Thereby, a high score measured on these dimensions will decrease the entire technology readiness [16]. The four dimensions as shown in figure 1 are fairly independent of each other, therefore, an individual could accommodate both contributor and inhibitor feelings towards technology [17].

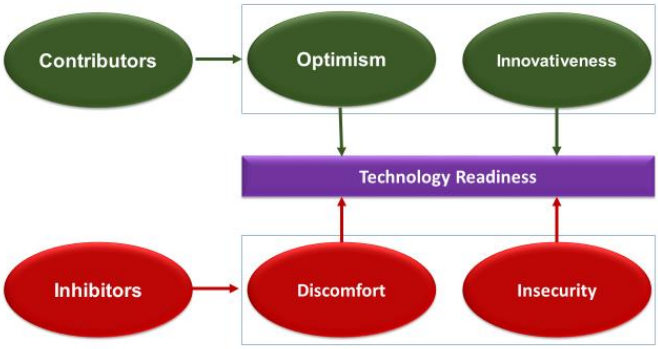

Figure:1 Technology Readiness Index (Parasuraman 2000,p34)

For many years, the TRI has been precious for researchers interested in social media, mobile access and other technology services. The 36-item scale established by Parasuraman was translated to multiple languages in order to ease their deployment in many countries. It has also been used in a wide variety of service sectors including education, banking, telecommunications, healthcare, and professional services.

B. Classification

Classification is a consequential way to capture the complexities of students' beliefs related to the use of a new technology. Based on the technology readiness scores, Parasuraman & Colby (2001) specifically, describes five classes of technology readiness users as following:

- **Explorers**: Who are the first people to adopt technology, who are highly motivated and who are a relatively easy group to attract when a new technology product or service is introduced because they have no fears about it.
- **Pioneers**: Who are the next to adopt technology, who desire the benefits of new technology by sharing the optimism and innovative views of explorers, but are more realistic about the difficulties and dangers by feeling some discomfort and insecurity.
- **Skeptics**: Who are low motivated and need to be tend to be convinced of the benefits of using the emerging technology.
- **Paranoids**: Who may find technology interesting, but at the same time they are feeling insecure.
- **Laggards**: Who are the resistant ones possess few motivations toward technology, who are the last to adopt technology unless they are forced to do so.

Table 1 presents a clear profile of each type of user's beliefs of technology adoption.

Table:1Characteristics of technology classes(Parasuraman and Colby,2001)

	OPTIMISM	INNOVATIVENESS	DISCOMFORT	INSECURITY
EXPLORERS	HIGH	HIGH	LOW	LOW
PIONEERS	HIGH	HIGH	HIGH	HIGH
SKEPTICS	LOW	LOW	LOW	LOW
PARANOIDS	HIGH	LOW	HIGH	HIGH
LAGGARDS	LOW	LOW	HIGH	HIGH

The markets for technologically based products studied by Parasuraman and Colby (2001) confirm the existence of five clusters basis on their technology readiness scores. Each TRI cluster is engaged to the market at different times such explorers entered to the market before pioneers, pioneers before sceptics, skeptics before paranoids and paranoids before laggards. However, it is important to note that an exact match for all five clusters mentioned in table 1 is not expected since the clusters were likely varied based on the population of interest. In fact, Tsikriktsis (2004) rebuilt Parasuraman and Colby's (2001) research in the UK and found evidence of the existence of only four clusters [26].

III. Research Model and Hypothesis

The main objective of the current study is to determine the dominant factor that have the most influence on the overall TRI change.

To understand TRI factors as specific characteristic profiles between student's e-learning system readiness and non-readiness (as seen in figure 1), and between technology motivated and non-motivated, we suggest the following hypotheses:

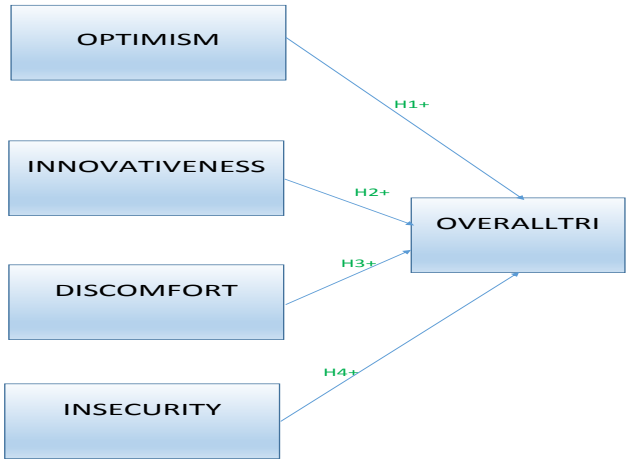

Figure:2 Model Hypothesis

- **H1**: The optimism factor, defined as a positive vision of technology, and the belief that its greater control, flexibility and efficiency in people's lives, is a differentiating element between motivated and non-motivated of e-learning system.
- **H1+**: The Optimism factor has a positive effect on the student's willingness on the use of e-learning system. The optimism is the most influential factor among all TRI factors.
- **H2**: The innovativeness factor, defined as a tendency to be a pioneer, leader or opinion-former in the use of technology, is a differentiating element between motivated and non-motivated of e-learning system.
- **H2+**: The Innovativeness factor has a positive effect on the student's readiness on the use of e-learning system. The Innovativeness is the most influential factor among all TRI factors.
- **H3**: The discomfort factor, defined as perception of lack of control over technology and the feeling of being pressured or oppressed by it, is a differentiating element between motivated and non-motivated of e-learning system.
- **H3+**: The Discomfort factor has a negative effect on the student's readiness on the use of e-learning system. The Discomfort is the most influential factor among all TRI factors.
- **H4**: The insecurity factor, defined as distrust of technology and skepticism of one's own abilities to use it appropriately, is a differentiating element between motivated and non-motivated of e-learning system.
- **H4+**: The Insecurity factor has a negative effect on the student's readiness on the use of e-learning system. The Insecurity is the most influential factor among all TRI factors.

IV. Methodology

A. Sample

Our preliminary sample consists of 400 non-graduate students attending five colleges of Umm Al-Qura University's Makkah Campus. These five colleges use the most learning management system provided by the university. After pretreatment by eliminating missed responses, the final sample contains 384 students, which 46% were male and 54% were female respecting approximately the real student's distribution as presented in table 2.

Table:2 Sample distribution

	Engineering	Medicine	Sciences	Administration	Education	TOTAL	%
MALES	40	45	21	55	16	177	46
FEMALES	48	51	25	64	19	207	54
TOTAL	88	96	46	119	35	384	-
%	23	25	12	31	9	-	100

B. Questionnaire

The data for this study is obtained via questionnaire distributed and collected from students in classrooms. Parasuraman's Technology Readiness Index (TRI) is the survey instrument used in this study (see Appendix 1). We translated it in Arabic for quality and understandability assurance.

The questionnaire contains a preface to explain the objective of the survey by making analogy between e-learning system and technology, the assurance of confidentiality and

anonymity of respondents and, the voluntary nature of respondent participation.

C. Measures

The questionnaire was designed to measure the four constructs in the research model comprising the demographic information of the participants. The original technology readiness scale of Parasuraman consists of totally 36 items divided into four dimensions: Optimism (10 items), innovativeness (7 items), discomfort (10 items), and insecurity (9 items). All measures were in the category of self-assessment and each item question was scored on a Likert scale from 1 to 5, with a 1 rating indicating strong disagreement and a 5 rating indicating strong agreement.

V. Data Analysis and Results

Before starting our empirical analysis, we conducted a detailed examination of data, including checks for missing values, outliers, and characteristics of the variables used in our study.

A. Measurement Model

We deployed Confirmatory Factor Analysis (CFA) in order to identify the underlying structure in the TRI theoretical model data proposed by Parasuraman (figure 1) [10].

However, the big number of items (36 items) composing the questionnaire from one side and the translation of all its items to Arabic from other side has led to a less accurate answers provided by students. Consequently, the number of factors could not be appropriately specified. To increase factor's reliability and to extract the dimensions of each construct of the TRI, Exploratory Factor Analysis (EFA) was conducted for several time to check the consistency of the proposed factor using SPSS 20.

During this validation process, from communalities table we remove items with poor factor loadings less than 0.5 [9], which indicates a weak correlation with all other items. Thus, 15 items were excluded from technology readiness index (see appendix 1) and then CFA was carried out using Amos 20 with the maximum likelihood estimation procedure to test the obtained measurement model (figure 3).

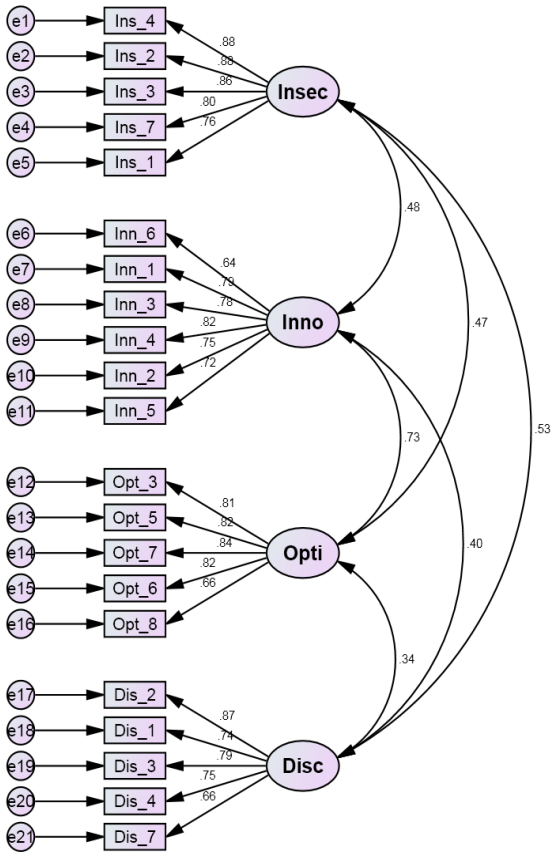

Figure:3 Measurement Model

Factor structure refers to the inter-correlations among variables being tested in EFA. Using the Pattern matrix shown in table 3, we can see that variables group into factors and more precisely, they load onto factors.

Table 3: Pattern Matrix

	Component			
	1	**2**	**3**	**4**
Ins_4	**.914**			
Ins_2	**.895**			
Ins_3	**.868**			
Ins_7	**.796**			
Ins_1	**.701**			
Inn_6		**.798**		
Inn_1		**.793**		
Inn_3		**.746**		
Inn_4		**.725**		
Inn_2		**.655**		
Inn_5		**.632**		
Opt_3			**.858**	
Opt_5			**.832**	
Opt_7			**.784**	
Opt_6			**.753**	
Dis_8			**.635**	
Dis_2				**.909**
Dis_1				**.794**
Dis_3				**.781**
Dis_4				**.658**
Dis_7				**.912**

B. Reliability and Validity Assessment

The reliability and validity of results are considered as the two major import issues in measurement theory. The reliability analysis of each factor determines its ability to yield the same results on different situation and validity refers to the measurement of what the factor is supposed to measure [4]. As reliability estimate we use Cronbach's alpha (CA) that measures internal consistency. We establish convergent validity to show measures that should be related are in reality related. In addition to the internal validity measurement, the convergent validity was examined by Composite Reliability (CR) and by the Average Variance Extracted (AVE) [7]. The recommendation level for the internal consistency reliability is at least should be 0.7 and at least 0.5 for AVE [1].

Table 4: Convergent validity for the measurement model

CONSTRUCT	ITEMS	CA	CR	AVE
OPTIMISM	5	0.889	0.894	0.629
INNOVATIVENESS	6	0.882	0.886	0.565
DISCOMFORT	5	0.873	0.876	0.588
INSECURITY	5	0.920	0.921	0.702

As shown in table 4, the Crombach's alpha and Composite Reliability for all constructs are above the acceptable level of 0.7, indicating a high the internal consistency. In addition, the surpass of all constructs AVE of the level 0.5, provides strong evidence of convergent validity that ensure the real measure of the four TRI dimensions.

C. Discriminant validity

Discriminant validity refers to the extent to which factors are distinct and uncorrelated. Thus, when the correlation between any two constructs is less than the square root of the AVE then the discriminant validity is established [8]. The rule is that variables should relate more strongly to their own factor than to other factor. In the table 5 the items on the diagonal represent the square roots of the AVE and the others elements are the correlation estimates. The square root of the AVE is greater than inter-item correlations and that conclude the approval of discriminant validity for each of the items.

Table:5 Discriminant validity for the measurement model

Construct	Optimism	Innovativeness	Discomfort	Insecurity
Optimism	0.793			
Innovativeness	0.733	0.752		
Discomfort	0.344	0.405	0.767	
Insecurity	0.468	0.484	0.530	0.838

D. Overall model fit

The measurement model shown in figure 3 is estimated with maximum likelihood estimation using AMOS 20. All scales remained are subject to CFA test to extract the dimensions of each construct and check the consistency of the proposed factor with actual data. The Pattern matrix illustrates a very clean factors in which convergent and discriminant validity are evident by high loadings within factors greater than 0.5 [1], and no cross-loadings between factors as shown in table 3.

Factor analysis results showed 21 items loaded on four Parasuraman TRI factors (figure 3). It is a common practice to deploy a variety of indices to measure the model fit, [11]. We can classify these indices into three categories as suggested by [10].

- The first is the absolute fit indices category that measure how well the measurement model reproduce the observed data which include the Chi-square statistic, the goodness-of-fit Index (GFI) and the standardized root mean residual (SRMR).
- The second is the parasimonious fit indices category takes into account the model's complexity which include the Root Mean Square Error of Approximation (RMSEA) and the Adjusted goodness-of-fit Index (AGFI).
- The third is the incremental fit indices category that asses how well a specified model fit relative to an alternative baseline model which include the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI).

Table 6 shows the recommended critical level of acceptable fit and the result fit indices for the research measurement model. The results show that the measurement model as recommended by the three fit indices categories has an excellent fit.

Table 6: Model fit indices

FIT INDEX	RECOMMENDED CRITICAL VALUE	RESULT
$\chi 2$/D.F	≤ 3	1.568
GFI	≥ 0.9	0.934
AGFI	≥ 0.8	0.917
CFI	≥ 0.9	0.979
TLI	≥ 0.9	0.976
RMR	≤ 0.08	0.023
RMSEA	≤ 0.05	0.039

E. Hypothesis research results

Table 7 presents the descriptive statistics of each TRI construct. For each respondent we calculate the overall TRI score as an average of the optimism, innovativeness, discomfort and insecurity after reverse coding the scores on discomfort and insecurity as indicated in table 7 (Parasuraman, 2000, p. 318). For contributor dimension, Innovativeness was rated with highest mean score, 3.938 and the optimism was the next highest mean score, 3.772. However, for the inhibitor dimension, the discomfort and insecurity factors yielded mean values of 2.856 and 3.585 respectively. The overall TRI mean was 3.317 with a standard deviation of 0.296.

Table:7 Summary statistics for TRI

	Min	Max	Mean	S.D
OPTIMISM	1.00	5.00	3.7724	0.61823
INNOVATIVENESS	2.00	5.00	3.9384	0.4866
DISCOMFORT	1.00	5.00	2.8568	0.71901
INSECURITY	1.00	5.00	3.5854	0.77453
OverallTRI*	2.40	4.50	3.3171	0.29614

**OverallTRI=[Optimism+Innovativeness+(6-Discomfort)+(6-Insecurity)]/4.*

After the CFA, the second step in this research was the determination of the factor with major effect on the overall TRI. To test the research hypothesis, we calculate the correlation between the Overall TRI and the real TRI factors observation to grasp more accuracy result. The figure 4` describes the influence of each TRI factor to the Overall TRI.

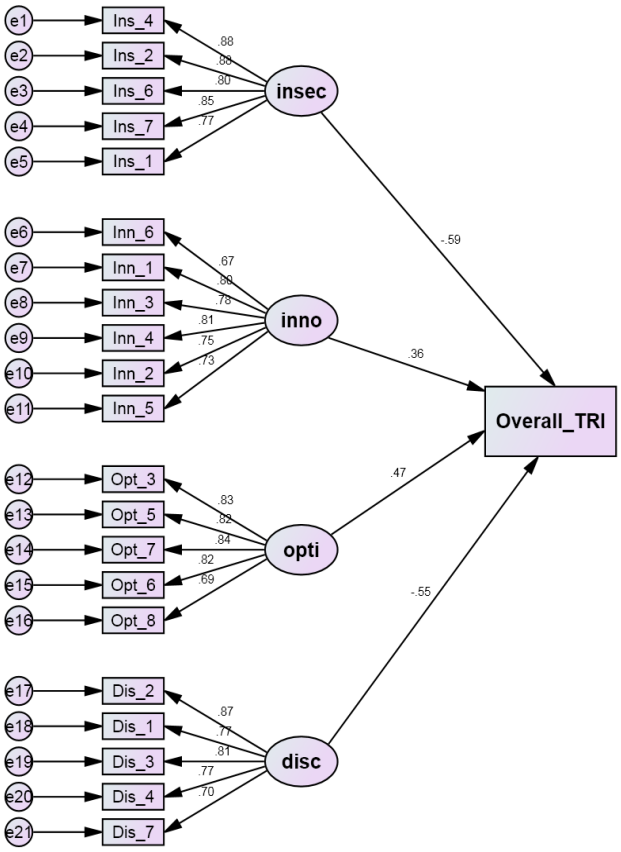

Figure:4 Model Hypothesis Result

F. Results of Technology Readiness Classification

The underlying belief structures of each Technology Readiness clustering may provide a meaningful explanation of why a particular student is more (or less) ready for using e-learning system. Several cluster techniques were deployed to obtain distinct groups with homogeneous user profiles based on technology readiness index dimensions [24,2]. The relatively large data set of the sample case study and the need of clustering procedure that can rapidly form clustering based on Likert scale lead to preconizing a two-step cluster technique. Therefore, in such situation methodologists advocate the use of a two-step cluster procedure. In the first step a hierarchical algorithm determines the number of clusters and starting means which are then as second step inputs into the subsequent non hierarchical algorithm that is run to achieve final clustering [23].

Using SPSS 20, the first step of the procedure was to calculate the Schwarz's Bayesian information criterion (BIC) for each number of clusters within a specific range that estimate the initial number of clusters. The second step refines the initial estimate using log-likelihood by finding the greatest change in distance between the two closest clusters in each hierarchical clustering stage. We first tested the existence of the five classes presented in table 1. Only three out of five clusters described by Parasuramen and Colby 2001 confirmed their existence, which are: Laggard, Pioneers and Skeptics. Then, we choose four clusters and the result confirmed the non-existence of Explorer class and only four of them are remaining.

Table:8 TRI Classification Result

Clusters

Input (Predictor) Importance
1.0 0.8 0.6 0.4 0.2 0.0

Cluster	2	3	1	4
Label				
Description	PARANOIDS	PIONNERS	SKEPTICS	LAGGARDS
Size	37.8% (145)	21.4% (82)	20.6% (79)	20.3% (78)
Inputs	Inno 3.23	Inno 2.22	Inno 2.26	Inno 3.44
	Inse 3.75	Inse 3.89	Inse 3.03	Inse 4.44
	Optim 3.79	Optim 3.48	Optim 2.60	Optim 4.31
	Disc 3.94	Disc 3.86	Disc 3.44	Disc 4.51

The ANOVA tests (with Games-Howell post-hoc comparisons) indicated that there are significant differences between the four classes in all TRI dimensions at the 0.001 level. The four remaining clusters matched four of the five classes described by Parasuraman and Colby (2001).

Table:8 TRI Dimensions per Class

	Classe1 Skeptics(N=79)		Classe2 Paranoids(N=145)		Classe3 Pioneers(N=82)		Classe4 Laggards(N=78)		One-way ANOVA	
	M	SD	M	SD	M	SD	M	SD	F	P
Optimism	**2.60**	**0.68 (2,3,4)***	**3.79**	**0.42 (1,3,4)**	**3.48**	**0.47 (1,2,4)**	**4.30**	**0.55 (1,2,3)**	**148.20**	**0.000**
Innovativeness	**2.26**	**0.60 (2,4)**	**3.22**	**0.36 (1,3)**	**2.22**	**0.32 (2,4)**	**3.43**	**0.66 (1,3)**	**152.27**	**0.000**
Discomfort	**3.44**	**0.56 (2,3,4)**	**3.94**	**0.20 (1,4)**	**3.86**	**0.24 (1,4)**	**4.51**	**0.33 (1,2,3)**	**130.11**	**0.000**
Insecurity	**3.03**	**0.61 (1,2,3,4)**	**3.75**	**0.33 (1,4)**	**3.88**	**0.29 (1,4)**	**4.43**	**0.43 (1,2,3)**	**149.28**	**0.000**
OverallTRI	**3.40**	**0.39 (2)**	**3.16**	**0.17 (1,3)**	**3.51**	**0.17 (2,4)**	**3.30**	**0.30 (3)**	**32.46**	**0.000**

VI. Discussion and Conclusion

The main objective of the current study is to determine the dominant factor that have the most influence on the overall TRI change.

Based on our results, one can state that the surveyed students are fairly ready for an e-learning system technology. In fact, the table 6 shows that the overall TRI, 3.31, is around the average of Likert scale deployed in this study. The correlation between optimism and innovativeness, 0.733, and between discomfort and insecurity, 0.53, are the highest correlation amongst all TRI factors (table 5). This result is predictable because the pairs of factors defined respectively the contributors and inhibitors which describe the readiness of students to use the e-learning system technology. To determine the main factor that influence the overall TRI, one can distinguish from figure 4 that the inhibitor factors shown to be more positive with absolute value (0.59; 0.55) in relation to technology than the contributor ones (0.47; 0.36). Thus, despite their belief that technology may offer efficiency and authority in their studies, students in Umm al-qura university are still reticent about the use of e-learning system. However, the survey found that the technology readiness varies from a student to another. The last result was validated and confirmed in table 7, where we obtained four student's belief classes. The Explorers class has not been found, which indicates the non existence of students who are highly motivated and fearless to try e-learning system technology. A relatively small percentage of students surveyed, 20.3%; belong to the Laggard class. They represent the resistant students who may never use the e-learning system unless they are forced to do so. Moreover, a relatively small class of the respondents were skeptics, 20.6 %. These students are no highly motivated nor highly resistant to use of e-learning system, but they need to be convinced of the benefit of the emerged e-learning system. Our results show that the majority of surveyed students belong to the class of Paranoids (37.8) %, who were convinced of the benefits of the e-learning system technology but were preoccupied about the imminent risks and obstacles of technology adoption. The second significant class is the Pioneers (21.4) %, in which students have an desire to acquire the benefits of the new technology but were more practical about difficulties and obstacles involved. Pioneers need help in making the technology work for them and require some degree of assurance. In fact, as shown in table 8, 79.4 % of the students manifested the presence of high score in insecurity and discomfort about technology. Thus, one can maintain that the students of Umm al-qura University feel insecure and this is the main factor that explains their reticence about the use of e-learning system. To resolve this situation, we need to reassure the students by encouraging them to participate in the training programs provided by university where they can be more aware and confident about the e-learning system.

Our study may suffer from some limitations specially related to the relatively small sample size explained by the recent implementation of the e-learning system in the university. Care should then be taken into account in interpreting and generalizing the reached results.

For future research, we recommend comparative studies to be conducted on other Saudi Arabia university students for a clearer vision about their tendency to embrace the e-learning system. In addition, further research may consider to take into account more than the student's belief but also the acceptance and the practice of the use of an e-learning system for students as well as for teachers.

Appendix 1

Optimism	
Opt_1*	Technology gives more control over their daily lives
Opt_2*	Products and services that use the newest technologies are much more convenient to use
Opt_3	You like the idea of doing business via computers because you are not limited to regular business hours
Opt_4*	You prefer to use the most advanced technology available
Opt_5	You like computer programs that allow you to tailor things to fit your own needs
Opt_6	Technology makes you more efficient in your occupation
Opt_7	You find new technologies to be mentally stimulating
Opt_8	Technology gives you more freedom of mobility
Opt_9*	Learning about technology can be as rewarding as the technology itself\\
Opt_10*	You feel confident that machines will follow through with what you instructed them to do
Innovativeness	
Inn_1	Other people come to you for advice on new technologies
Inn_2	It seems your friends are learning more about the newest technologies than you are [reverse scored]\\
Inn_3	In general, you are among the first in your circle of friends to acquire new technology when it appears
Inn_4	You can usually figure out new high-tech products and services without help from others
Inn_5	You keep up with the latest technological developments in your areas of interest
Inn_6	You enjoy the challenge of figuring out high-tech gadgets
Inn_7*	You find you have fewer problems than other people in making technology work for you
Discomfort	
Dis_1	Technical support lines are not helpful because they do not explain things in terms you understand
Dis_2	Sometimes, you think that technology systems are not designed for use by ordinary people
Dis_3	There is no such thing as a manual for a high-tech product or service that is written in plain language
Dis_4	When you get technical support from a provider of a high-tech product or service, you sometimes feel as if you are being taken advantage of by someone who knows more than you do
Dis_5*	If you buy a high-tech product or service, you prefer to have the basic model over one with a lot of extra features
Dis_6*	It is embarrassing when you have trouble with a high-tech gadget while

	people are watching
Dis_7	There should be caution in replacing important people-tasks with technology because new technology can breakdown or get disconnected
Dis_8*	Many new technologies have health or safety risks that are not discovered until after people have used them
Dis_9*	New technology makes it too easy for governments and companies to spy on people
Dis_10*	Technology always seems to fail at the worst possible time
Insecurity	
Ins_1	You do not consider it safe giving out a credit card number over a computer
Ins_2	You do not consider it safe to do any kind of financial business online
Ins_3	You worry that information you send over the Internet will be seen by other people
Ins_4	You do not feel confident doing business with a place that can only be reached online
Ins_5*	Any business transaction you do electronically should be confirmed later with something in writing
Ins_6*	Whenever something gets automated, you need to check carefully that the machine or computer is not making mistakes
Ins_7	The human touch is very important when doing business with a company
Ins_8*	When you call a business, you prefer to talk to a person rather than a machine
Ins_9*	If you provide information to a machine or over the Internet, you can never be sure it really gets to right place

**item excluded from the analysis with low loading(less than 0.5)*

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