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On the Factors Affecting Computing Students' Awareness of the Latest ICTs

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***Abstract*—**The education sector is constantly faced with rapid changes in technologies in terms of ensuring that the curriculum is up to date and in terms of making sure that students are aware of these technological changes. This challenge can be seen as the motivation for this study, which is to examine the factors affecting computing students' awareness of the latest Information Technologies (ICTs). The aim of this study is divided into two sub-objectives which are: the selection of relevant theories and the design of a conceptual model to support it as well as the empirical testing of the designed model. The first objective is achieved by a review of existing literature on technology adoption theories and models. The second objective is achieved using a survey of computing students in the four universities of the KwaZulu-Natal province of South Africa. Data collected from this survey is analyzed using Statistical package for the Social Science (SPSS) using descriptive statistics, ANOVA and Pearson correlations. The main hypothesis of this study is that there is a relationship between the demographics and the prior conditions of the computing students and their awareness of general ICT trends and of Digital Switch Over (DSO) a new technology which involves the change from analog to digital television broadcasting in order to achieve improved spectrum efficiency. The prior conditions of the computing students that were considered in this study are students' perceived exposure to career guidance and students' perceived curriculum currency. The results of this study confirm that gender, ethnicity, and high school computing course affect students' perceived curriculum currency while high school location affects students' awareness of DSO. The results of this study also confirm that there is a relationship between students prior conditions and their awareness of general ICT trends and DSO in particular.

***Keywords*—**Education, Information Technologies, IDT, awareness.

I. Introduction

EXISTING literature reveals that education is faced with constantly changing technologies, as indicated by various researchers from different academic disciplines including mechanical engineering [1], civil engineering [2], and information technology [3]. It is therefore important for a good curriculum to keep up with technological changes in terms of content and in terms of teaching methods even though it is difficult to anticipate technology changes in the design phase of a curriculum. This is because the curriculum is expected to be the medium by which students can become more aware of new ICT trends such as Digital Switch Over (DSO), thereby enabling them to play a creative and active role in the design and adoption of new technologies.

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A. Problem Statement

Computing students are the expected architects of the hardware and software requirements of new technologies as they emerge, however the risk of having redundant and unskilled workers in the industry is unavoidable if the curriculum is not constantly reviewed by incorporating new advances in technology into it, especially if the students are not aware of these technologies. Therefore, the curriculum must always be up to date to prepare graduates for the future. In addition, strategies must be put in place to ensure that students are aware of new technologies. This problem of having redundant and unskilled workers in the industry, which can result from computing students being unaware of new technologies gives rise to the main research question of this study, which is also further divided into sub research questions. These research questions will be followed by the research aim and objectives of this study.

B. Main Research Question

How can the analysis of the factors affecting computing students' awareness of the latest ICTs be translated into recommendations on the improvement of technology awareness in the education sector?

Research question 1: Which theories or theory can help to understand the factors affecting ICT students' awareness of the latest ICTs?

Research question 2: How can the factors affecting ICT students' awareness of the latest ICTs be shaped into a conceptual model?

Research question 3: How can the conceptual model of research question 2 be empirically validated?

Research question 4: Which recommendations can be suggested from the analysis of the factors affecting ICT students' awareness of the latest ICTs for the improvement of technology awareness in the education sector

C. Aim and Objectives

The aim of this study is to examine factors affecting computing students' awareness of the latest ICTs.

This aim is carried out by the following research objectives:

a. To select relevant theories that can help to understand the factors affecting students' awareness of the latest ICTs;
b. To design a conceptual model of the factors affecting students' awareness of the latest ICTs;
c. To empirically test the above conceptual model of the factors affecting students' awareness of the latest ICTs; and
d. To make appropriate recommendations for the improvement of technology awareness within higher

education, especially through curriculum initiatives

II. Literature Review

Internet keywords were derived from the research objectives of this study in order to carry out the literature review hereby presented.

A. Theories

Evidence from existing literature indicate that technology awareness is a primary stage of technology adoption. Actually, a technology user is said to be aware of a given technological innovation when he or she obtains rudimentary information about that technology, and perhaps about its benefits and drawbacks; and many studies have shown that technology awareness is one of the first steps of technology adoption. For this reason, technology adoption theories can be selected as a theoretical framework which can help to understand the factors affecting students' awareness of the latest ICTs. These technology adoption theories are Technology acceptance model, Social learning theory, Theory of Planned Behavior and Innovation Diffusion Theory, which was finally selected as the theoretical framework of this study.

1. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by [4], and it is a model which has a reputation of being one of the most useful in technology adoption studies [5]-[6]. According to TAM, a person will cultivate an attitude towards an innovation based on how he or she perceives the usefulness of that innovation to him or her and depending on how he or she perceives that innovation's ease of use. Thus, the attitude of an individual towards the innovation will lead him or her to develop an intention to use or not to use the innovation in question, and it is that intention which will ultimately lead to the acceptance or refusal to use the innovation.

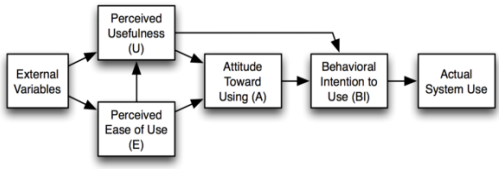

Fig. 1 Technology Acceptance Model (TAM)

2. Theory of Planned Behaviour (TPB)

The theory of planned behaviour posits that the behaviour of an individual is driven by his or her intentions, and people's intentions depend on their attitudes, on their subjective norm, and their perceived behavioral control [7].

3. Social Learning Theory (SLT)

Social learning theory is grounded on the belief that the behaviour of a person depends on three types of factors: cognitive, behavioural, and environmental factors [8]. A person's cognitive features are his or her expectations and attitudes; while his or her behavioural characteristics are his or her skills, self-efficacy, and experience. Environmental factors which may affect the behaviour of a person are his or her social norms, the facilities accessible in his or her community, and his or her ability to influence others. This theory explains that people's behaviour depends on what they have learned from their own environments, from their personality, and from their past experiences, also from the knowledge they have acquired from the behaviour of others.

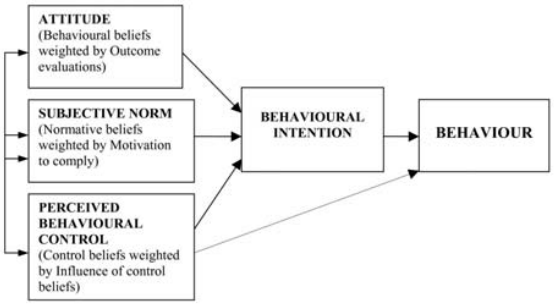

Fig. 2. Theory of Planned Behavior

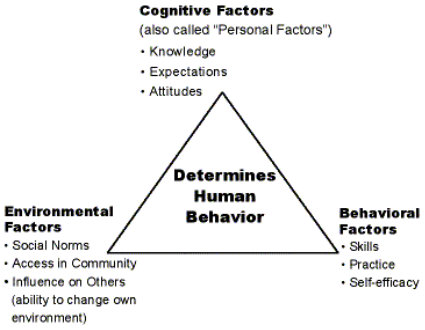

Fig. 3 Social Learning Theory

4. Innovation Diffusion Theory (IDT)

The innovation diffusion theory (IDT) states that, a primary step that precedes the acceptance or rejection of an innovation is the acquisition of knowledge about the innovation. It is the acquired knowledge that will encourage the potential adopter to decide to adopt or reject the innovation in question, either permanently or temporarily. Furthermore, according to IDT, there are five attributes of an innovation: relative advantage, compatibility, complexity, trialibility, and observability. Relative advantage is the extent to which an innovation is believed to provide more benefit than its antecedents. Compatibility is the extent to which an innovation is perceived as being consistent with existing values, with past experiences and with the users' needs. Complexibility is the extent to which an innovation is perceived as being relatively difficult to use. Trialibility is the degree to which an innovation can be tested, and observability is the extent to which an innovation is tangible rather than being intangible. The IDT finally postulates that users' prior conditions such as their prior needs, previous practices, and their personal characteristics such as their demographics and their socioeconomic conditions have an effect on their

knowledge of innovations whose diffusion is propagated via relevant communication channels [9].

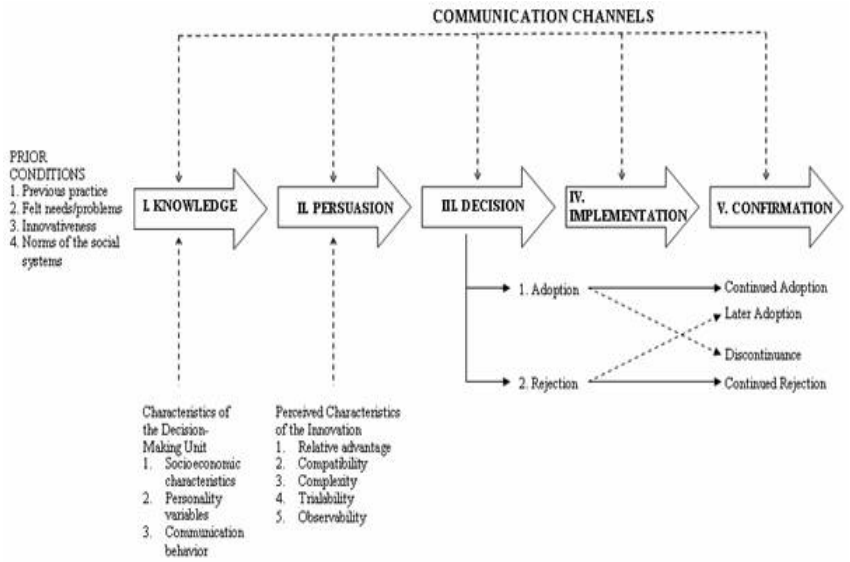

Fig. 4 Innovation Diffusion Theory

B. A New Conceptual Model

Four theoretical models (TAM, TPB, SLT and IDT) have been presented in the section above on technology adoption models. Seven constructs were identified from these models (perceived usefulness, perceived ease of use, intention, behaviour, knowledge, and perceived behavioural control) in order to choose the ones that are closest to the concept of technology awareness. It seems that the knowledge construct from the Innovation Diffusion Theory or IDT is the nearest construct to awareness. For this reason, this study is choosing IDT as the main theoretical framework that can help in the design of a conceptual model of the factors affecting ICT students' awareness of the latest ICTs. The IDT postulates that a person's knowledge on a given technology depends on their previous experiences, on their previous practices, and on their innovativeness. These previous experiences and practices are classified as prior conditions by IDT. Thus, IDT posits that technology knowledge is affected by prior conditions. One of the main hypotheses of the current study is, therefore, that technology awareness is affected by prior conditions, and this is directly inspired from IDT except that in this study, prior conditions refer to exposure to career guidance opportunities and perceived currency of existing curriculum, and awareness refers to students' awareness of latest ICT trends as well as their awareness of DSO. This study finally postulates that both prior conditions and awareness have a relationship with students' demographics.

The model presented in Fig. 5 represents the following hypotheses to be empirically tested by the third objective of this study:

Ha0: The demographics of a student have a direct relationship with his or her perceived exposure to career guidance.

Hb0: The demographics of a student have a direct relationship with his or her perceptions on the currency of his or her curriculum.

Hc0: The demographics of a student have a direct relationship with his or her perceived awareness of the latest ICT trends.

Hd0: The demographics of a student have a direct relationship with his or her perceived awareness of DSO.

He0: A student's perceived exposure to career guidance opportunities has a direct relationship with his or her perceived awareness of DSO.

Hf0: A student's perceptions on the currency of his or her curriculum have a direct relationship with his or her perceived awareness of DSO.

Hg0: A students' perceived awareness of the latest ICT trends has a direct relationship with his or her perceived awareness of DSO.

Hh0: A student's perceived exposure to career guidance has a direct relationship with his or her perceived awareness of the latest ICT trends.

Hi0: A student's perceptions on the currency of his or her curriculum have a direct relationship with his perceived awareness of the latest ICT trends.

Hj0: A student's perceived exposure to career guidance has a direct relationship with his or her perceptions on the currency of his or her curriculum.

C. Empirical Studies

After a review of existing literature, studies were found which studies the factors that affect the adoption of technologies by education stakeholders such as students and faculties. The studies utilized the Innovation diffusion theory in their research, but they were carried out in different

countries United States [10] – [16], Iran [17], Bhutan [18], Malaysia [19], Lesotho [20], Nigeria and Benin Republic [21].

TABLE I
DERIVATION OF CONCEPTUAL MODEL

Construct	Model	Closeness to awareness
Perceived Usefulness	TAM	No
Perceived ease of use	TAM	No
Attitude	TRA, TPB, TAM	No
Intention	TRA, TPB, TAM	No
Subjective Norms and environmental factors	TRA, TPB, social learning theory	No
Behaviour	TRA, TAM, Social learning theory	No
Knowledge	IDT	Yes
Persuasion	IDT	No
Decision	IDT	No
Implementation	IDT	No
Confirmation	IDT	No
Perceived behavioural control	TPB	No

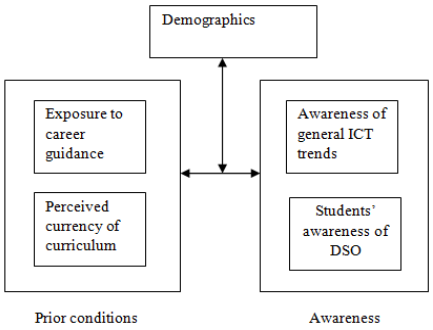

Fig. 5 Conceptual model

1. Innovation Characteristics

According to [17] and [18] innovation characteristics such as relative advantage, compatibility, complexity, triability and observability affect faculty adoption of technologies. On the other hand, according to [21]-[23], Innovation characteristics also affect university students' adoption of technologies.

2. Prior conditions

Reference [11], [16] assert that prior conditions such as norms of the social system like peer support, friends, physical resources affect faculty members' adoption of a technology. In addition, [12] explains that previous practices of faculty members such as their expertise affect their adoption of innovations.

3. Characteristics of Decision Making Unit

Reference [11] explains that the interest of faculty members in improving learning affects their decisions to accept or reject an innovation. Furthermore, [24] explains that characteristics of decision making unit such as ability to devote time to innovation affect their adoption of that innovation.

D. Research Gap

The studies that were reviewed in this paper which utilized the IDT examined the factors that influence students or the faculty members' adoption or rejection of a new technology. However, none of the studies were found to examine the factors that affect students' awareness of the latest technologies.

III. Research Design

The objectives of this study were attained with the aid of quantitative (1, 2, and 4) objectives and quantitative (objective 3) research methods.

A. Content Analysis Using Literature Review Method

Research objectives 1, 2 and 4 were achieved by examining the content that was obtained from existing literature on adoption of technology in the education sector.

B. Survey of Computing Students

The conceptual model proposed by this study was empirically validated using a survey of 116 students chosen from the four universities of the KwaZulu-Natal province of South Africa.

1. Population and Sampling

The population of this study is made up of 619 computing students. The sample was calculated using (1). Where Z is the level of confidence, P is the proportion and d is the precision or acceptable margin of error, N is the population size, which gives a sample of 121 computing students. However, five of the questionnaires were not fully completed which resulted in their removal from the final questionnaire that were analyzed.

$$n = \frac{Z^2 P(1-P)}{d^2(N-1) + Z^2 P(1-P)} \quad (1)$$

2. Research Variables and Data Collection

The research variables for this study are illustrated in fig 4. Data for this study was collected using a Likert scale of 10 items for students' exposure to career guidance, 10 items for perceived curriculum currency, 10 items for general ICT trends, and 10 items for students' awareness of DSO. The demographic of the students had items such as age, gender, high school location, high school computing course and ethnicity.

IV. Results

This section presents the result of this study on the factors affecting computing students' awareness of the latest ICTs. This presentation starts with reliability and validity test results of the questionnaire variables.

A. Data Validity and Reliability

Table II shows that the data collected in this study are reliable due to the fact that all the variables have Cronbach's alpha > 0.7.

B. Descriptive Statistics

This section presents the results of the descriptive statistics on demographics of the computing students that were surveyed, their perceived exposure to career guidance, their perceived awareness of general ICT trends, their perceived curriculum currency, and their DSO awareness.

TABLE II
RELIABILITY TABLE FOR THE RESEARCH VARIABLES

Research Variables	No of questionnaire Items	Cronbach's Alpha Coefficient (α)
Exposure to Career guidance Opportunities	10	0.755
Awareness of general ICT trends	10	0.836
Perceived currency of the curriculum	10	0.869
Digital Switch Over (DSO) awareness	10	0.948

1. Demographics

The results of the descriptive statistics of the demographic items presented in Table VII show that certain group dominate the others but other demographic items are almost balanced. The demographic items that are almost balanced are: A4 (programme of study), A7 (high school location), and A8 (high school computing option). On the other hand, the demographic item A6 (high school maths option) is clearly dominated by students who took core maths. This is also the situation with the demographic item A5 (mode of study) which is clearly dominated by full time students. In addition, A3 (Ethnicity) is dominated by students from African origins. The same applies to gender item with male students, and to the age item with most students aged between 20 and 22 years old.

2. Students' Exposure to Career Guidance

Table III indicates that the majority of the career guidance mechanisms is rated as average by students. However, students believe that they hardly receive career guidance from voluntary work, internships, WIL, apprenticeships, etc., but on the other hand, they receive much helpful career guidance from the media, and from the teachers. Also, the students rate their overall exposure to career guidance opportunities as average.

3. Students' Exposure to General ICT Trends

Results from Table IV shows that students rate their awareness of most ICT trends as average. However, they rate their awareness of social media technologies, mobile wireless technologies, voice over internet protocol (VOIP) technologies used for transmitting voice over the internet as high. However, students rate their overall awareness of ICT trends as average.

4. Students' Perceived Curriculum Currency

Table V shows that students rate the currency of their curriculum as average for half of the curriculum currency perception items. However, students rate the currency of their curriculum as high for the other half items use of technology for teaching and learning, catering for diversity within the student population, applied to many real life situations, regular updating of textbooks and learning materials, regular professional training opportunities for lecturers. It is very interesting to note that, students are rating the currency of their curriculum as high.

TABLE III
STUDENTS' EXPOSURE TO CAREER GUIDANCE

B	S1	S2	S3	S4	S5	Mean	SD
B1	13	16	22	35	14	3.22	1.243
B2	12	27	28	27	7	2.9	1.137
B3	4	10	28	46	12	3.51	0.982
B4	9	23	22	39	7	3.1	1.13
B5	5	16	27	16	46	3.38	1.069
B6	1	8	16	46	30	3.97	0.922
B7	4	16	27	41	12	3.41	1.031
B8	12	37	31	17	3	2.61	0.994
B9	16	41	26	15	3	2.47	1.008
B10	8	34	38	16	3	2.73	0.945
TOTAL	**8**	**23**	**27**	**30**	**14**	3.13	

TABLE IV
STUDENTS' EXPOSURE TO GENERAL ICT TRENDS

C	S1	S2	S3	S4	S5	Mean	SD
C1	2	13	3	44	9	3.47	.899
C2	2	16	42	34	7	3.28	.873
C3	3	16	32	40	9	3.34	.969
C4	3	6	27	42	22	3.76	.957
C5	6	16	38	33	7	3.18	.992
C6	5	21	31	34	9	3.22	1.045
C7	4	23	32	32	9	3.17	1.024
C8	5	22	29	24	26	3.27	1.114
C9	2	5	24	46	23	3.84	.904
C10	3	13	26	41	17	3.55	1.033
TOTAL	**4**	**15**	**31**	**37**	**13.8**	3.41	

5. Students' DSO Awareness

It is interesting to note that, students rate their awareness of digital switchover as low for each of the DSO awareness items and for DSO awareness as a variable (Table VI).

C. Correlations

The results from Tables VII and VIII are summarized in Fig. 6 whose interpretation combined with the initial hypotheses leads to the following results.

TABLE V
STUDENTS' PERCEIVED CURRICULUM CURRENCY

D	S1	S2	S3	S4	S5	Mean	SD
D1	3	11	40	41	13	3.36	.859
D2	3	12	50	31	3	3.19	.823
D3	3	7	37	42	10	3.49	.899
D4	3	8	29	47	12	3.57	.925
D5	3	10	45	32	9	3.34	.913
D6	3	4	43	42	7	3.45	.827
D7	4	4	28	41	22	3.72	1.001
D8	3	3	33	47	15	3.66	.884
D9	3	5	40	41	10	3.50	.880
D10	3	4	18	42	32	3.95	.994
TOTAL	**3**	**7**	**36**	**41**	**13**	3.52	

TABLE VI
STUDENTS' DSO AWARENESS

E	S1	S2	S3	S4	S5	Mean	SD
E1	22	33	28	11	4	2.44	1.113
E2	22	33	28	13	3	2.42	1.081
E3	17	32	28	20	3	2.6	1.094
E4	16	28	34	20	3	2.65	1.057
E5	14	26	30	26	4	2.81	1.103
E6	15	29	30	22	3	2.71	1.08
E7	12	25	29	28	5	2.9	1.106
E8	15	26	35	18	6	2.75	1.102
E9	15	32	39	10	4	2.58	1.006
E10	14	37	22	22	4	2.66	1.103
TOTAL	**16**	**30**	**30**	**19**	**4**	2.65	

TABLE VII
DESCRIPTIVE STATISTICS FOR DEMOGRAPHICS

A		Percentage
A1	Less 20	10.3
	20-22	66.4
	23-25	14.7
	26-28	6.9
	Above 28	1.7
A2	Male	71.6
	Female	28.4
A3	African	80.2
	Indian	17.2
	Coloured	0.9
	White	1.7
A4	DUT	25
	MUT	18.1
	UKZN	36.2
	UNIZULU	20.7
A5	Computer System	24.1
	Computer Science	42.2
	Information Technology	33.6
A6	Full Time	94.8
	Part Time	5.2
A8	Maths Literacy	1.7
	Core	98.3
A9	Urban	54.3
	Rural	45.7
A10	End User Computing	52.6
	Programming	37.1
	Others	10.3

- Ha_1: The demographics of a student has no direct relationship with his or her perceived exposure to career guidance.
- Hb_0: Gender, ethnicity and high school computing course of a student have a direct relationship with his or her perceptions on the currency of his or her curriculum.
- Hc_1: The demographics of a student has no direct relationship with his or her perceived awareness of the latest ICT trends.
- Hd_0: The high school location of a student has a direct relationship with his or her perceived awareness of DSO.
- He_0: A student's perceived exposure to career guidance opportunities has a direct relationship with his or her perceived awareness of DSO.
- Hf_0: A student's perceptions on the currency of his or her curriculum have a direct relationship with his or her perceived awareness of DSO.
- Hg_0: A students' perceived awareness of the latest ICT trends has a direct relationship with his or her perceived awareness of DSO.
- Hh_0: A student's perceived exposure to career guidance has a direct relationship with his or her perceived awareness of the latest ICT trends.
- Hi_0: A student's perceptions on the currency of his or her curriculum have a direct relationship with his perceived awareness of the latest ICT trends.
- Hj_0: A student's perceived exposure to career guidance has a direct relationship with his or her perceptions on the currency of his or her curriculum.

TABLE VIII
CORRELATIONS INVOLVING DEMOGRAPHICS

		B	C	D	E
A1	Pearson Correlation	0.625	0.423	0.044	0.521
	Sig (2-tailed)	0.646	0.792	0.996	0.721
	N	115	115	115	115
A2	Pearson Correlation	0.241	0.748	8.151	0.026
	Sig (2-tailed)	0.625	0.389	0.005	0.872
	N	115	115	115	115
A3	Pearson Correlation	0.931	1.698	2.88	1.283
	Sig (2-tailed)	0.428	0.172	0.039	0.284
	N	115	115	115	115
A4	Pearson Correlation	2.053	2.656	1.608	2.527
	Sig (2-tailed)	0.111	0.052	0.191	0.061
	N	115	115	115	115
A5	Pearson Correlation	0.323	0.683	1.183	0.419
	Sig (2-tailed)	0.725	0.507	0.31	0.659
	N	115	115	115	115
A6	Pearson Correlation	0.394	0.184	0.431	0.433
	Sig (2-tailed)	0.532	0.669	0.513	0.512
	N	115	115	115	115
A7	Pearson Correlation	2.609	0.028	0.295	4.058
	Sig (2-tailed)	0.109	0.868	0.588	0.046
	N	115	115	115	115
A8	Pearson Correlation	0.428	0.059	0.579	0.007
	Sig (2-tailed)	0.514	0.808	0.448	0.935
	N	115	115	115	115
A9	Pearson Correlation	0.325	0.616	1.183	4.608
	Sig (2-tailed)	0.57	0.434	0.279	0.034
	N	115	115	115	115
A10	Pearson Correlation	0.629	2.954	4.422	2.074
	Sig (2-tailed)	0.535	0.056	0.014	0.13
	N	115	115	115	115

TABLE IX
CORRELATIONS BETWEEN VARIABLES

		B	C	D	E
B	Pearson Correlation	1	.288**	.508**	.350**
	Sig. (2-tailed)		.002	.000	.000
	N	116	116	116	116
C	Pearson Correlation	.288**	1	.303**	.375**
	Sig. (2-tailed)	.002		.001	.000
	N	116	116	116	116
D	Pearson Correlation	.508**	.303**	1	.362**
	Sig. (2-tailed)	.000	.001		.000
	N	116	116	116	116
E	Pearson Correlation	.350**	.375**	.362**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	116	116	116	116

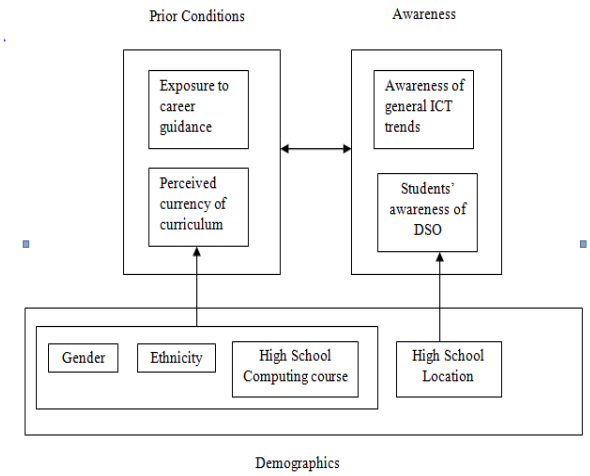

Fig. 6 The validated model

V. DISCUSSION AND CONCLUSION

The following points properly explain the paper on the factors that affect computing students' awareness of the latest ICTs.

a. Existing literature reviewed by this study assert that the IDT can be used to analyze or study the factors that affect education stakeholder awareness and possible adoption of innovations.
b. According to existing literature, one can hypothesize a model linking students' demographics and their prior conditions with the following constructs: student' perceived exposure to career guidance, students' perceived exposure to general ICT trends, Students' perceived curriculum currency, and students' DSO awareness.
c. According to the result of the survey conducted in this study, gender, ethnicity, and high school computing course affect students' perception on the currency of their curriculum and high school location affects their DSO awareness.
d. According to the results of the current study, students' awareness of DSO is low. Therefore, this study recommends that further research should be conducted on methods of ensuring that students become more aware of new ICT trends such as DSO in order to facilitate their active participation in the design and adoption of new technologies.

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