Innovation for Computing Students Matters, of Course!

Full Paper

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Abstract. Literature identifies enablers promoting Innovative Behavior (IB) among employees. Modelling motivation, metacognition and affective aspects of learning towards developing IB among Information Systems (IS) and Information Technology (IT) Higher Education Institution (HEI) students is, however, not well-understood. The study objectives included addressing this literature gap by examining how motivation, metacognition and affective aspects of Self-Directed Learning (SDL) act as antecedents of IB via Knowledge Sharing Behavior (KSB). A quantitative cross-sectional survey was employed with 268 students enrolled in IS and IT programs, from seven Kenyan public HEIs. Data collected using a questionnaire, with a 2,000-bootstrap sample generated direct and indirect effects. Findings are summated in a structural equation model for students in an educational context, largely supporting all hypotheses. Findings also revealed that SDL acted as a driver of KSB and IB among IS and IT students. Implications for HEI managers include leveraging attributes of IB antecedents in learning contexts.

Keywords: Self-Directed Learning, Innovation, Motivation, Metacognition, Affective Aspects.

1 Introduction

With Schuh, Zhang, Morgeson, Tian and Van Dick [1] pointing out that organizations are increasingly depending on employees' efforts towards innovation, research has identified several individual and contextual level factors that promote Innovative Behavior (IB) among employees. However, the effect of Self-Directed Learning (SDL), Course Design Characteristics (CDC) and Knowledge Sharing Behavior (KSB) in facilitating the development of innovative behavior among Information Technology (IT) students at Higher Education Institutions (HEIs) is not well understood. Most of the existing literature, correlating knowledge-sharing behavior with innovative behavior, however, focus on employee innovation and has limited applicability to students [2].

In terms of the determinants of students' innovation in higher education, Martín, Potočnik and Fras [3] view university education in the changing environment of computer technologies [4] as engines driving countries' growth and development, as innovation is being nurtured, and university students as the employees of tomorrow; as such, they are a major source of future innovation in organizational settings. Consequently, it is of interest to society to establish what happens within the confines of university education, as it plays a crucial role in molding and shaping students' innovative behavior.

Based on the aforementioned, the purpose of the study reported on in this paper was to develop a Structural Equation Model (SEM) of the individual and contextual drivers of innovative behavior among Information Systems and Information Technology students.

2 Innovative Behaviour

In terms of the research context represented by the study reported on in this paper, Foster and Heeks [5] analyzed the policy for inclusive innovation with regard to the mobile sector and base-of-the-pyramid markets in Kenya. Other on-going initiatives reported on by Kinyanjui and Spooner [6] included young innovators in Africa, who have formed technology incubators and co-working spaces, such as the iHub in Kenya.

In a qualitative study, drawing from social cognition perspectives within a constructivist paradigm, Schuh, et al. [1] shared the inter-active effects of employee Innovative Work Behavior (IWB) and leader-member exchange on performance rating, and found that these "may affect the recognition that employees receive for their innovative work behaviors." In the context of team performance management, Agarwal [7] examined the role of work engagement, together with the impact of social exchange relationships, on innovative work behavior.

In a related context, Bysted [8] investigated the moderating effects of mental involvement and job satisfaction on contextual variables related to innovative employee behavior, while Liu, Hodgson and Lord [9] explored the role of culture in e-learning against the background of innovation in construction education. Finally, Duff [10] observed multiple effects related to innovative behavior in a multi-source field study, whereas, in terms of design methods, Kumar [11], followed a structured approach to driving innovation in an organization.

3 Self-Directed Learning

Boekaerts, Pintrich, and Zeidner [12] pointed out that self-regulation involves affective, behavioral, cognitive and motivational components, which provide individuals with capacities towards adjusting their goals and actions towards achieving desired results in terms of changing environmental conditions. In their introductory review on the psychology of self-regulation, Forgas, Baumeister and Tice [13] also referred to affective, cognitive and motivational processes.

The contextual environment of Information Technology students provides them with high levels of autonomy and self-directed activities in the design of new technological solutions, during their project work. This autonomy requires the technology student to exercise a level of self-control in managing their project work and their work environment. Consequently, and similar to some aspects of that of O'Shea [14], this study places the focus on how undergraduate Information Systems and Information Technology students, as early-stage entrepreneurs, engage with and integrate their cognitive, emotional and motivational self-regulatory processes to continually aid, enhance, promote and support the success of" their ventures or innovative behavior [15, p. 118].

While Zimmerman, Boekaerts, Pintrich and Zeidner [16] provided a social cognitive perspective in their handbook of self-regulation, Zimmerman and Schunk [17] looked at the roles of theory, research and practice in self-regulated learning and academic achievement.

In an open and distance education context, Idrus [18] studied technological innovation towards adult self-directed learning in the off-campus academic program at the Universiti Sains Malaysia, whereas Fink [19] provided a self-directed guide to designing courses for significant learning.

3.1 Self-Directed Learning and Innovative Behavior

This paper further extends on modelling motivation, metacognition and affective aspects of learning towards smart innovation for IS and IT students [20].

In the context of management education and challenges for staff development, according to Broos [21], an important part of learning to learn is the ability to self-direct learning. Piskurich [22] looked at fostering self-directed learning in the context of a medical school, when curricular innovation was not enough. In terms of innovation in dental education, Hendricson, et al. [23] probed educational strategies associated with development of problem-solving, critical thinking and self-directed learning. Gabrielle, Guglielmino and Guglielmino [24] developed the self-directed learning readiness of future leaders in a military college through instructional innovation.

Chang [25] examined the organizational innovation environment, self-directed learning, course design strategies, technology factors and the performance of Web-based training, while Jen-Obrom [26] explored self-directed learning in the context of innovation for teaching and learning. In the context of teacher education and, more specifically, the Bologna Process, Kazlauskiene, Masiliauskiene, Gaucaite and Poceviciene [27] considered the organization of self-directed learning as educational innovation.

In the keynote presentation at the Asia-Pacific Educational Research Association conference, Mok [28] therefore interrogated self-directed learning-oriented assessment in terms of evolution and innovation, towards assessing to what extent students can engage with relevant possibilities in this regard [29].

In a book chapter on situated, self-directed knowing and learning in the Vocational Education and Training system, Falk and Surata [30] scrutinized the borderlands, where innovation and future directions meet the performativity of vocational learning.

For introducing self-directed learning in an innovation-friendly institutional context, the setting of the experiment conducted by Bailly and Carette [31] was that of the "French Department for Foreign Students" (DEFLE), which "is an old department of the University of Nancy, originally designed for the training of foreign students to prepare them to study a wide range of subjects.

In a synthesis of biology, innovation and education, Gadapati, Zhou and Huang [32] facilitated self-directed learning by providing first and second year students with an early research experience.

The purpose of the study by Sassiru [33] was the development of effective web-based learning/online lessons for Fundamental Marketing courses. To study the self-directed learning achievement of undergraduate students of the College of Social Communication Innovation, Srinakharinwirot University evaluated how efficient and congruent the courses were, with the 80/80 basic marketing curriculum (on which these were based).

4 Course Design Characteristics

The construct of course design characteristics was inspired by literature drawn from the field of Human Resource Management (HRM). The course design characteristics was an adaptation of the Work Design Questionnaire (WDQ), formulated by Hackman and Oldham [34]. The WDQ was developed and validated as a comprehensive measure for assessing job design and the nature of work, and later improved by Morgeson and Humphrey [35].

The WDQ scale has been used extensively in literature, and consists of four (4) subscales, namely task and knowledge characteristics, as well as aspects relating to social and work contexts. According to Morgeson and Humphrey [35, p. 1324], the social characteristics included "social support, interdependence, interaction outside the organization, and feedback from others", while "ergonomics, physical demands and equipment use" constituted the contextual characteristics.

In their more recent article, Parker, Morgeson and Johns [36] a bigger picture perspective was taken on one hundred years of work design research, while Morgeson, Brannick and Levine [37] investigated methods, research, and applications for human resource management in the context of work and job analysis. According to Morgeson, Spitzmuller, Garza and Campion [38], making job analysis judgments had a pivotal role in just about every aspect of Human Resources and was one of several high performance work practices, which were thought to underlie firms' performance. Finally, Battistelli, Montani and Odoardi [39] looked at the impact of feedback from job design and task autonomy in the relationship between dispositional resistance to change and innovative work behavior.

Strategy formulation is critical in guiding the process of course design, including aspects relating to the pedagogy underlying a particular course, as well as how such a course can be adapted [40] towards the end product and learning outcomes already in sight before the course commences. A good teaching strategy helps to organize the sequence of learning activities, with the aim of finding the sequence and combination of

learning activities, which work together best towards building high levels of student energy, which could be applied towards the task of learning [30].

In addition, effective course design leads to intended learning having greater meaning, resulting in students being provided with an increased range of technologies towards creating this learning [19]. Further, students get opportunities towards working closely with other students to promote each other's learning. This concept correlates with knowledge sharing as used in this study.

In terms of rethinking teaching and learning in the 21st century, course design characteristics can be implemented towards innovative behavior [41], like when Scott and Cong [42] evaluated course design principles for multimedia learning materials.

When computer lecturers use their institutional learning management system for Information Systems and Information Technology education in the cyber world [43], researchers such as Tabata and Johnsrud [44] can correlate the impact of faculty attitudes toward technology, distance education, and innovative behavior, in the context of research into university education, with course design.

5 Knowledge Sharing Behavior

According to Erasmus, Seale and Venter [45, p. 147], champions "engage in knowledge sharing within triad service learning partnerships. However, the" effect of knowledge sharing on the development of such champions needs further exploration. There is, however, ample evidence in literature of studies that have investigated the determinants of knowledge sharing behavior, including Amayah [46] in a public sector organization, as well as Papadopoulos, Stamati and Nopparuch [47] via employee weblogs. Kamasak and Bulutlar [48] identified knowledge-sharing behavior enablers and analyzed the influence of knowledge-sharing behavior processes on innovation performance on Spanish innovative firms. Studies having used Harman's single-factor test with knowledge-sharing behavior include Akram, Lei, Haider, Hussain and Puig [49], who provided empirical evidence from the Chinese telecommunication sector on the effect of organizational justice on knowledge sharing.

Literature like the study by Choi, Kim, Ullah and Kang [50] provided evidence that knowledge sharing significantly mediated how workers' transformational leadership facilitated the dependent variable of innovative behavior in Korean manufacturing firms. Camelo-Ordaz, García-Cruz, Sousa-Ginel and Valle-Cabrera [51] explored the mediating role of affective commitment and the influence of human resource management on the two independent variables of knowledge-sharing behavior and innovative behavior in Spain.

Previous studies like Afsar and Badir [52] also provided empirical evidence on the impacts of *person-organisation* fit and perceived organisational support, to suggest that knowledge-sharing behavior has mediating effects on innovative work behaviour. In terms of impact, Afsar [2] found that a nurse's *person-organization* fit was positively correlated with self and doctor ratings of innovative work behaviors, and knowledge-sharing behavior acted as a partial mediator between person-organization fit and innovative work behavior.

Previous studies also found that knowledge-sharing behavior mediated the relationship of various constructs to Individual Innovative Behavior (IIB). For example, Schuh, et al. [1, p. 397] found evidence to suggest that knowledge-sharing behavior moderated the relationship between employee innovative work behavior, perceived organizational support and the related constructs of leader–member exchange and performance ratings. Finally, computer lecturers can use emerging technologies in their course design to promote knowledge-sharing behavior and innovative behavior [53].

6 Research Design and Methodology

6.1 Population and Sampling

In this study, a population sample of 2000 was created and a 95% confidence interval for the population indirect effect was used to determine statistical significance. Considering the sample size of 249 participants, the moderate sample size problem was eliminated, like Hu and Wang [54], through the use of bootstrapping using Analysis of Moment Structures (AMOS) software.

6.2 Instruments Used in the Study

Measurement of Self-Directed Learning: The original Motivated Strategies for Learning Questionnaire (MSLQ) scale has two broad components: the motivation and learning strategies subscales, respectively. Usually, the motivation subscale is shown as having three subcomponents, namely value, expectancy, and affective components.

In formed by the manual for the use of the MSLQ from Pintrich, Smith, Garcia and McKeachie [55, p. v], the resource management strategies assumed the following four (4) subscales, namely:

(1) Time and study environment (8 items),
(2) Effort regulation (4 items),
(3) Peer learning (3 items), and
(4) Help seeking (4 items).

This study, however, adopted the remaining part of the cognitive and metacognitive learning strategies subscale of the MSLQ.

Measurement of self-directed learning was with the aid of a revised version of the Pintrich [56] 31-item, motivated strategies for learning questionnaire, which involved multiple goals and pathways, in terms of the role of goal orientation in learning and achievement.

Pintrich et al. [55] provided the reliability coefficients for the motivation scales as 0.68 and for the learning strategies scale as 0.62. For the present study, the reliability scores for the sub-constructs were as indicated in Table 1.

The scales had high reliability scores, which also closely compared to the original 0.62 value provided by Pintrich et al. [55].

Table 1. Comparison of reliability coefficients reported in the MSLQ manual and pilot study.

Scale	No. of Items	α in pilot study	α from MSLQ Manual
Rehearsal	4	.695	.69
Elaboration	6	.580	.76
Organization	4	.645	.64
Critical thinking	5	.787	.80
Metacognitive self-regulation	12	. 881	.79

Measurement of Course Design Characteristics: For the purpose of measuring course design characteristics, an adaptation of the motivational work characteristics developed by Morgeson and Humphrey [35] was used.

Measurement of Knowledge Sharing Behavior: The scale developed and validated by Yi [57] as a measure of knowledge sharing behavior was used in this study.

Measurement of Innovative Behavior: The instrument for the measurement of innovative behavior was described in Goosen and Ngugi [41].

In Goosen and Ngugi [58], further details will be provided with regard to especially the pilot study conducted, and how some of the data collection instruments were reduced. In this regard, Fan and Yan [59] provided a systematic review of factors affecting response rates for web surveys, while Morgeson, et al. [38] looked at the liabilities of the respondent experience.

6.3 Bootstrapping

Bootstrapping was employed, as it was the most appropriate analytic strategy to test the mediation effect of knowledge sharing. Further, bootstrapping, helps overcome the problem of underestimation of the significance of the mediation effect if the variables have measurement errors. In addition, it allows researchers to assess the stability of parameter estimates and can be applied to overcome the challenges posed by not having a large sample and problems in fulfilling the multivariate normality assumptions. Authors like Açıkgöz and Günsel [60] had applied the bootstrapping method in studies related to the mediating role of team decision processes on individual creativity and team climate in software development projects, with regard to the management of innovation behavior.

6.4 Missing Data Analysis

Byrne [61] argued that issues of missing data must be resolved irrespective of the cause of the data being missing. Following the latter author's suggestions with regard to the basic concepts, applications and programming related to structural equation modeling

with AMOS software, this research investigated the amount and the pattern of missing data in terms of randomness, in order to find suitable techniques to overcome the problem of missing data.

6.5 Ethical Considerations

Since this study involved research into real people, key ethical considerations included privacy issues with regard to anonymity and confidentiality, as suggested by Daymon and Holloway [62] with regard to especially qualitative research methods in public relations and marketing communications.

7 Results

As indicated by Goosen and Pieterse [63], courses that speak to and inform students' perceptions of their learning Information Systems and Information Technology in that particular context are more likely to stimulate innovative tendencies than courses that have limited Information Systems and Information Technology feedback. This finding is well corroborated by the available literature [39]. Similarly, the path linking self-directed learning and knowledge-sharing behavior, though significant (β=.287, $p<.01$), was not very strong, in comparison to the path linking course design characteristics and knowledge-sharing behavior.

As also discussed by Alsaeed [64] in terms of the association between firm-specific characteristics and disclosure for the case of Saudi Arabia, and illustrated in Table 2, Variance Inflation Factors (VIF) values for an explanatory variable greater than 10 posed a problem of multicollinearity with other explanatory variables.

Table 2. Collinearity statistics of the driver variables with self-regulated learning as the dependent variable.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	β	Std. Error	Beta			Tolerance	VIF
(Constant)	2.011	.433		4.646	.000		
Course design characteristics	.528	.161	.219	3.274	.001	.731	1.368
Knowledge sharing	.249	.105	.190	2.362	.019	.507	1.973
Innovative behavior	.142	.094	.118	1.520	.130	.547	1.827

By providing for theoretical sagacity, SEM generated indices of error modification, and the resultant suggestion of possible covariation. The resultant measurement model for learning strategies was as indicated in Fig. 1 and the corresponding fit indices in Table 3.

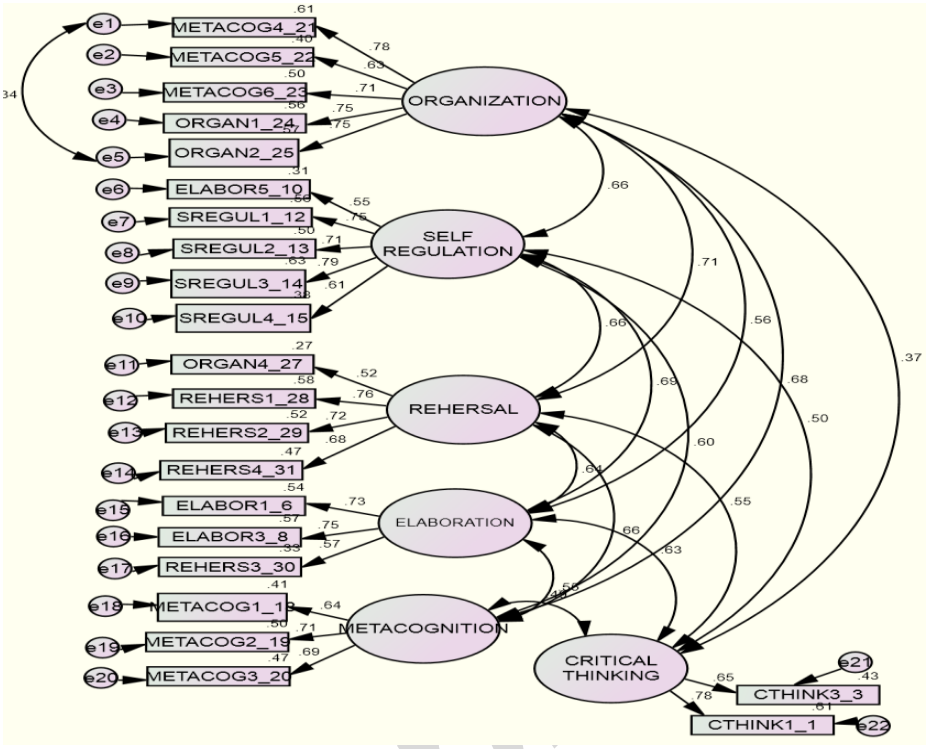

Fig. 1. Measurement model and fit indices for self-regulated learning factor solution.

With regard to the Chi-square ($\chi 2$) statistic, the measurement model for the **self-directed learning** construct, as illustrated in Table 3, did not produce acceptable fit, as the $\chi 2$ statistic was significant ($\chi 2$ =362.576, df=193, $p<0.05$). According to Hair, Wolfinbarger, Money, Samouel and Page [65], with regard to the essentials of business research methods, this suggested that the measurement model did not sufficiently explain for the observed covariation among the variables. All the other fit indices supported a good fit with the Tucker-Lewis Index (TLI) above the desired cut-off of 0.90. However, the Comparative Fit Index (CFI), Normed Fit Index (NFI), Goodness-of-Fit Index (GFI), and Adjusted Goodness-of-Fit Index (AGFI) were just below the border line and above 0.85. On the other hand, the Root Mean Square Error of Approximation (RMSEA) and Root Mean Square Residual (RMR) did not meet the recommended levels of 0.08 and 0.10 respectively, as suggested by Kline [66] regarding the principles and practice of structural equation modeling.

With regard to the Chi-square ($\chi 2$) statistic, the measurement model for the **knowledge-sharing behavior** construct, as illustrated in Table 4, did not produce acceptable fit, as the $\chi 2$ statistic was significant ($\chi 2$ =140.381, df=86, $p<0.05$), suggesting that the measurement model did not sufficiently explain the observed covariation among the variables [65]. All the other fit indices lent credence to a good fit, with GFI, AGFI, TLI, CFI, and NFI surpassing the recommended cut-off point of 0.90. However,

Table 3. Measurement model and fit indices for self-regulated learning six (6) factor solution.

Fit Index	Value
Chi-Square Value	362.576
Degrees of Freedom	193
P value	.001
CMIN/DF	1.879
GFI*	.886
AGFI*	.850
RMR*	.148
TLI*	.901
CFI*	.917
NFI*	.841
RMSEA*	.060

Table 4. Fit indices for knowledge sharing six (6) factor solution.

Fit Index	Value
Chi-Square Value	140.381
Degrees of Freedom	86
P value	0.00
CMIN/DF	1.632
GFI*	.928
AGFI*	.899
RMR*	.954
TLI*	.963
CFI*	.910
NFI*	.057
RMSEA*	0.51

the RMSEA and RMR were above the recommended levels of 0.08 and 0.10 respectively as suggested by Kline [66]. Further, the factor loading t-values were all significant. In addition, all reliability and variance extracted measures surpassed the recommended levels of 0.5 [65]. The low value for the item KS.C4 '*Share success stories which may benefit the class*' resulted in its removal from the model. This may suggest that such sharing of success stories is not a common day-to-day activity among Information Technology students.

With regard to the Chi-square ($\chi 2$) statistic, the measurement model for the **innovative behavior** construct, as illustrated in Table 5, did not produce acceptable fit, as the $\chi 2$ statistic was significant ($\chi 2 = 52.568$, df=18, $p<0.00$), suggesting that the measurement model did not sufficiently explain the observed covariation among the variables [65]. All the other fit indices lent credence to a good fit with GFI, TLI, CFI, and NFI

surpassing the recommended cut-off point of 0.90. On the other hand, the RMR was below the recommended levels of 0.10 as suggested by Kline [66]. However, the RMSEA was slightly above the recommended value of 0.08. Further, the factor loadings t-values were all significant. In addition, all reliability and variance measures extracted surpassed the level of 0.5 [65] – these were as had been recommended by Bagozzi, Yi and Nassen [67] in their review of approaches and extension to three-facet designs, as these relate to the representation of measurement error in marketing variables, as well as Fornell and Larcker [68] for evaluating structural equation models with unobservable variables and/or measurement errors.

Table 5. Fit indices for innovative behavior scale solution.

Fit Index	Value
Chi-Square Value	52.568
Degrees of Freedom	18
P value	.000
CMIN/DF	2.920
GFI*	.945
AGFI*	.891
RMR*	.922
TLI*	.950
CFI*	.926
NFI*	.060
RMSEA*	.089

Please note that the measurement model and fit indices for the 4-factor solution of the **course design characteristics** scale is provided as Table 2, together with other pertinent details, in Goosen and Ngugi [41].

8 Conclusions and Recommendations

This paper should have **relevance** for not only attendees of this Southern African Computer Lecturers' Association (SACLA) 2019 conference, but also for their students' learning levels and interest. The paper forms part of a series of publications from a thesis, and as such, additional information about the larger study can be obtained from Ngugi and Goosen [69] and [70] on:

- the effects of course design characteristics, self-regulated learning and knowledge sharing behaviour in facilitating the development of innovative behaviour among Information Technology students at universities, and
- modelling course-design characteristics, self-regulated learning and the mediating effect of knowledge-sharing behaviour as drivers of individual innovative behaviour.

Given the standard, depth and **originality** of the research, Ngugi and Goosen [70] are convinced that this represents a contribution to the field of expertise and scholarly debate in the field, with something new and original, which fills the knowledge gap identified in literature.

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