

Modelling Course-Design Characteristics, Self-Regulated Learning and the Mediating Effect of Knowledge-Sharing Behavior as Drivers of Individual Innovative Behavior

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Received 9 February 2018 • Revised 28 May 2018 • Accepted 8 June 2018

ABSTRACT

Literature identifies factors promoting Individual Innovative Behaviour (IIB) among employees. The effects of Knowledge-Sharing Behaviour (KSB), Self-Regulated Learning (SRL) and Course-Design Characteristics (CDC) to facilitate developing IIB among undergraduate technology university students is not well understood. The research question and objectives aim to address this literature gap by examining how SRL and CDC act as antecedents of IIB, via the action of knowledge-sharing behaviour. The research employed a quantitative cross-sectional survey. The subjects were 268 students enrolled in technology programmes, from seven Kenyan public universities. Data collection was with the aid of a questionnaire. A 2,000-bootstrap sample generated tested standardised total, direct and indirect effects. Findings are summated in a KSB-IIB structural equation model, with the results largely supporting all hypotheses. Results reveal that CDC and SRL act as significant drivers of KSB and IIB among undergraduate technology students. Recommendations enable academic university education managers to leverage attributes of IIB antecedents.

Keywords: course-design characteristics, individual innovative behaviour, knowledge-sharing behaviour, self-regulated learning

INTRODUCTION

This study was inspired by the paucity of multi-disciplinary studies that simultaneously investigate the antecedents of Individual Innovative Behaviour (IIB), and the possible mediating role of Knowledge-Sharing Behaviour (KSB), in the context of undergraduate technology students. Many existing studies, which correlate KSB with IIB, have focused on organisations and employees, and not students in a university setting (Afsar, 2016; Seo, Kim, Chang, & Kim, 2016), making this an area where there are still questions to be explored. Additional information regarding the study reported on in this paper can be obtained from Ngugi and Goosen (2017).

THEORETICAL AND CONCEPTUAL FRAMEWORKS

This section presents the key theoretical underpinnings that support and inform the study, with a view to providing justification for the seven study hypotheses. The section attempts to explore the sub-components of the selected individual and contextual factors of Course-Design Characteristics (CDC) and Self-Regulated Learning (SRL). Further, the dependent endogenous variable of IIB is discussed, and how it is influenced by CDC, SRL and KSB. The theoretical and conceptual frameworks, which guide the study, are thus presented.

Course-Design Characteristics (CDC)

Individual innovative behaviour has also been correlated with job design (Battistelli, Montani, & Odoardi, 2013), as well as course design (Tabata & Johnsrud, 2008).

Contribution of this paper to the literature

- This study contributes by validating the CDC construct as significant antecedent driver of IIB, investigating relationships surrounding CDC.
- The study bridges the knowledge gap on research modelling the mediating influence of KSB on IIB, with CDC and SRL as possible antecedents of knowledge-sharing behaviour in the university education setting, and context of undergraduate technology students.
- This study contributes to KSB and IIB literature by examining the mediating mechanisms through which CDC and SRL influence IIB. This study generated empirical evidence that bands CDC and SRL at contextual and individual levels, and how these drivers impact technology students' KSB and IIB.

The Job Characteristics Model (JCM) represented one attempt at unravelling the concept of job design. The JCM has historical roots in the work of Hackman and Oldham (1980), whose model hinged on the idea that the task or job itself is pivotal to employee motivation, presented five intrinsic components or factors for any given job or task. These five components described the extent of task identity, job feedback, autonomy, task variety and task significance. The JCM outlined the interrelationship between the five job characteristics, the associated psychological states, and the resultant personal outcomes. Overall, the outcomes indicated a higher level of motivation, satisfaction, and effectiveness. Hence, the five job characteristics may exert a significant influence on the effectiveness and satisfaction of IT lecturers and employers, as well as the quality of higher education institution graduates.

More recently, Oldham and Fried (2016, p. 25) conducted an extensive review of job design research and theory and found a link between "motivational characteristics of employees' jobs and their creativity". Other researchers, who have linked job design and creativity, include Coelho and Augusto (2010), Raja and Johns (2010), and Zhang and Bartol (2010). Specifically, Dwivedula, Bredillet, and Müller (2017, p. 609) compiled a comprehensive review of literature, grounded in a job design perspective. In their theoretical lenses review, they conceptualized work motivation in temporary organizations, in the context of leadership, innovation and entrepreneurship as driving forces of the global economy, by utilizing the job design perspective. The review identified "various facets of job design that constitute motivating nature of work".

Morgeson and Humphrey (2006) sought to address related issues, by developing the Work Design Questionnaire (WDQ), which was an adaption of the framework by Morgeson and Campion (2003). The questionnaire shifted the focus from job to work design and developed three major categories of work characteristics, namely motivational, social, and contextual. For the purpose of the present study, only the motivational work characteristics were considered, as in the view of the researcher, they had attributes that could be linked to the contextual factors in IT education. Morgeson and Humphrey (2006) dichotomized motivational work characteristics into task and knowledge characteristics.

This study expands the work of Morgeson and Humphrey (2006), by focusing on two motivational constructs of their work design questionnaire, to develop a new construct, termed course-design characteristics. CDC, in the context of the study, refer to students' perceptions of the range of knowledge and task requirements in a technology course. The idea to develop this new construct was informed by a suggestion by the conceptualized students study by Cotton, Dollard and de Jonge (2002), with the university as a form of a job. Consequently, an examination of students' work context may provide an answer and linkage to the development of innovative tendencies among undergraduate technology students.

Task characteristics

Task identity, according to Morgeson and Humphrey (2006, p. 1323), is defined as "the degree to which a job involves a whole piece of work, the results of which can be easily identified". Similarly, task identity is defined by Burke (1990, p. 23) as "the degree to which the job requires the completion of a 'whole' and identifiable piece of work, doing the job from the beginning to the end with a visible outcome".

Autonomy. The task characteristic of autonomy has received great attention in literature on motivational work design (Barrick, Mount, & Li, 2013; Battistelli, et al., 2013; Langfred & Rockmann, 2016; Parker & Zhang, 2016; Parker, Van den Broeck, & Holman, 2017). Hackman and Oldham (1980, p. 79) defined autonomy "as the degree to which the task provides substantial freedom, independence, and discretion in scheduling the work and in determining the procedures to be used in carrying it out". Similarly, autonomy, according to Karasek (1998, p. 291), refers to the extent of a worker's potential control over her/his tasks and her/his "conduct during the working day".

Task Variety is defined by Morgeson and Humphrey (2006, p. 1323) as referring to "the degree to which a job requires employees to perform a wide range of tasks". A similar definition of task variety by Burke (1990, p. 21) is

“the degree to which a job requires a variety of different activities in carrying out the work, which involves the use of a number of different skills and talents of the employee”. Evidence from research suggested that task variety enhances learning (Narayanan, Balasubramanian, & Swaminathan, 2009).

Self-Regulated Learning (SRL)

According to Fink (2007), learners tend to be inspired and get involved fully when academic programs are well designed. The differences between learners and lecturers in their views of course design have hindered the realization of the expected returns of the education system, as the graduates may not be well prepared for the complex, competitive and changing world. Martín, Potočnik, and Fras (2017) posited that today’s undergraduates will be tomorrow’s employees. Evidently, this preparation of tomorrow’s employees transcends the core preparation at higher education institutions, through rigid courses and fixed examination systems. It calls for a preparation of the cognitive framework of undergraduate learners, in terms of positive psychology, to instill traits such as self-regulated learning (Pintrich, 2000). Such traits have been found to be durable enough to influence long-term behaviour and performance. Thus, self-regulated learning provides a lens for viewing individual-level determinants of learner innovativeness.

According to Boekaerts, Pintrich and Zeidner (2000, p. 751), self-regulation “involves cognitive, affective, motivational and behavioural components that provide the individual with the capacity to adjust his or her actions and goals to achieve desired results in light of changing environmental conditions”. While Forgas, Baumeister and Tice (2009), in their introductory review on the psychology of self-regulation, also referred to cognitive, affective and motivational processes, Schraw, Crippen, and Hartley (2006) modelled self-regulation in science education and partitioned it into three components, namely cognition, metacognition, and motivation.

Zimmerman, Boekaerts, Pintrich, and Zeidner (2000, p. 14) defined self-regulated learning “as self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals”. Further, Effeney, Carroll and Bahr (2013, p. 58) viewed self-regulated learners as having the capacity to “actively set goals, decide on appropriate strategies, plan their time, organize and prioritize materials and information, shift approaches flexibly, monitor their learning by seeking feedback on their performance and make appropriate adjustments for future learning activities”. Some recent studies specifically promote the uptake of SRL in various contexts at the university level of education. Seraphin, Philippoff, Kaupp, and Vallin (2012) found evidence that metacognitive reflection is a significant driver of change in the scientific thought patterns of students, resulting in better critical-thinking and scientific skills.

According to Zimmerman and Schunk (2012), there is vast literature on self-regulated learning at various levels of the education system. Barak (2010, p. 381) investigated the field of technology education and proposed a compensative model for SRL comprising of cognitive, metacognitive, and motivational domains. The findings provided evidence that SRL “is highly correlated with an individual’s motivation to handle challenging assignments and with his or her internal satisfaction from being engaged in a task that contributes more to creativity than to receiving external rewards”.

Specifically, in a distance education context, Rockinson-Szapkiw, Wendt, and Lunde (2013) looked at the influence of electronic versus print textbook formats on higher education institution learners’ self-regulated learning strategies, motivation, and text anxiety.

In the context of educational technology and society, Liu and Chi (2012) investigated learner affective performance in web-based learning, by using entrepreneurship as a metaphor. In an adjacent context, the PhD thesis of O’Shea (2011) looked at integrating cognitive, motivational, and emotional self-regulation in early-stage entrepreneurs.

Zheng, Skelton, Shih, Leggette, and Pei (2009) found an imperative need for engineering faculty to adapt new instructional strategies that can help engineering learners to effectively regulate their learning motivation, strategies, and efforts, particularly in the early stages of learning. Their findings proposed a new instructional strategy and its implementation plan for a freshmen entry-level course, which included direct instruction to learners as stand-alone learning contents, and immersion instruction, which merged instruction as salient cues and scaffolded it into the Problem/Project-Based Learning (PBL) process through a co-curricular design project. In that study, the course project required learners to identify a problem and provide innovative technological solutions that could impact and improve learners’ studies and lives around campus. This is indeed the future of how IT courses ought to be taught.

Measures of self-regulated learning

One of the most widely used measures of SRL is the Motivated Strategies for Learning Questionnaire (MSLQ), reported on by Pintrich, Smith, Garcia, and McKeachie (1991). This scale has nine learning strategies that contribute to self-regulation among learners, namely:

- 1) Rehearsal,
- 2) Elaboration,
- 3) Organization,
- 4) Critical thinking,
- 5) Metacognitive SRL,
- 6) Time and study environment,
- 7) Effort regulation,
- 8) Peer learning, and
- 9) Help seeking (Pintrich et al., 1991, p. v).

The definitions of the nine sub-constructs by Pintrich et al. (1991) were retained to convey the original meaning. For the purpose of this study, the first five constructs were used to represent the individual context of SRL. The researcher deemed the construct of time and study environment to be more of a contextual antecedent of the study, and thus not apt for use as an individual factor.

Knowledge-Sharing Behaviour (KSB)

Defining KSB, according to Yi (2009, p. 68) and Ryu, Ho, and Han (2003), refers to a set of individual behaviours involving sharing and/or disseminating one's acquired "work-related knowledge and expertise with other members within" the organisation.

Literature, such as Bartol and Srivastava (2002, p. 65), suggests that KSB has four major components by which individuals share their knowledge within an organisation, which include, firstly, the

contribution of knowledge to organizational databases; second sharing knowledge in formal interactions within or across teams or work units; third, sharing knowledge in informal interactions among individuals; and fourth sharing knowledge within communities of practice, which are voluntary forums of employees around a topic.

In the present study, an attempt was made to adapt the four components of the KSB scale by Yi (2009), or as assessed by the scale identified by Ramayah, Yeap, and Ignatius (2014), both of which contained Communities of Practice (CoP), as well as Written Contributions (WC), Organisational Communications (OC) and Personal Interactions (PI).

Camelo-Ordaz, García-Cruz, Sousa-Ginel, and Valle-Cabrera (2011) explored how affective commitment mediated the relationship between human resource management and the two independent variables of knowledge-sharing behaviour and individual innovative behaviour.

According to Lu, Leung, and Koch (2006), knowledge-sharing behaviour is time consuming and is often viewed as loss of power. It also involves trust and this human factor demands considerable expense of time, resources, and energy, as learners balance the motivation to help each other learn and share their hard-earned knowledge. This may lead to KSB being a possible mediating variable in the relationship between the individual and contextual antecedents of individual innovative behaviour.

Individual Innovative Behaviour (IIB)

According to Messmann and Mulder (2011), the challenge of providing solutions to emerging problems and challenges require students to develop innovative tendencies. This has, however, not been the case, as many countries in Africa have failed to attain the critical threshold of producing knowledge workers, who can trigger the process of innovation, and hence leverage technological innovations to provide solutions for societal challenges (World Bank, 2011). This makes the need for the stimulation of innovation in Africa, as a factor for societal development, even more explicit. All is not lost for Africa, however, as it is beginning to command the attention of business executives, as well as scholars, as a viable investment destination. In South Africa, Shuttleworth is credited for developing the Ubuntu operating system, which has found wide application (Hill, Helmke, & Burger, 2009). The telecommunications industry in Africa has clearly leapfrogged the Western world in the field of mobile technologies (Nyaundi, 2011).

The study employed the four components of individual innovative behaviour detailed by de Jong and den Hartog (2010, p. 24), i.e. “opportunity exploration, idea generation, idea championing and idea implementation”. Seminal work by Scott and Bruce (1994), on the determinants of IIB, found empirical evidence that problem-solving style, leadership and work climate have a significant influence on IIB.

Aim, Research Questions and Hypotheses

The aim of this study was to develop and test a structural model, which hypothesizes that CDC and SRL are positively related to KSB among technology students. In turn, CDC, SRL and KSB are positively related to students’ IIB, with KSB acting as a mediator variable.

To achieve the study purpose, the primary research question was: What is the influence of CDC and SRL on the IIB of undergraduate technology students in Kenya, and how does KSB mediate the relationship between these individual and contextual antecedents of IIB?

Based on the main research question, the study sought to answer seven secondary research questions, which are stated as follows, using full terminology:

- 1) What are the psychometric properties of the proposed course-design characteristics, self-regulated learning, knowledge-sharing behaviour and individual innovative behaviour scales in the context of university education, and are these valid and reliable measures?
- 2) What is the relationship between course-design characteristics and the endogenous variable of individual innovative behaviour?
- 3) What is the relationship between self-regulated learning and the endogenous variable of individual innovative behaviour?
- 4) What is the relationship between knowledge-sharing behaviour and the endogenous variable of individual innovative behaviour?
- 5) What is the relationship between course-design characteristics and students’ knowledge-sharing behaviour?
- 6) What is the relationship between self-regulated learning and knowledge-sharing behaviour?
- 7) How does knowledge-sharing behaviour mediate the relationship between course-design characteristics and SRL and the endogenous variable of individual innovative behaviour?

Based on the literature review, the study sought to simultaneously test seven hypotheses associated with the research questions, which are:

- Hypothesis 1) Course-design characteristics are positively related to technology students’ individual innovative behaviour.
- Hypothesis 2) Self-regulated learning is positively related to technology students’ individual innovative behaviour.
- Hypothesis 3) Knowledge-sharing behaviour is positively related to technology students’ individual innovative behaviour.
- Hypothesis 4) Course-design characteristics are positively related to technology students’ knowledge-sharing behaviour.
- Hypothesis 5) Self-regulated learning is positively related to technology students’ knowledge-sharing behaviour.
- Hypothesis 6) Knowledge-sharing behaviour mediates the relationship between the interaction of individual innovative behaviour and course-design characteristics among technology students.
- Hypothesis 7) Knowledge-sharing behaviour mediates the relationship between the interaction of individual innovative behaviour and self-regulated learning among technology students.

Based on an extensive literature search (see e.g. Choi, Kim, Ullah, & Kang, 2016; French, McCarthy, Baraitser, Wellings, Bailey, & Free, 2016; Laycock, Bailie, Matthews, & Bailie, 2016), it became evident that this study was necessary, because of the paucity of studies on the mediating role of KSB in linking the individual and contextual antecedents of IIB. This paucity is especially in the context of university students in Africa, and specifically a developing country like Kenya (Afsar, 2016; Seo, et al., 2016). Consequently, the study offers theoretical and practical applications, by providing a multi-disciplinary lens, to explore the individual and organisational antecedents of IIB and the possible mediating role of KSB in that relationship.

Specifically, this study could contribute theoretically by seeking to validate the CDC construct as a significant antecedent and driver of IIB, by investigating relationships surrounding CDC. Further, the study seeks to bridge the knowledge gap on research that models the mediating influence of KSB on IIB, with CDC and SRL as possible

antecedents of knowledge-sharing behaviour in the setting of university education, in the context of undergraduate technology students.

RESEARCH METHODOLOGY

The research setting was undergraduate technology classes from public chartered universities in Kenya. The students selected were undertaking technology programmes. The participants were either in their third or fourth years of study, and had participated in project work as prescribed in their study programmes. The study was conducted in various counties of Kenya, with a rider that universities included be publicly chartered.

Research Design

In a cross-sectional study, a quantitative, non-experimental research design was chosen to explore the relationships between the constructs, as such a design is suitable for data obtained in a relatively short period of time (Creswell, 2013). The research method chosen was a correlation survey of an explanatory nature, as this method can produce a quantitative description of various aspects of the population under study (Fowler, 2002). A survey was considered most appropriate to measure the perceptions and attitudes of technology students, as it embraces the positivist framework and the related quantitative methods (Creswell, 2013). Further, survey research elicits “standardized information in order to define or describe variables or to study relationships between variables” (Malhotra & Grover, 1998, p. 409).

Data-Collection Instruments

The measurement of the latent exogenous and endogenous variables made use of a set of quantitative self-report measures. This entailed the use of Likert scales, in conjunction with other demographic measures. The CDC scale was composed of 20 items, which measured knowledge characteristics, and 24 items that gauged task characteristics. The measurement of SRL was with the aid of a revised version of the 31 items from the Motivated Strategies for Learning Questionnaire (MSLQ). The measure of KSB involved a variation of the scale from Yi (2009). Finally, the measure of IIB was based on the scale by De Jong and Den Hartog (2010), which had 11 items, which measured the four sub-constructs of opportunity exploration, idea generation, championing, and implementation. The actual wording used, however, was changed, where necessary, to fit the context of undergraduate technology students – see [Table 1](#).

Table 1. Scales, subscales and examples of items used in data-collection instruments

Scale	Subscale	Number of items	Example of item
Course-Design Characteristics	Knowledge Characteristics	20	The project work requires a depth of knowledge and expertise.
	Task Characteristics	24	The project work involves performing a variety of IT tasks.
Self-Regulated Learning	Rehearsal	4	I make lists of important items for this course and memorize the lists.
	Elaboration	6	When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.
	Organisation	4	When I study the readings for this course, I outline the material to help me organize my thoughts.
	Critical Thinking	5	Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.
	Metacognitive Self-Regulation	12	If I get confused taking notes in class, I make sure I sort it out afterwards.
Knowledge-Sharing Behaviour		20	I frequently share ideas and thoughts on specific topics through email communication.
Individual Innovative Behaviour		11	I look for opportunities to improve an existing process, technology, product, or service.

Self-regulated learning scale

Pintrich and De Groot (1990) developed the original MSLQ, which had two (motivation and learning strategies) broad subscales. Usually, the motivation subscale is shown as having three subcomponents, namely value, expectancy and affective. Kahraman (2011, p. 73), however, is of the opinion that under the original motivation

scale, there were six subcomponents, namely “intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance and test anxiety”.

Measurement of course design characteristics

The construct of course design characteristics was inspired by literature drawn from the field of human resource management. Other work included Pukienė and Škudienė (2016) looking at the role of human resource management and affective commitment in Innovative Work Behaviour (IWB). The CDC was an adaptation of the work design questionnaire, formulated by Hackman and Oldham (1980) and later improved by Morgeson and Humphrey (2006). The WDQ scale has been used extensively in literature, and consists of four subscales, namely task and knowledge characteristics, as well as aspects relating to social and work contexts.

Population, Sampling, and Sample Technique

The context as already described, of technology students, was employed in delineating the sample population of students. The study was conducted in the Kenyan university education sector, with a focus on public universities, which offer applicable technology courses. As of September 2015, Kenya had 33 public universities and 37 private universities. Out of the public universities, seven universities (21%) were selected at random as the target population, based on logistical and time considerations. Therefore, a representative selection of these universities was made, using stratified random sampling techniques.

Within these, the target populations were three clusters of Bachelor courses, which were classified as falling under the field of computing by the International Standard Classification of Education (ISCED). A ‘technology’ student was thus defined as qualifying for inclusion in the sample if (s)he was:

- a) enrolled for a Bachelor of Science (BSc) in Computer Studies or BSc in Information Technology or Bachelor of Business (Information Technology);
- b) enrolled in the third or fourth year of study; and
- c) had recently undertaken project work as part of the programme requirement.

The generalizability of the study relied on the representativeness of the respondents. Fifty students were selected from each public university, using simple random sampling, to yield a sample of 350 undergraduate technology students. A response rate of 81% (n=284) was achieved. Sixteen responses were discarded, as they contained missing data; hence, 268 students satisfied the minimum criteria for inclusion and were retained for further use.

The survey was conducted over the period 2014-2015, in order to cater for different university’s academic calendars - some of the universities involved used a trimester system, while others used a semester system. The questionnaire was estimated to take approximately 35 minutes to complete.

The researcher requested lecturers in the programmes involved to assist in the process of administering the questionnaires to an agreed sample of participants.

Validity and Reliability

The estimation of the internal consistency reliability in terms of composite or construct reliability was based on the computation of coefficient alpha (Cronbach, 1951) using the critical value of 0.7 (Hair, Anderson, Babin & Black, 1998). The results suggest that the scales had suitable reliability, as they were all above this critical value of 0.7 – see **Table 2**. Further, each of the composite scales had at least three items, which were adequate to realize content adequacy. To ensure construct validity, the measurement items were sourced and adapted from previous validated multi-disciplinary measures with proven and acceptable reliability, as recommended by Boudreau, Gefen, and Straub (2001). Confirming construct validity involved an exploration of the convergent validity and discriminant validity, as during the pilot study, the nomological and face validity were already examined. Content validity was achieved by using measures available from literature, which had acceptable psychometric properties (Hair et al., 2010). The results of the study indicated that there was evidence of convergent validity, since all the average variance extracted values were above 0.5 (Hair et al., 2010), as well as above the correlation coefficients for the other variables, thus providing support for discriminant validity.

Table 2. Reliability coefficient of scales and subscales

Scale	Cronbach's Alpha	Number of Items
Self-Regulated Learning	0.945	31
Knowledge Characteristics	0.720	13
Task Characteristics	0.777	17
Knowledge-Sharing Behaviour	0.884	16
Individual Innovative Behaviour	0.789	11
Total number of items		88

Data Analysis

Following Gaskin (2016), data analysis started with the preliminary stages of data entry, exploration, and screening by examination of the “outliers, independence of errors, absence of multicollinearity, normality, linearity, and homoscedasticity of residuals”, as recommended by Su, Cuskelly, Gilmore, and Sullivan (2017, p. 1178). Besides the exploration of missing values, outlier patterns were examined by following the three steps suggested by Field (2005).

The next step was an exploratory factor analysis, through an examination of the appropriateness of data, communalities, dimensionality, and factor structure to obtain an orderly simplification. Following this, Confirmatory Factor Analysis (CFA) techniques were used to assess the model fit, validity and reliability, common method bias, invariance and second-order factors. The existence of common method bias was tested using Harman’s single-factor test in the Statistical Package for Social Sciences (SPSS) and the common latent factor method in the Analysis of Moment Structures (AMOS) (Byrne, 2016; Fuller, Simmering, Atinc, Atinc, & Babin, 2016). This data analysis made use of SPSS version 18. SPSS was also used to generate descriptive and inferential statistics.

Other data-analysis techniques used included computation of correlation, multiple linear regression, and Structural Equation Modelling (SEM). For the statistical treatment of data, the study utilized the two-stage model-building procedure (Schumacker & Lomax, 2010) that required developing a measurement model and later a structural model. AMOS 18 software was employed to conduct the SEM analysis, generating data for hypothesis testing. This study innovates by applying the advanced analytical techniques of SEM, which is well-suited to analyse correlations between the hypothesized constructs. Using SEM analysis, the computation of the direct, indirect, and total effects involved an examination of the effect of the exogenous variable on the endogenous variable to compute the direct effect, as well as an examination of the indirect effect of the exogenous variables of CDC and SRL, through the mediating variable of KSB. Finally, the sum of the direct and indirect effects provided a measure of the total effect (Schreiber, Nora, Stage, Barlow & King, 2006) – see **Table 3**.

Table 3. Standardized total, direct and indirect effects and corresponding standardized two-tailed significance bias corrected confidence intervals after bootstrapping

		Course-Design Characteristics	Self-Regulated Learning	Knowledge- Sharing Behaviour
Knowledge-Sharing Behaviour	Total Effects	0.531**	0.316**	
	Direct Effects	0.664**	0.435**	
	Indirect Effects	0.000	0.000	
Individual Innovative Behaviour	Total Effects	0.552**	0.261**	0.872**
	Direct Effects	-2.04	-0.035	0.846**
	Indirect Effects	0.439**	0.261**	0.000

**Correlation is significant at the 0.01 level (2-tailed)

Following the suggestion of Shrout and Bolger (2002), mediation analysis employed bootstrapping techniques, using 2,000 bootstrap samples, to generate the bootstrapped *ab* term, as well as the corresponding *p*-values. The bootstrapping method has been applied by multiple authors to test mediation in the field of KSB (Liou, Chih, Yuan & Lin, 2016) and IIB (Du, Liu, Straub, & Knight, 2017). Cheung, Gong, Wang, Zhou, and Shi (2016) applied bootstrapping in studies involving both KSB and IIB.

Because of the sample size involved, the bootstrapping method proved to be a suitable analytic strategy for testing hypotheses 6 and 7, on the direct and indirect effects. This study employed the parametric bootstrap method, which involves measurement of the parameter estimates between the independent variables (CDC and SRL) and the mediator variable (KSB), in addition to the relationship between the mediator variable and the dependent variable of IIB. The generated parameter estimates were later used to create a sampling distribution of the indirect effect (Lee, Lei, & Brody, 2015; Tofighi & MacKinnon, 2016).

Criteria for identification of ideal fit indices provided by Marsh, Balla, and McDonald (1988, p. 8) included “accurately and consistently reflect differences in” goodness-of-fit “for competing models of the same data”. The model fit indices available for use in SEM could be grouped into four types, as indicated in **Table 4**.

Table 4. Grouping of model fit indices based on Newsom (2012)

Absolute Fit Indices	Relative Fit Indices	Parsimonious Fit Index	Non-Centrality-Based Indices
Normed Chi-Square (χ^2)			Comparative Fit Index (CFI)
Adjusted Goodness-of-Fit Index (AGFI)	Non-Normed Fit Index (NNFI)	Parsimony Goodness-of-Fit Index	Centrality Index
	Tucker-Lewis Index (TLI)		Root Mean Square Error of Approximation (RMSEA)
Goodness-of-Fit Index (GFI)			

The results suggested a good model fit ($\chi^2= 92.84$, $p< 0.001$, $GFI=0.94$, $AGFI=0.91$, $CFI=0.95$, $NNFI=0.90$, $TLI=0.93$, and $RMSEA=0.061$). The path coefficients results provided ample evidence to suggest that CDC and SRL had significant direct effects on IIB. Hence, there was support for hypotheses 2 and 4.

DISCUSSION OF RESULTS

The examination of the reliability and validity of the measures utilized CFA. The resulting measurement model is presented in **Figure 1**.

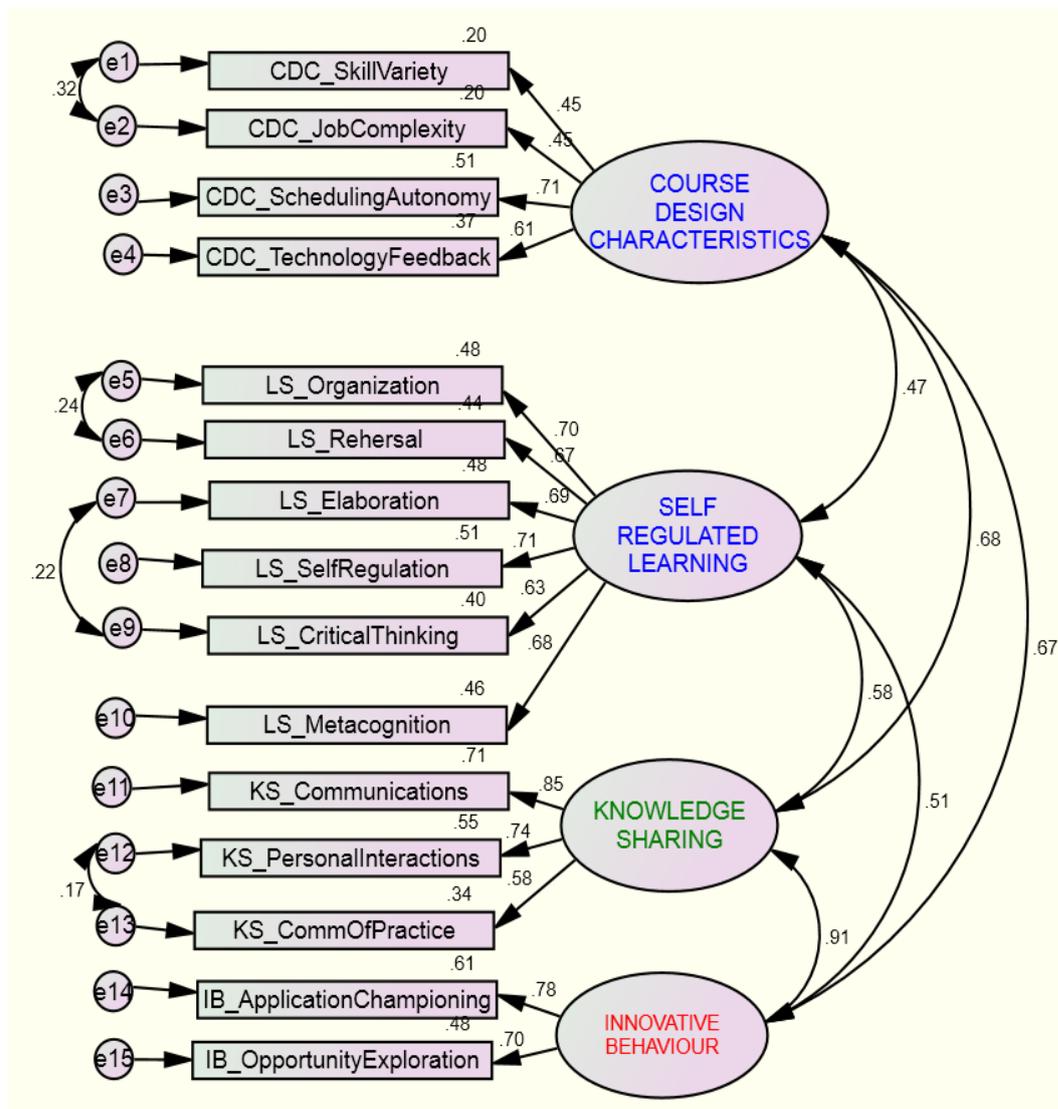


Figure 1. Measurement model used for discriminant and convergent validity analysis

These results suggest that most of the factor loadings were above 0.7, except for two variables from self-regulated learning and course design characteristics. Further factor analysis extracted four factors, which explain 82.3% of the total variance. In addition, twelve out of the nineteen variables had standardized regression weights just below 0.7. The weights of the items, however, were above 0.6 for seventeen of the items, and the related t-values were significant.

The main finding of the present study was that knowledge-sharing behaviour partially mediated the effect of course-design characteristics on individual innovative behaviour, and fully mediated the effect of self-regulated learning on individual innovative behaviour. Further, KSB had a significant direct effect on IIB. Hence, the study reveals that both CDC and SRL have significant positive indirect effects on individual innovative behaviour. The study thus contributes to KSB and IIB literature by examining the mediating mechanisms through which both CDC and SRL ultimately influence IIB. The present study generated empirical evidence that bands CDC and SRL at the contextual and individual level respectively, and how these two drivers impact technology students' KSB and IIB.

Figure 2 shows the final model of the mediating effect of KSB on IIB, with the four oblong shapes representing each of the four main variables in this study, including CDC and SRL. The rectangular shapes represent the elements contributing to each of these four variables.

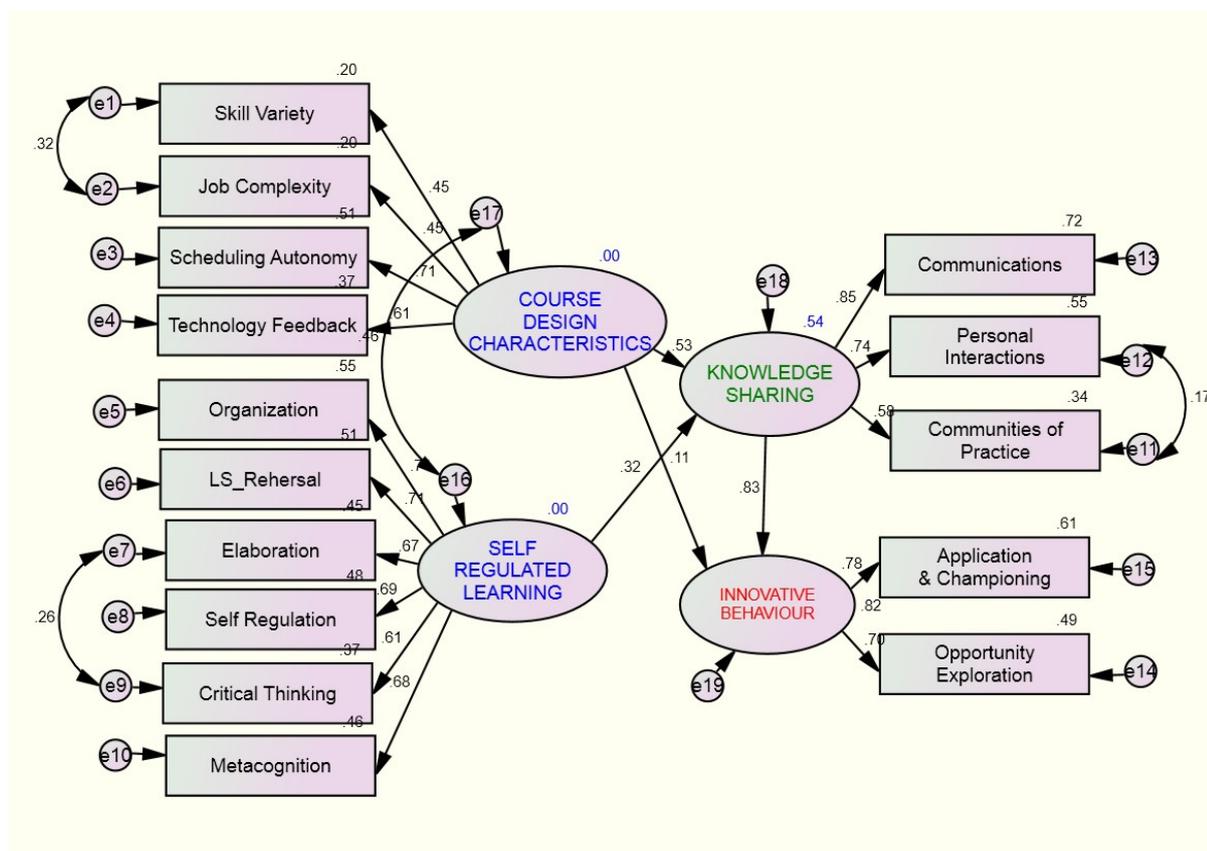


Figure 2. Final model of the mediating effect of KSB on IIB

Course-Design Characteristics as Contextual Antecedent

The study presents CDC as a contextual antecedent of both KSB and IIB. The construct of CDC explores the contextual-level factors that act as barriers or enablers in the context of university education, for promoting innovative competencies in undergraduate technology students. This has the implication that it matters how courses are designed, as this ultimately influences the individual innovative behaviour of university students. The need, therefore, is for university management to involve those responsible for programme evaluation, so as to ensure that contextual factors are embedded in the design of courses. This may translate to developing policies and guidelines that inform the process of programme design.

In addition, the task and knowledge design components in the process of course design demand the development of an innovative ecosystem. In the domain of entrepreneurship and innovation, such an innovative

ecosystem comprises “academic coursework, access to mentors, the organization of business plan competitions, (and) student clubs with networking events” (Heukamp, 2015, p. 214).

Self-Regulated Learning

Past studies (see e.g. Holman, Totterdell, Axtell, Stride, Port, Svensson & Zibarras, 2012) suggested that SRL has a significant positive effect on the innovative work behaviour of employees. The results of this study complement these works by demonstrating that, at the individual level, SRL is a significant antecedent of IIB. This has the implication that SRL promotes IIB, which may facilitate better foundations for students’ innovation, not only in university education, but also in the world of work.

Courses that speak to and inform the IT learner are more likely to stimulate innovative tendencies than courses that have limited IT feedback. This finding is well corroborated by the available literature (Battistelli, et al., 2013; De Spiegelaere, Van Gyes, De Witte, Niesen, & Van Hootehem, 2014; Hofmans, Gelens, & Theuns, 2014).

Similarly, the path linking SRL and KSB, though significant ($\beta=.287$, $p<.01$), was not very strong, in comparison to the path linking CDC and KSB.

Knowledge-Sharing Behaviour as Mediator

The present study confirms the findings of Radaelli, Lettieri, Mura, and Spiller (2014), who posited that idea promotion is enabled by knowledge-sharing behaviour. While the sharing of best practices in the research by the latter authors promoted idea generation among healthcare professionals in hospice and palliative care organisation, this has now also been confirmed in the context of technology students in higher education. Further, Seo et al. (2016) found a significant effect for employees’ knowledge-sharing behaviour on individual innovative behaviour for a sample of 188 personal trainers from 11 fitness clubs. More closely related to the present context of university education, the present study affirms the findings of Martín, et al. (2015), who explored the determinants of students’ innovation in university education, utilizing a sample of 78 students.

CONCLUSION

The findings were summated in a knowledge-sharing–innovative-behaviour SEM, with the results largely supporting all hypotheses. The findings lend support to the positive effect of course-design characteristics in fostering technology students’ individual innovative behaviour. The indirect relationship between course-design characteristics and individual innovative behaviour was significant and partially mediated by knowledge-sharing behaviour. The results of the research suggest a significant indirect relationship between self-regulated learning and individual innovative behaviour, which is fully mediated by knowledge-sharing behaviour. The results also reveal that both course-design characteristics and self-regulated learning act as significant drivers of knowledge-sharing behaviour and individual innovative behaviour among undergraduate technology students.

Theoretical Implications

- 1) **Drivers of knowledge-sharing behaviour:** The study findings contribute significantly to our understanding of the roles of the three significant drivers of IIB among technology students, through a focus on SRL, CDC and KSB. While Martín et al. (2015) examined the role of knowledge sharing on IWB among students, their study did not include the variables of the present study of SRL and course design characteristics, the latter having further enriched the theoretical underpinnings.
- 2) **Self-regulated learning predicting individual innovative behaviour:** By establishing a positive direct link between SRL and IIB, this conclusion extends the findings of Martín et al. (2015) for technology students, who engage in SRL as an explicit part of good study practices.
- 3) **Course-design characteristics predicting individual innovative behaviour:** This study amplified the critical role played by decision-making, methods, and scheduling autonomy, technology feedback, task identity, task variety, task significance (Morgeson & Humphrey, 2006) in the context of technology education. The study lays a foundation for theoretical sense by elucidating the salient features of the course-design characteristics–knowledge-sharing relationship, in predicting the behavioural outcome of individual innovative behaviour. This finding agrees with literature that suggests that knowledge-sharing behaviour mediates individual innovative behaviour among employees (Chiu, Wang, Shih & Fan, 2011; Ramayah et al., 2014; Titi Amayah, 2013).
- 4) **The mediating role of knowledge-sharing behaviour:** The results suggest that knowledge-sharing behaviour positively mediates the relationship between CDC, SRL and the exogenous variable of IIB. Hence, the study contributes to literature on both SRL and IIB, by introducing knowledge-sharing behaviour as the

situational variable that interacts with both CDC and SRL to influence IIB. Prior studies have only provided evidence that knowledge-sharing behaviour has a significant effect on IIB, and that individual and contextual factors can enhance the level of IIB among employees (Afsar, 2016; Camelo-Ordaz et al., 2011; Choi et al., 2016; Seo et al., 2016).

Practical Implications

- 1) **University management:** The results of this study generate a significant lesson for managers involved in the university sector, on how to leverage the attributes of SRL and CDC at individual and contextual level, to trigger IIB: it is important for university management to understand what fosters individual innovative behaviour among students.
- 2) **Implications for curriculum experts:** Since task and knowledge characteristics have the potential to enhance both knowledge-sharing behaviour and individual innovative behaviour, the review of university curricula should progress beyond the minimum requirements placed by a specific the university education regulator. With this background, curriculum planners and reviewers should consider carefully how the university designs specific task and knowledge characteristics.
- 3) **Implications for faculty:** With regard to the development of faculty to facilitate an innovative climate, the demand by technology students is for frequent communication on developments in their field. Hence, lecturers should communicate regularly with students about the latest developments in their field of study, expectations from industry, and values of the university in spurring innovation.
- 4) **Other drivers of knowledge-sharing behaviour at individual and contextual level:** The SEM model generated explains only 46.5 % of the variance in the individual innovative behaviour of technology students. Hence, future research should explore alternative and additional factors that act as antecedents of KSB.

Limitations

The study that this article reports on does not claim perfection, as it has a few potential limitations that require more attention in future research. Firstly, the results were collected using self-reporting measures, which has the potential limitation of introducing common method variance. To overcome this challenge, the research design incorporated use of reverse coded items to reduce this possibility. McGrath, Mitchell, Kim, and Hough (2010) posit that respondents may respond to question items moderately or provide neutral answers leading to common method bias. To control for common method bias, Harman's one-factor test was applied as suggested by Podsakoff and Organ (1986). Common method bias was not a problem in the present study. To avoid a situation where common method bias is problematic, however, future research should collect data from multiple sources such as observer ratings and other methods devoid of self-reporting (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

The second limitation is aligned to methodological issues regarding the instruments used. The construct of course design characteristics was an attempt by the researcher to develop a construct for use in a university setting. The construct of CDC represents the contextual determinants of individual innovative behaviour. Being a new scale, it requires to be validated as a comprehensive measure for assessing course design, before full scale application to the university sector. This requires an investigation of the psychometric properties of the new scale using a different sample.

Thirdly, the generalizability of the findings may also pose some limitation. This study utilized a sample of technology students undertaking a computer related undergraduate programme in public universities. As suggested by MacCallum and Austin (2000, p. 211), the results and "conclusions may be limited to the particular sample, variables, and time frame". There is a possibility that the outcome may not generalize well in the context of private universities, that may have unique characteristics and organizational culture that are distinctively different from public universities.

It is therefore desirable if the model provided is tested in a different context of students to explain the individual and contextual antecedents of individual innovative behaviour. In addition, the findings may not generalize well to students in other academic programmes. Since the data was collected from students undertaking computer related programmes under the general domain of technology education, the implications of the findings to other technology subjects, such as Engineering or other university level programmes such as Arts and Humanities should be interpreted with caution.

Fourthly, the cross-sectional design is plagued by inherent weaknesses. Possibly a longitudinal study to investigate the development of individual innovative behaviour for a cohort group over the duration of their undergraduate programme may present different results. The results of such a four year longitudinal study continuing for the duration of the undergraduate programme should provide empirical evidence of changes in

both knowledge-sharing behaviour and individual innovative behaviour. Consequently, university education providers and policy makers can take appropriate actions to make the university education more responsive to developing individual innovative behaviour in university students.

A fifth limitation may relate to the narrow range of individual and contextual exogenous variable identified by the researcher. As explained by the quantitative results, there could be other factors that are significant antecedents of knowledge-sharing behaviour and individual innovative behaviour other than CDC and SRL included in the study. Elaborating on the other antecedents, refining the definition of each construct, and operationalizing each construct into additional measurement items would help overcome the limitation. Due to concerns on response rate and user fatigue, the present study could not include more variables, on consideration of questionnaire length and respondents fatigue.

Recommendations

The authors recommend that especially with regard to future research, the following avenues be explored:

- 1) **Additional individual and contextual factors to explain students' knowledge-sharing behaviour and individual innovative behaviour:** The present study proposes only a subset of the many possible individual and contextual factors that act as antecedents of both knowledge-sharing behaviour and individual innovative behaviour. Hence, other important antecedents could have been left out of the present study. Future research should take a more extensive approach to cover variables, other than CDC and SRL. One possible extension would be to explore additional theories that provide significant individual and contextual factors. One possible field is to use alternative theories, such as creativity theory, that explores the "production of novel and useful ideas or solutions concerning products, services, processes, and procedures" (Rego, Sousa, Marques, & e Cunha, 2012, p. 429).
- 2) **Influence of learning strategies on knowledge-sharing behaviour and individual innovative behaviour:** Another possible extension of the model might involve exploring the effect of each of the individual factors of the SRL scale. Hence, future studies could explore the effects of rehearsal, self-regulation, metacognition, elaboration and critical thinking on knowledge-sharing behaviour and the endogenous variable of individual innovative behaviour.
- 3) **Influence of task and knowledge characteristics on individual innovative behaviour:** The study investigated the effect of CDC on both KSB and individual innovative behaviour. The CDC scale is a composite scale of two main sub-factors: task and knowledge characteristics. It would be interesting to investigate the effect of each of the two subscales of task and knowledge characteristics, in order to explore how they influence individual innovative behaviour. This could involve an exploration of how the existing and new academic programmes can be redesigned to accommodate an increase in both task and knowledge demands.
- 4) **Additional research in other programme areas and universities:** The scope of this study was a sample of students undertaking undergraduate technology courses. Hence, future research could involve other programme areas, to establish the generalisability of the findings to other disciplines. In addition, the sample was from public universities in Kenya. It would be noteworthy to replicate the study among private universities and perform a test of significant differences in the variable of the study in the two independent samples. Such a study will help to establish an all-encompassing view of the antecedents of innovation in universities in Kenya.
- 5) **Different methodologies of data collection:** The current study used survey methodology, which has some limitations. As technology students work on projects under supervision by faculty, future research using different observation methods may provide empirical data and overcome the problem of self-reporting of individual innovative behaviour among students.
- 6) **Model replication:** Future studies should aim at model replication to establish if the results can be replicated using different student samples from other disciplines. Kline (2005, p. 65) observed that it is "critical to eventually replicate a SEM if it is ever to represent anything beyond a mere statistical exercise". Consequently, so as to ensure that the present model is not just another statistical endeavour, future studies should replicate the model and proceed to explore other drivers of both knowledge-sharing behaviour and individual innovative behaviour. This should help to establish meaningfulness and provide generalisability of findings.
- 7) **Further research with the course-design characteristics questionnaire:** The CDC scale has been proposed by the researcher and has therefore not been validated in the context of students in university education. Consequently, additional research is required to establish the psychometric properties of the scale CDC, as well as its multi-dimensionality and factor structure. Hence, more research with a specific focus on populations and other types of universities is recommended.

- 8) **Role of autonomy in individual innovative behaviour:** The study finding that Scheduling Autonomy accounted for fourteen percent of the variance in individual innovative behaviour makes it a significant factor in the design of undergraduate courses. The autonomy is with respect to the extent to which the design of the curriculum allows students increasing options and independence to schedule their work during the semester, make relevant and weighty decisions regarding the programme, as well as have the liberty to choose the task methods required. This scenario poses a real dilemma for university regulators and curriculum designers, as it raises the question of whether to provide for more scheduling autonomy in course design, or remain rigid in course design, as per the existing design, policies, rules, regulations, and standards that inform the sector. This then provides a new avenue for further research on the operationalization of autonomy in the context of programme design and delivery of instruction to students.
- 9) **Role of organisation in individual innovative behaviour:** The study provided empirical evidence that organisation as a learning strategy explains 14% of the variance in individual innovative behaviour. This finding should inspire future research to conceptualise and explore the role of organisation in developing individual innovative behaviour among undergraduate technology students. For instance, could it be that students with more organisational skills tend to innovate more? Future conceptual models investigating the individual level antecedents could explore the mechanics through which organisation influences individual innovative behaviour and, in the process, make the results more intelligible. This represents contributing something new and original towards scholarly debates in the field, by filling a major gap in knowledge identified in the literature.

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