Education and Information Technologies (2023) 28:15523–15541
https://doi.org/10.1007/s10639-023-11776-8

# Leader support and the integration of innovative teaching–learning technologies: the mediating role of technological level of knowledge

Elizabeth Landa[1,2] · Chang Zhu[1] · Jennifer Sesabo[3] · Haruni Machumu[3]

Received: 23 May 2022 / Accepted: 28 March 2023 / Published online: 29 April 2023


## Abstract

While there have been recent trends in investigating the role of leader support on technological integration, such research in educational settings is rare. Moreover, the attention paid towards investigating leadership support for the integration of technological changes in education has not led to the explicit specification of what support teachers would entail from their mid-level academic leaders regarding the current challenge of ITLTs-low uptake in developing countries. Therefore, the present study investigates the influence of leader support and integration of ITLTs among academicians of the selected Tanzanian universities, mediating the effect of the Technological Knowledge Level (TKL). A questionnaire was used as the main collection tool to collect data from 192 academic staff. The study used Structural Equation Modeling (SEM) to analyse the extent to which leader support influences the integration of ITLTs, mediated by the TKL when controlled for demographic factors such as age, gender, and ITLTs prior knowledge. The yielded results reveal that the integration of ITLTs among academics is positively influenced by leader support; the higher the support the academics receive from their leaders, the better the integration of ITLTs. Furthermore, the perceived leader support is also predictive of academicians' technological knowledge level; however, no significant effect of technological knowledge level was found when mediating the two variables, indicating that leaders support strongly influenced the integration of ITLTs. This study, therefore, proves the inclusive findings and extends the research on the potential of mid-level academic leadership to bring about educational change in higher learning and thus, enhance the integration of ITLTs.

**Keywords** Innovative teaching and learning technologies · Leader support · Universities · Technological knowledge level · Academicians

✉ Elizabeth Landa
elizabeth.jacob.landa@vub.be

Extended author information available on the last page of the article

## 1 Introduction

Since the realization of the integration of Information Communication and Technology (ICT) in education, the predominant focus has been upon technologically and technically savvy (Chatterjee, 2016). In particular, the aim was to develop the technological capabilities of teachers to craft and articulate the teaching–learning process in order to meet the demands for technical expertise of effective integration of technology in education. More specifically, those technological capacities are expected useful for fostering the confidence of users (Tondeur et al., 2018; Foutsitzi & Caridakis, 2019), served as incentives for teacher to adopt the most innovative teaching approaches in order to ensure meaningful learning (Jansen, 2019; Volman et al., 2015) and to further facilitate ease of use of technology in education (Rabah, 2015; Botero, 2019). However, in many higher education institutions (HEIs) in developing countries and in some portion of the developed countries, the integration of these potential Innovative Teaching and Learning Technologies (ITLTs) has neither been fully realized nor systematically integrated (Singh & Hardaker, 2014). Studies further evidently have revealed that there has been a relatively low level of integration of innovative teaching and learning technologies in HEIs in Tanzania, meaning it thus remains a significant challenge (Ilechukwu, 2013; Lashayo & Olahraga, 2017; Grimmer et al., 2020).

Besides, with ongoing initiatives to integrate innovative teaching and learning technologies, several factors such as leadership support, readiness, preparedness, and funds have become critically important. There have been a number of studies on the uptake of innovation that suggest recognizing the effects of academic leaders on facilitating the move towards the effective and efficient realization of education-technology-integration (Clausen et al., 2019; Graziano et al., 2017). Moreover, due to the importance of integration of ITLTs and the benefits it brings, attention has been drawn to various areas, evidenced by the growing number of scientific articles that has been published. Previous studies have focused on instructors' technology competency on use of innovative teaching technologies (Vovk et al., 2019), and effective of innovative teaching technology (Albashtawi & Al Bataineh, 2020). Others put forth on factors that are related to the use of computer technology in teaching and learning processes with more apprehension on technological considerations, content characteristics, organizational and institutional capacity, perception of educator on innovative teaching technologies (Oke & Fernandes, 2020), and attitudes towards usage (Purwanto, 2020). Few studies in Tanzania have focused on academic leader support to academics' integration of ITLTs in HEIs. Predominantly, integration of ITLTs in higher education require sufficient technological pedagogical knowledge of its users (Cheng et al., 2022). As such, in response to HEIs reforms seeking a more effective integration of ITLTs, academic leadership should also be examined along with the level of technological knowledge of instructors.

Technological knowledge is important on the adoption of innovation process throughout all its stages (Leoste et al., 2021). On the other hand, instructors with technological knowledge have confidence and attitudes towards technology, therefore they are like to adopt and use innovative teaching technology. Technological knowledge might be a key evaluation dimension about adoption of technology innovation. Therefore, this study seeks to ascertain the leadership support of mid-level academic leaders given this affects the integration of ITLTs, in order to improve the effective and efficient integration of ITLTs among instructors. The study could compel the educational practitioners to design and envision roles, and to direct their attention towards mid-level academic leaders and the achievement of the effective integration of ITLTs.

## 2 Literature review

### 2.1 ITLTs- integration

Innovative teaching and learning technology- integration refers to the application of technology to facilitate learning through different mediums (Ertmer et al., 2012). The use of technology in education has proven to be crucial for heightening the quality of education as a whole (Livingstone, 2012), as it can also be a valuable form of assistance in improving the teacher's carrying-out of their tasks while streamlining the process of teaching–learning (Özdemir, 2017). Now that instructors have to engage in the integration of ITLTs, the responsibility of academic leaders has drastically changed to focus on facilitating the effective realization of technological integration in teaching and learning in Tanzanian universities as global. ITLTs including e-learning, e-teaching tools, online learning platforms such as Moodle, social media and use of student-centered learning technologies (collaborative tools such as wiki, group work) are captured in this study while unveiling important factors of collaborative learning, learning by doing tasks and student centre learning (Bebell et al., 2004; Tang & Austin, 2009; Machumu et al., 2016). This study involves the ITLTs integration for accessing and sharing of information, providing feedback-assessment to students, presenting materials in class and online interactions.

Adoption of innovative teaching technologies are carried out in higher education institutions to improve learning and meet external challenges and demands. Integration of ITLTs is witnessed to be more essential to expand the effectiveness of teaching and learning methods. As technology reveals an important role in teaching activities, it can also perform a significant role in the process of education (Liu et al., 2020). Adapting great levels of ITLTs in various higher education institutions, it has been observed that it brings a change in practicing teaching and learning (Al-Samarraie et al., 2017). Worldwide, different countries advocate integration of ITLTs. Foristance, Russia adopted use of online learning technologies in higher education (Larionova et al., 2018). It enhances expansion in the educational choice for students, the development of virtual academic mobility, reduction in the cost of educational services, and improvement in the accessibility of education. The adoption of innovative technology enables use of blended for teaching. Students gain access to electronic materials, including video lectures, text materials, training tasks, and tests. Moreover, in Indonesia, higher education institution adopted use of mobile learning to effectively improve learning and teaching through the context of learning, communication, it also well as enable the students to access various useful resources many times (Suartama et al., 2019).

Corresponding to the global trend of technology-integration in educational systems, Tanzanian universities and colleges have nevertheless managed to integrate digital instructional technologies and computer-mediated learning environments (Tanzania Commission for University [TCU], 2016). Moreover, the integration of innovative teaching and learning approaches led by the adoption of digital instructional technologies in higher education (HE) was stipulated in the 2003 National ICT Policy ([United Republic of Tanzania] URT, 2003), wherein it was proclaimed that academic leadership structures should consolidate the administration of HEIs for the assumption and promotion of instructor leadership.

### 2.2 Leader support

It has been evidenced that technological-innovation implementation challenges, this includes ITLTs low uptake, can be further resolved if teachers receive support from their academic leaders (Khalid et al., 2012). Moreover, a previous study conducted by Edvard Hatlevik & Christian Arnseth (2012) demonstrated that leadership support fosters positive attitudes towards ICT among instructors and facilitates innovative uses for ICT in education. In the context of this study, the term "leader support" refers as a "bearable assistance by a leader to a subordinate." That is, academics (subordinate) need considerable leader support from mid-level academic leaders in order to effectively integrate technology into their curricula, including a nurturing work environment that provides opportunities for them to take risks and collaborate with one another (AlAjmi, 2022; Dinh et al, 2021; Hughes & Zachariah, 2001).

While there have been recent trends in investigating the role of leader support on technological integration (Han, 2002; Edvard Hatlevik & Christian Arnseth, 2012; Hauge & Norenes, 2015), such research in educational settings is rare. Moreover, the attention paid towards investigating leadership support for the integration of technological changes in education has not led to explicit specification of what support HEIs instructors would entail from their mid-level academic leaders regarding this current challenge. For instance, the recent study conducted by Lindqvist (2019) asserts how educational-school organizers support mid-level leaders' practices in creating suitable environments for technology-enhanced learning. In that regard, it was crucially important to ascertain and understand the influence of higher management on the support practices for mid-level leaders regarding the integration of ITLTs, such as promoting and advancing innovative sustainable teaching and learning environments towards the use of teaching and learning technologies. However, how leader support practices at the meso-level (mid-level leadership) affect the actual technological integration by the academics in universities have not been adequately established. Technology integration in education institution can be fruitful only when the employee needs are taken into consideration (Serdyukov, 2017). This then integrates innovators, implementers, educational leadership, Innovation in education professional community and, certainly, the learners. Therefore, the leaders need to create an innovative professional culture within an institution for success adoption of an innovation.

### 2.3 The mediating role of technological knowledge level

Technological knowledge is a crucial aspect in attaining remarkable outcomes on technological integration and has been a fundamental driver for innovative transformation in education. With the advent of ITLTs, Higher Education Institutions (HEIs) require the establishment of appropriate technological knowledge flows among academics. This poses a number of challenges for most academic leaders, such as how to best support increasing the Technological Knowledge Level (TKL) among academicians in order to achieve the effective integration of ITLTs. Study by Castéra et al., (2020) assessed the strategies to enhance technological knowledge level and thus revealed that technological-pedagogical knowledge is crucial for instructor.

While the challenge remains on inculcating teachers with the capability to fully grasp the appropriate technological knowledge, study by Jaipal-Jamani et al. (2018) and Clausen et al. (2019) assert that leadership has become key to developing new ways of confronting such a complex issue, and that the leadership must address the core knowledge base components inclusive of content, pedagogy and technology. Similarly, Thomas et al. (2013) reported that the enhancement of the technological knowledge capacities of the members of educational institutions is to be considered as the main role of academic leaders such as Deans and Head of Departments (HoDs). In this regard, Avidov-Ungar & Shamir-Inbal (2017) emphasize also that academic principals must influence and compel instructor to take the lead regarding ICT implementation and that they must be able to see the added value that technology brings to education.

While academic leadership offers the promise of supporting academics on handling the challenges posed by technological knowledge associated with ITLTs, yet many academics are opposing the use of ICT since they lack the practical knowledge on how to use it wisely in their class curricula (Ertmer et al., 2015). Studies on technological knowledge level (Kafyulilo et al, 2012; Mtebe and Raphael, 2018) reported sufficient knowledge related to Content Knowledge (CK), Pedagogical knowledge (PK), Technological Knowledge (TK)and Pedagogical Content Knowledge (PCK) among instructors in Tanzanian HEIs, that is limited knowledge level is only to TK, TPK, TCK, and TPCK dimensions of the TPACK (Technological, Pedagogical and Content Knowledge) model. This study therefore assesses the influence of Leader Support (LS) on integration of ITLTs when mediated by TKL, while controlling for other factors such as age, gender, prior knowledge and working experience. Therefore, it considers specific research questions which are:

### 2.4 Specific RQs

1. To what extent do Leader Support influence Integration of Innovative Teaching–Learning Technologies (ITLTs).

2. To what extent do Technological Knowledge Level Influence Integration of ITLTs.
3. To what extent does Technological Knowledge Level mediate the relationship between Leader Support and Integration of ITLTs, when controlled by Age, ITLTs-Prior Knowledge, Gender, and Working Experience.

Figure 1 below depicts a graphical representation of the influence of leader support on the integration of ITLTs when mediated by technological knowledge.

## 3 Methods

### 3.1 Research design and data collection

This study adopted a cross-sectional design involving a quantitative research approach carried out in the higher education domain, comprised of academic members of staff from Mzumbe University and the University of Dodoma. Both web-based surveys and paper-based questionnaires were employed in the course of the data collection. The survey contained mainly four-subsections including demographic characteristics or variables, leadership support, technological knowledge level, and the integration of ITLTs. Additionally, a pre-test study was conducted at the university, which held almost similar qualifications requirements to the universities under study, while the Spearman–Brown split-half Cronbach's alpha of the instrument was found to be 0.81, which is considered reliable (Pallant, 2010).

### 3.2 Participants

Scholars provide that for a sound econometric analysis of every single variable in a model, there must be at least 15 respondents. As such, this study considered 15 respondents per variable, as recommended (Ahmad, & Halim, 2017) with this study possessing three main variables, which were: leader support, ITLTs and TKL. That means the dimensions of Leader Support (3), ITLTs (4) and TKL (4) were multiplied

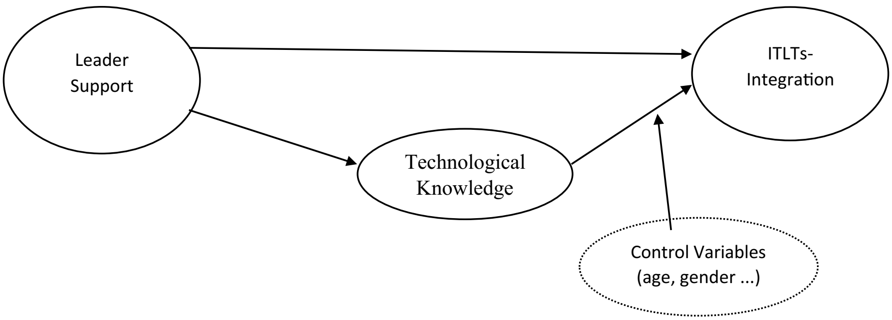


**Fig. 1** Conceptual framework of the study

by 15, i.e., 11 × 15 = 165 respondents. Hence, the sample of 192 academic staff is enough to make the inferential statistics (Yin, 2018). Furthermore, the participants hailed from a variety of different disciplines including the social sciences, law, public administration and management. Age and gender-based factors were also be considered when determining the sample size.

On average, the participants were 39 years old, with a range from 25–72. Approximately more than half of the sample was male (63.5%). Most of the participants were assistant lecturer (41.7%), followed by lecturers (37%) and few were Professors (1.0%). The academics had on average of 10 years' experience, working as academic staff (Table 1).

## 3.3 Instruments and measurements

### 3.3.1 Leader Support (LS)

In this study, we employed a Leader Support Survey (LSS) with the dimensions and statements modified from the original Supportive Leadership for Managing Innovations constructs based on McGilton, (2003). The LSS consists of three dimensions including, Involvement/participatory methods (three items), Information (three items) and Encouragement actions (three items). Thus, the instrument had 9 items. As well, the study adopted a five-point scoring scale ranging from 1 (strongly disagree) to 5 (strongly agree).

**Table 1** Demographics of the sample (*N* = 192)

| Respondents' characteristics | Categories | % |
|---|---|---|
| Gender | Female | 36.5 |
| | Male | 63.5 |
| Age | 25–35 | 30.9 |
| | 36–45 | 47.5 |
| | 46–55 | 17.0 |
| | 56 + | 4.5 |
| Academic ranks | Tutorial assistant | 9.4 |
| | Assistant lecturer | 41.7 |
| | Lecturer | 37.0 |
| | Senior lecturer | 10.9 |
| | Professors | 1.0 |
| Teaching experiences | 1 – 5 | 24.2 |
| | 6 -10 | 43.5 |
| | 11 -15 | 22.9 |
| | 16 – 20 | 5.4 |
| | More than 20 | 4.0 |

#### 3.3.2 Technological Knowledge Level (TKL)

We used T-related elements from the TPACK framework, which means TK, TPCK, TCK, & TPK. The Technological Knowledge Level Survey (TKLS) questionnaire modified based on the work of Mishra and Koehler (2006) was employed to assess the Technological Knowledge Level among the academic staff members, and consists of four subscales including: Technological Knowledge—TK (four items, e.g. *I have the technical skills to use ITLTs effectively*), Technological Pedagogical Knowledge—TPK (four items, e.g. *I am able to use ITLTs to introduce my students to real-world scenarios*), Technological Content Knowledge—TCK (three items, e.g. *I can use the teaching and learning technologies/software that have been created specifically for the subject I teach*), and Technological Pedagogical Content Knowledge—TCPK (four items, e.g. *I can select which teaching and learning technologies to use in my classroom that enhance what I teach, how I teach and what students learn.*).

#### 3.3.3 Integration of Innovative Teaching–Learning Technologies (IITLTs)

The Integration of Innovative Teaching and Learning Technologies Survey (IITLTs) was self-revised with 22 items corresponding to teaching and learning technological tools, with the integration of ITLTs having been measured mainly through the use of four sub-scales revolving around the use of various teaching and learning technological tools related to online interactions and technological competency based on the work of Aslan & Zhu, (2016), and John (2015). This includes the use of technology for the accessing & sharing of information; the use of technology for assessment/feedback; and the use of technology in presentations. Ratings were provided from never used (1) to always used (5), with the mean score computed for each dimension.

### 3.4 Data analysis

The data were coded using the Statistical Package for Social Sciences (SPSS), while the devised hypothesis (to assess the extent to which leader support influences the integration of ITLTs, mediated by the TKL when controlled for demographic factors such as age, gender, and ITLTs prior knowledge) was tested using Structural Equation Modeling (SEM). Subsequently, a reliability analysis was conducted to assess the correlation among the items of each study variable, with a Cronbach's of 0.7 or higher indicating a reliable scale. In this study, the Cronbach's α obtained for each variable was 0.8 for LS, 0.8 for TKL, and 0.8 for ITLTs. Since the higher the Cronbach's α is, the better the internal consistency, this indicates that all the variables were reliable. Furthermore, mean scores TK, TPCK, TCK, & TPK and accessing & sharing of information; the use of technology for assessment/feedback; the use of technology in presentations were computed.

Data analysis were carried out using the following steps.

First step: Exploratory factor analysis (EFA).
The exploratory factor analysis was carried out through principal component analysis to reduce the 17 items into three dimensions The study adopted principal component analyzing (PCA). using an orthogonal rotation (varimax rotation), which maximize variation in the matrix system. The data was suppressed at 0.4 factors loading. As well, the Kaiser–Meyer–Olkin score was 0.903 which is significant, since it means that the data was appropriate for performing an exploratory factor analysis. Likewise, the Bartlett's test of sphericity (2401.3, df = 136 and p = 0.001) implying that the correlation matrix was not an identity for all factors (Field, 2013). Table 2 depicts the findings from the Principal Component Analysis (PCA), with all three variables explaining 69.70% of the total variation. The first principal component (PC1) accounted for 46.96% of the total variation, with the PC1 representing items related to leader support. The items that fell under this component include supervisors' encouragement to academics to use ITLTs, consulting the leader when faced with a challenge relating to ITLTs (Information), and supervisors imploring academics to meet the demands posed by ITLTs. The mean value of the four items associated with PC1 was found to be close to 3 (Table 3), which means that most of the respondents receive an average level of support from their leaders. The second principal component accounted for 14.88% of the total variation and was comprised of the items related to the Technological Knowledge Level. The mean score for most of the items was higher than 2.5, which means that the respondents had an average Technological Knowledge Level (Table 3). Lastly, the third principal component accounted for 7.86% of the total variation, containing statements related to the use of teaching & learning technologies. The mean score for this was generally near 2.8, which implies that most of the respondents moderately used teaching & learning technologies.
Second Step: Confirmatory Factor Analysis (CFA).
Subsequently, Confirmatory Factor Analysis (CFA) was performed and analysed by using the Analysis of Moment Structures (AMOS) version 22 in order to verify the construct validity. The results of the CFA were used to assess the three original factors that had been derived as already highlighted in the conceptual framework and this study's research questions. This model contains 17 statements (9 items for LS, 4 items for TKL, and 4 items for ITLTs). Additionally, the study used various indices in order to assess the fitness of the CFA model, including ratio of $\chi 2$ statistics to the degree of freedom (CMIN/DF), the GoF index (GFI), an adjusted GoF index (AGFI), the normed fit index (NFI), expected cross-validation index (ECVI), Tucker-Lewis Index (TLI), comparative fit index (CFI) and root mean square error of approximation (RMSEA).

The yielded results demonstrate that the ratio of the minimum discrepancy to the degree of freedom (CMIN/DF) was 2.007, which is less than 3 as recommended by (Byrne 2010). Furthermore, the results in Table 4 indicate that the CFA model fits the data well (Byrne, 2010).

**Table 2** Factor loadings for various principal component analyses of items

| Items | PC1 (46.96%) | PC2 (14.88%) | PC3 (7.86) |
|---|---|---|---|
| LS6: My supervisor encourages me even in difficult situations when comes to the issues related to ITLTs | .840 | | |
| LS1: My supervisor encourages me to express my ideas or suggestions on teaching and learning technologies | .811 | | |
| LS8: My supervisor tries to meet my needs related to use of ITLTs | .795 | | |
| LS2: My supervisor listens receptively to ITLTs ideas and suggestions | .781 | | |
| LS3:My supervisor uses ITLTs suggestions to make decisions on matters related to educational technological change | .765 | | |
| LS4: I consult my supervisor when facing a problem related to ITLTs | .741 | | |
| LS7: My supervisor makes a point of expressing appreciation when I do a good job on matters related to use of ITLTs | .735 | | |
| LS5: My supervisor recognizes my ITLTs strengths and area for development | .707 | | |
| LS9: My supervisor keeps me informed of any decisions that were made in regards to teaching and learning technologies | .689 | | |
| TKL4: TPK | | .847 | |
| TKL2: TPCK | | .843 | |
| TKL1: TK | | .775 | |
| TKL3: TCK | | .702 | |
| TU4: *Use of technology in presentations* | | | .877 |
| TU1: *Online interactions* | | | .844 |
| TU2: *Use of technology for accessing & sharing of information* | | | .816 |
| TU3: *Use of technology for assessment/feedback* | | | .722 |

Kaiser–Meyer–Olkin score = 0.903 Bartlett's test of sphericity (2401.3, df = 136 and p = 0.001

PC1: Leaders support

PC2: Technological Knowledge Level

PC3: Use of teaching & learning technologies

**Table 3** Descriptive statistics on the responses to the items for leader support and the integration of innovative teaching–learning technologies: the mediating role of the level of technological knowledge ($n = 192$)

| Items | Mean | Standard deviation |
|---|---|---|
| LS1 My supervisor encourages me to express my ideas or suggestions on teaching and learning technologies | 3.13 | 1.10 |
| LS2 My supervisor listens receptively to ITLT ideas and suggestions | 3.07 | 1.07 |
| LS3 My supervisor uses ITLT suggestions to make decisions on matters related to educational technological change | 2.88 | 1.07 |
| LS4 I consult my supervisor when facing a problem related to ITLTs | 2.76 | 1.14 |
| LS5 My supervisor recognizes my ITLTs' strengths and area for development | 2.77 | 1.11 |
| LS6 My supervisor encourages me even in difficult situations when it comes to issues related to ITLTs | 2.81 | 1.09 |
| LS7 My supervisor makes a point of expressing appreciation when I do a good job on matters related to the use of ITLTs | 2.75 | 1.07 |
| LS8 My supervisor tries to meet my needs related to the use of ITLTs | 2.73 | 1.08 |
| LS9 My supervisor keeps me informed of any decisions that were made in regards to teaching and learning technologies | 2.87 | 1.07 |
| TKL1 TK | 2.64 | 0.74 |
| TKL2 TPCK | 2.62 | 0.79 |
| TKL3 TCK | 2.87 | 0.77 |
| TKL4 TPK | 2.56 | 0.80 |
| TU1 *Online interactions* | 2.84 | 0.89 |
| TU2 *Use of technology for accessing & sharing of information* | 3.51 | 0.79 |
| TU3 *Use of technology for assessment/feedback* | 2.53 | 1.03 |
| TU4 *Use of technology in presentations* | 3.08 | 0.76 |

**Table 4** Indices in order to assess the fitness of the CFA model

| Indices | Value |
|---|---|
| GFI | 0.93 |
| AGFI | 0.860 |
| NFI | 0.708 |
| ECVI | 4.594 |
| TLI | 0.691 |
| CFI | 0.748 |
| RMSEA | 0.066 |
| PCLOSE | 0.16 |

However, since the sample size was small ($n = 192$), the path requires further validation. Therefore, the validation requires a large sample size or the bootstrapping procedure (Fan et al., 2016). The procedure obtained 2000 usable bootstrap samples, which is sufficient for the bootstrapping procedure as recommended by Byrne (2016). The results of the present model was $p = 0.081$, implying that the model tested via bootstrapping procedure was not statistically significant to the hypothesized model.

Furthermore, the estimates based on all 17 items indicated that the standardized regression weights for LS ranged from 0.712 to 0.904, TKL (0.650 to 0.897), and ITLTs (0.632 to 0.851) as shown in Fig. 1. The results revealed that there was an explanatory interrelationship between all the items contained within the variables. As well, the standard regression coefficients for all the statements were higher than 0.5, which is the minimum value (Rauniar et al., 2014). As mentioned previously, these 17 items have been further subdivided into three component factors: LS, TKL and ITLTs (Fig. 2).

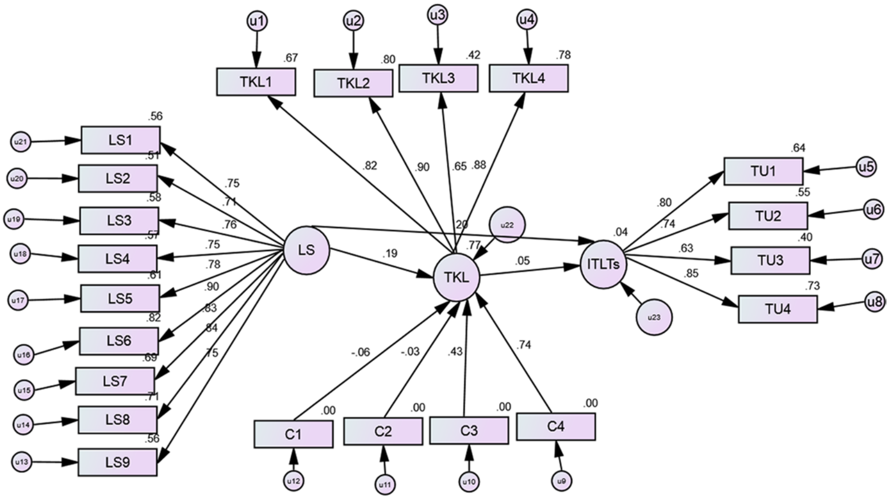


Fig. 2 Standardized estimate of the confirmatory factor analysis

# 4 Results

## 4.1 The extent of leader support influence on the integration of innovative teaching–learning technologies (RQ1)

In view of the first research question, the study sought to examine whether the support of mid-level academic leaders to academics influence their integration of ITLTs. The results from Table 5 reveals that the integration of ITLTs is influenced by leader support (LS) (β = 0.199, $p$ = 0.015).

## 4.2 The extent does technological knowledge level influence integration of ITLTs (RQ2)

With regard to the research question two, the relationship between perceived technological knowledge level and the integration of ITLTs were analysed using SEM results. The results in Table 5 show that TKL were not significant influence integration of ITLTs (β = 0.046, $p$ = 0.573). It implies that TKL is not the factor determine the integration of ITLTs by academics. This further means that when TKL acts as a mediator between leader support and ITLTs integration, it does not show a significant relationship with the ITLTs integration.

## 4.3 Technological knowledge level mediates the relationship between leader support and the integration of ITLTs (RQ3)

Table 5 presents the summary of the SEM path coefficients, with the results showing that C3 *(*β = 0.429, $p$ = 0.000*)* was statistically significant predictors of TKL. This implied that an increase in teaching experience influences the level of technological knowledge. Furthermore, ITLTs was influenced by LS (β = 0.199, p = 0.015), while LS significantly influenced TKL (β = 0.191, p = 0.000). Though C1, C2 and C4 did not significantly influence TKL (C1(β = -0.061, $p$ = 0.145; C2(β = -0.429, $p$ = 0.502;

**Table 5** The summary of the SEM results

| SEM regression path | SRW | SE | CR | P |
|---|---|---|---|---|
| TKL < —C1 | -.058 | .004 | -1.391 | .164 |
| TKL < —C2 | -.026 | .058 | -.636 | .525 |
| TKL < —C3 | .429** | .005 | 9.715 | *** |
| TKL < —C4 | .739 | | | |
| TKL < —LS | .191** | .038 | 4.261 | *** |
| ITLTs < —TKL | .046 | .085 | .563 | .573 |
| ITLTs < —LS | .199* | .073 | 2.422 | .015 |

SRW, standardized regression weights; r, Correlation; SE, standard error; CR, critical ratio

*$p$ < 0.05; **$p$ < 0.01; C1, Age; C2, Gender; C3, Working experience; C4, Prior knowledge of ITLTs

C4($\beta$ = -0.739, $p > 0.05$). The strongest significant path is C3 → TKL (= 0.429, $p = 0.000$) while the weakest path is C2 → TKL ($\beta$ = -0.026, $p = 0.525$).

## 5 Discussion

This study sought to assess the influence of Leader Support (LS) on integration of ITLTs when mediated by TKL, while controlled for other factors such as age, gender, prior knowledge and working experience. Specifically, this study examined academics' technological knowledge level as a mediator of the support received from their mid-level academic leaders, and its relationship with the integration of ITLTs in the selected public universities in Tanzania.

The results reveal that, academics receive an average level of support from their mid-level academic leaders, with supervisors having been reported to sufficiently encourage academics to express ideas or suggestions on the use of ITLTs. However, MLALs were reparted to be challenged on meeting the academics' needs related to the use of ITLTs. Similarly, Clausen et al. (2019) study on TPACK leadership diagnostic tool, found that academic leaders challenged with complying with academics' additional resources such as incentives, operating funds to support ITLTs actions to enhance integration of ITLTs.

The results further suggest that the integration of ITLTs among academics is positively influenced by leader support, that is, the higher the support the academics receive from their leaders, the better the integration of ITLTs. In this regard, Thomas et al. (2013) and Clausen et al. (2019) identified a solid interaction between LS and IITLTs which positively results in effective teaching with technology. However, (AlAjmi, 2022; Kashef, 2016) reveal that without meso-leadership to prioritize goals and support teachers to integrate ITLTs, the ability to empower faculties and transform the HEIs may linger in a drift.

Moreover, the results indicate that, perceived leader support also predicts academicians' technological knowledge level. However, no direct influence of technological knowledge level was significantly found when mediating the two variables, indicating that leaders support had strong influenced the integration of ITLTs. Buabeng-Andoh (2012) recommended that leadership could help to improve integration of information technology in teaching. In that regard, these results further suggest a need to enable leaders to support the academic staff that is, to promote support for the ITLT integration-ready environments for teachers.

Besides, amongst control variables, the results also indicate that the strongest significant predictive path is working experience, while the weakest path is age. This further suggest that working experience directly and positively influences the technological knowledge level of academics regarding the integration of ITLTs. Surprisingly, the findings indicate that neither age nor prior knowledge of ITLT use controlled the relationship between TKL and integration of ITLTs. This finding supports the previous literature on use of ICT in education, which suggesting that the role of age and prior knowledge should be reframed. This is consistent with the extant literature, which has also currently examined this kind of relationship (Sanchez-Mena et al., 2019; Lawrence & Tar, 2018; Schiler, 2003).

This study was limited to two universities in Tanzania, meaning that any generalisation of the findings should be dealt with caution. It is therefore suggested that in order to obtain a more holistic overview, further study on this subject could be conducted at other HEIs. Furthermore, the study was limited to a quantitative research approach only, and specifically to academic staff, therefore we propose that further study can be conducted with other staff and in a manner more inclusive of senior leaders.

### 5.1 Practical implications of the results

This study provides insights on the critical role of leadership support has in influencing the execution of education change, referring to ITLTs integration. In theoretical perspective, it identifies the relationship between academic leader support and the integration of ITLTs when mediated with technological knowledge level. Practically, it implies that leader support is a crucial aspect to consider in promoting ITLTs integration among academics in the relevant Tanzanian universities. In order to facilitate technological integration in HEIs the study recommends the following actions and strategies put in place. In the light of the findings, leaders should provide support to the teaching staff such as training as a form of capacity building, supervisors' encouragement to academics to use ITLTs, providing the room for consulting when instructors face with a challenge relating to ITLTs. Therefore, the findings of this study could be helpful to education practitioners and policymakers to include or recognize meso-level dimensions such as leadership support, leadership characteristics when designing the implementation of ITLTs integration in Tanzanian contexts.

### 5.2 Limitations

This study was limited to two universities in Tanzania, so any generalisation of the findings should be dealt with caution. Therefore, it is suggested that to obtain a more holistic overview, further study on this subject could be conducted at other HEIs while considering highly on a level of reflection on technological contexts be developed. Furthermore, the study was limited to a quantitative research approach only, and specifically to academic staff, so therefore we propose that further study can be conducted with other staff and in a manner more inclusive of senior leaders.

## 6 Conclusion

Leader support in integrating ITLTs should be fostered among managerial roles with the utmost consideration. For example, the current study generally envisaged that the support received by academicians from their mid-level academic leaders has a positive relationship with the integration of ITLTs and TKL. However, TKL was found to not have a direct effect on IITLTs when mediating the relationship between LS and IITLTs. This further proves the inclusive findings of leader support (LS) as a key driver and important aspect behind the implementation of educational technologies. This study, hence, extends the research on the potential of mid-level academic leadership to bring about educational change in higher learning and thus, enhance the integration of ITLTs. From the findings, this study recommends the following: first, leader support should be taken into consideration for the effective integration of ITLTs in higher education institutions. This will ensure successful in producing a desired or intended result for ITLTs which is to make the learning process more productive and interesting. Second, higher education practitioners, such as administrators, should consider the socio-demographic characteristics of academic staff when designing and planning for the integration of ITLTs in higher education institutions.

## Declarations

**Data availability statement** "Our manuscript contains non-digital primary data whereas the respondents were academicians from two public universities in Tanzania. Due to ethical concerns, supporting data cannot be made openly available. As such, the data supporting this study are stored by corresponding author at Vrije Universiteit Brussel who can made it available whenever deemed necessary. However, some data is provided partially in the results section of our manuscript".

We have no known conflict of interest to disclose. This research work was supported by the Vlaamse Interuniversitaire Raad.



## References

Ahmad, H., & Halim, H. (2017). Determining sample size for research activities. *Selangor Business Review*, 20–34.

AlAjmi, M. K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *International Journal of Educational Research, 112*, 101928.

Albashtawi, A., & Al Bataineh, K. (2020). The effectiveness of google classroom among EFL students in Jordan: An innovative teaching and learning online platform. *International Journal of Emerging Technologies in Learning (iJET), 15*(11), 78–88.

Al-Samarraie, H., Teng, B. K., Alzahrani, A. I., & Alalwan, N. (2017). E-Learning continuance satisfaction in higher education: A unified perspective from instructors and students. *Studies in Higher Education, 43*(11), 2003–2019.

Aslan, A., & Zhu, C. (2016). Variables influencing pre-service and starting teachers' integration of ICT into teaching practices in the Turkish context. In *Dissertation for the academic degree of Doctor in Educational Sciences*. VUB.

Avidov-Ungar, O., & Shamir-Inbal, T. (2017). ICT Coordinators' TPACK-based leadership knowledge in their roles as agents of change. *Journal of Information Technology Education, 16*(1).

Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education, 37*(1), 45–63.

Botero, G. A. G. (2019). Towards the integration of informal-mobile assisted language learning in out-of-class settings (ongoing PhD).

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development Using ICT, 8*(1), 136–155.

Byrne, M. B. (2010). *Structural Equation Modeling with AMOS; Basic Concepts, Applications, and Programming*. New York: Taylor & Francis Group.

Byrne, B. M. (2016). *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming* (3rd ed.). Routledge.

Castéra J, Marre CC, Yok MCK, et al. (2020). Self-reported TPACK of teacher educators across six countries in Asia and Europe. *Education and Information Technologies* 25(4). Education and Information Technologies: 3003–3019. DOI: https://doi.org/10.1007/s10639-020-10106-6.

Chatterjee, S. (2016). Digital culture: a paradigm shift in communication perspective in post-globalized world. *Journal of Content, Community & Communication*, 44.

Cheng, P. H., Molina, J., Lin, M. C., Liu, H. H., & Chang, C. Y. (2022). A New TPACK Training Model for Tackling the Ongoing Challenges of COVID-19. *Applied System Innovation, 5*(2), 32.

Clausen, J. M., Finsness, E. S., Borthwick, A. C., Graziano, K. J., Carpenter, J. P., & Herring, M. (2019). TPACK leadership diagnostic tool: Adoption and implementation by teacher education leaders. *Journal of Digital Learning in Teacher Education, 35*(1), 54–72.

Dinh, N. B. K., Caliskan, A., & Zhu, C. (2021). Academic leadership: Perceptions of academic leaders and staff in diverse contexts. *Educational Management Administration & Leadership, 49*(6), 996–1016.

Edvard Hatlevik, O., & Christian Arnseth, H. (2012). ICT, teaching and leadership: How do teachers experience the importance of ICT-supportive school leaders? *Nordic Journal of Digital Literacy, 7*(1), 55–69.

Ertmer, P., Ottenbreit-Leftwich, A. & Tondeur, J. (2015). Teachers beliefs and uses of technology to support 21st century teaching and learning. In H. Five M. Gills (Eds.), *International Handbook of Research on Teachers Beliefs* Routledge.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423–435.

Fan, Y., Chen, J., Shirkey, G., John, R., Wu, S. R., Park, H., & Shao, C. (2016). Applications of structural equation modeling (SEM) in ecological studies: An updated review. *Ecoology. Process., 5*, 1–12.

Field, A. (2013). Discovering statistics using IBM SPSS statistics. sage.

Foutsitzi, S., & Caridakis, G. (2019). ICT in education: Benefits, challenges and new directions. In *2019 10th International Conference on Information, Intelligence, Systems and Applications (IISA)* (pp. 1–8). IEEE.

Graziano, K. J., Herring, M. C., Carpenter, J. P., Smaldino, S., & Finsness, E. S. (2017). A TPACK diagnostic tool for teacher education leaders. *TechTrends, 61*(4), 372–379.

Grimmer, R., Pollard, A., & Rolls, N. (2020). COVID-19 induced change in higher education: Reflections on rapidly transitioning a first-year undergraduate academic literacies unit from face-to-face to online. *Journal of Academic Language & Learning, 14*(2), 95–105. https://journal.aall.org.au/index.php/jall/article/view/695

Håkansson Lindqvist, M. (2019). School leaders' practices for innovative use of digital technologies in schools. *British Journal of Educational Technology, 50*(3), 1226–1240.

Han, C. (2002). Leadership roles of a pre-school principal in the use of information and communication technology: A Hong Kong experience. *Contemporary Issues in Early Childhood, 3*(2), 293–297.

Hauge, T. E., & Norenes, S. O. (2015). Collaborative leadership development with ICT: Experiences from three exemplary schools. *International Journal of Leadership in Education, 18*(3), 340–364.

Hughes, M., & Zachariah, S. (2001). An investigation into the relationship between effective administrative leadership styles and the use of technology, 5 (5). *IEJLL: International Electronic Journal for Leadership in Learning*.

Ilechukwu, L. C. (2013). The assessment of utilization of e-learning opportunities for effective teaching and learning of religion in Nigerian tertiary institutions. *European Journal of Educational Studies*, *5*(3).

Jaipal-Jamani, K., Figg, C., Collier, D., Gallagher, T., Winters, K. L., & Ciampa, K. (2018). Developing TPACK of university faculty through technology leadership roles. *Italian Journal of Educational Technology, 26*(1), 39–55.

Jansen, R. S., Van Leeuwen, A., Janssen, J., Jak, S., & Kester, L. (2019). Self-regulated learning partially mediates the effect of self-regulated learning interventions on achievement in higher education: A meta-analysis. *Educational Research Review, 28*, 100292.

John, S. P. (2015). The integration of information technology in higher education: A study of faculty's attitude towards IT adoption in the teaching process. *Contaduria y Administracion, 60*, 230–252. https://doi.org/10.1016/j.cya.2015.08.004

Kafyulilo, A., Fisser, P., & Voogt, J. (2012). Transforming Classroom Practices through Teachers' Learning of TPACK: The Case of In-service Teachers at Kibasila Secondary School in Tanzania. In *Society for Information Technology & Teacher Education International Conference* (pp. 2861–2869). Association for the Advancement of Computing in Education (AACE).

Kashef, F. (2016). Challenges to Creating and Sustaining Effective Technology Integration in Teacher Education Programs. *Education*.

Khalid, S., Irshad, M. Z., & Mahmood, B. (2012). Job satisfaction among academic staff: A comparative analysis between public and private sector universities of Punjab. *Pakistan International journal of Business and Management, 7*(1), 126.

Larionova, V., Brown, K., Bystrova, T., & Sinitsyn, E. (2018). Russian perspectives of online learning technologies in higher education: An empirical study of a MOOC. *Research in Comparative and International Education, 13*(1), 70–91.

Lashayo, D., & Olahraga, O. (2017). *Investment in e-learning relative to East African countries., 13*(2), 111–118.

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International, 55*(1), 79–105.

Leoste, J., Heidmets, M., Ley, T., & Stepanova, J. (2021). Classroom Innovation Becoming Sustainable: A Study of Technological Innovation Adoption by Estonian Primary School Teachers. *Interaction Design and Architecture, 21*, 144–166.

Liu, Q., Geertshuis, S., & Grainger, R. (2020). Understanding academics' adoption of learning technologies: A systematic review. *Computers & Education, 151*, 1–19.

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford Review of Education, 38*(1), 9–24.

Machumu, H. J., Zhu, C., & Sesabo, J. K. (2016). Blended learning in the vocational education and training system in Tanzania: Understanding vocational educators' perceptions. *International Journal of Multicultural and Multireligious Understanding*, 3(2), 30–45.

McGilton, K. S. (2003). Development and psychometric evaluation of supportive leadership scales. *Canadian Journal of Nursing Research Archive*, 72–86.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mtebe, J. S., & Raphael, C. (2018). Eliciting in-service teachers' technological pedagogical content knowledge for 21st-century skills in Tanzania. *Journal of Learning for Development, 5*(3), 263–279.

Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th industrial revolution (4IR). *Journal of Open Innovation: Technology, Market, and Complexity, 6*(2), 31.

Özdemir, S. (2017). Teacher Views on Barriers to the Integration of Information and Communication Technologies (ICT) in Turkish Teaching. *International Journal of Environmental and Science Education, 12*(3), 505–521. https://doi.org/10.12973/ijese.2017.1244p

Pallant, J. (2010). *SPSS Survival manual* 4th edn., Open University Press. Berkshire.

Purwanto, A. (2020). Effect of hard skills, soft skills, organizational learning and innovation capability on Islamic University lecturers' performance. *Systematic Reviews in Pharmacy*.

Rabah, J. (2015). Benefits and challenges of information and communication technologies (ict) integration in québec english schools. *Turkish Online Journal of Educational Technology-TOJET, 14*(2), 24–31.

Rauniar, R., Rawski, G., Yang, J. & Johnson, B. (2014). Technology acceptance model (TAM) and social media usage: an empirical study on Facebook. *Journal of Enterprise Information Management*, 27(1), 6–30. http://www.emeraldinsight.com.sci-hub.cc/doi/abs/10.1108/JEIM-04-2012-0011

Sánchez-Mena, A., Martí-Parreño, J., & Aldás-Manzano, J. (2019). Teachers' intention to use educational video games: The moderating role of gender and age. *Innovations in Education and Teaching International, 56*(3), 318–329.

Schiler, J. (2003). Working with ICT: Perceptions of Australian principals. *Journal of Educational Administration, 41*(3), 171–185.

Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning., 10*(1), 4–33.

Singh, G., & Hardaker, G. (2014). *Barriers and enablers to adoption and diffusion of e-learning: A systematic review of the literature–a need for an integrative approach*. Education+ Training.

Suartama, I. K., Setyosari, P., & Ulfa, S. (2019). Development of an instructional design model for mobile blended learning in higher education. *International Journal of Emerging Technologies in Learning, 14*(16), 4–22.

Tang, T. L. P., & Austin, M. J. (2009). Students' perceptions of teaching technologies, application of technologies, and academic performance. *Computers & Education, 53*(4), 1241–1255.

TCU. (2016). *University qualifications framework* (UQF). Dar es Salaam: Tanzania Commission for Universities (TCU).

Thomas, T., Herring, M., Redmond, P., & Smaldino, S. (2013). Leading change and innovation in teacher preparation: A blueprint for developing TPACK ready teacher candidates. *TechTrends, 57*(5), 55–63.

Tondeur, J., Aesaert, K., Prestridge, S., & Consuegra, E. (2018). A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies. *Computers & Education, 122*, 32–42.

URT. (2003). *National information & communication technologies policy*. Dar es Salaam: Ministry of Communications and Transport, Tanzania.

Volman, M. L., Zijlstra, B. J., Gaikhorst, L., & Beishuizen, J. J. (2015). Contribution of a professional development programme to the quality and retention of teachers in an urban environment. *European Journal of Teacher Education, 38*(1), 41–57.

Vovk, M. P., Sotska, H. I., Trynus, O. V., & Muzyka, O. J. (2019). Assessment of instructors' technology competency to be used in the settings of formal and non-formal education. *International Journal of Higher Education, 8*(5), 29–44.

Yin, R. K. (2018). *Case study research and applications*. Sage.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## Authors and Affiliations

**Elizabeth Landa[1,2] · Chang Zhu[1] · Jennifer Sesabo[3] · Haruni Machumu[3]**

[1] Department of Educational Sciences, Vrije Universiteit Brussel, Brussels, Belgium

[2] School of Psychology and Educational Sciences, Vrije Universiteit Brussel, Postbox 1050 Etterbeek Campus 3B204, Brussels, Belgium

[3] Faculty of Social Sciences, Mzumbe University, Morogoro, Tanzania