



## Research article

## Effects of Gauteng province's educators' ICT self-efficacy on their pedagogical use of ICTS in classrooms

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## ABSTRACT

The proliferation of ICT in South African basic education has not been associated with effective pedagogical uses of ICT in classrooms. While there is differential deployment of ICT as cognitive tools of instruction in South Africa's schools, the effects of educators' ICT self-efficacy on their pedagogical use of technologies is yet to be fully grasped. This research gap has been attributed to, inter alia, the lack of a detailed profile of ICT self-efficacy beliefs of educators and its effects on pedagogical uses of ICT by educators. This study employs a cross-sectional survey, adapting a structured questionnaire to investigate the relationship between purposively selected 163 Gauteng educators' ICT self-efficacy beliefs and their pedagogical use of ICT. An exploratory factor analysis on pedagogical use of ICT (PUI) revealed three factors of 'traditional PUI' and one 'constructivist PUI'. Results suggest that ICT self-efficacy had a positive significant but moderate effect on the three traditional PUI and a positive significant and strong relationship with the constructivist PUI. Furthermore, a linear regression analysis found ICT self-efficacy to significantly predict all four PUI factors. The study recommends initial educator training that emphasises exposure of trainee educators to extended periods of hands-on engagement with ICTs in classroom environments. Furthermore, it recommends continuous ICT integration and the development of practicing educators with a focus on the "how to" integrate ICT tools as 'generative' mind tools. These interventions have potential to increase educators' ICT self-efficacy in resource constrained contexts. The implication is that educator training curricula are re-designed with an emphasis on practical lesson planning that includes ICTs as seamless resources used in the classroom in basic education.

## 1. Introduction

While Information and Communications Technologies (ICTs) such as laptops, interactive whiteboards, tablet PCs, data projectors, Web 2.0 tools, and clickers have proliferated and have become permanent features of 21<sup>st</sup> Century classrooms, these have not been associated with effective pedagogical use in South African classrooms (Nkula and Krauss, 2014; nulls). For instance, ICTs have the capacity to meaningfully engage learners in problem solving and critical thinking (Kurt, 2010), provide multimodal features that enable greater flexibility and interaction for teaching and learning at individual and group levels (Department of Basic Education, 2011; Lawrence and Tar, 2018). However, their pedagogical uses in South African primary and secondary classrooms remains widely erratic, differentiated and often suboptimal regionally, institutionally and at individual educator levels (Adukaite et al., 2016). For instance Adukaite et al. (2016) reports that there are vast differences

between under-resourced schools and resourced ones – viz, there is limited ICTs use in class at the former compared to the later.

The promises of educational gains through effective pedagogical uses of technology have contributed to huge investments in digital devices and the training of educators in technology integration by governments worldwide. Some examples are, the UK's Next Generation Learning project (Becta, 2008), and the National Grid for Learning Strategy, Australian's Digital Education Revolution (Department of Education, Employment and Workplace Relations of Australia, 2011), the National Education Technology Plan 2010 in the United States (U.S. Department of Education, 2010), and Singapore's Master Plan for Information Technology in Education (Commonwealth of Learning, 2015). These constitute interventions targeting the deployment of ICTs to enhance pedagogical activities. Although all nine provincial departments of education in South Africa have implemented various interventions aimed at the 'digitization' of classrooms, only Gauteng and Western Cape

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provinces have developed projects aimed at ICT integration and are pioneers in the pedagogical use of technology (Western Cape Government, 2013; Gauteng Department of Education, 2015) in South African public schools. Despite these modest educational gains, it is evident there are concerns that ICTs have not been fully utilised as cognitive tools (Jonassen, 1999; Eteokleous, 2008; Pakdaman-Savoji et al., 2019). Notwithstanding the potential of ICTs to enhance learners' learning capabilities, South Africa's school educators have predominantly harnessed them as alternative tools to prepare and present subject content in a more aesthetic way rather than as cognitive tools to enrich learners' learning experiences by facilitating cognitive processes such as critical thinking and higher-order learning (Adukaite et al., 2016; Pakdaman-Savoji et al., 2019). Thus, ICTs have been applied for 'representational use' instead of the richer 'generative use' (Hokanson and Hooper, 2000; Nkula and Krauss, 2014). 'Representational use' is when educators use ICTs to re-present content by incorporating ICTs in activities but with little or no construction of new knowledge (Hokanson and Hooper, 2000). These educators use ICTs merely as demonstration tools (Aslan and Zhu, 2016) and as technological tools related to representation rather than pedagogical ones (Padayachee, 2017). In contrast, 'generative use' involves educators using ICTs to generate ideas and construct new knowledge (Hokanson and Hooper, 2000).

DiGregorio and Liston (2018) found that for educators to successfully use the technologies in their classrooms in 'generative' and constructivist ways, one key ingredient is their ICT efficacious beliefs. Hong et al. (2014) support this view, and found a positive significant relationship between educators' computer self-efficacy and their computer use in classrooms. ICT self-efficacy (sometimes referred to as computer self-efficacy), describes self-confidence beliefs about the effective use of computers/ICTs with respect to one's capability to perform a specific task (Hong et al., 2014). Although there are multiple reasons for ineffective pedagogical use of technology in contemporary classrooms, it can be implied that low levels of ICT self-efficacy of educators are among the major reasons for limited use of ICTs (DiGregorio and Liston, 2018). For instance Thongsri et al. (2019) found computer self-efficacy among learners to have the highest influence on acceptability of technology. Equally, lack of self-efficacy has been reported to influence acceptance and use of ICTs by educators, which directly or indirectly predict use of ICTs in the classrooms (Alt, 2018). Contrastingly, high levels of educators' ICT self-efficacy increase the use of ICTs in the classrooms (Hong et al., 2014; Siyam, 2019). Thus educators' technology or ICT self-efficacy is a significant predictor of the educators' use of ICTs (Li et al., 2019). Furthermore, ICT self-efficacy has been reported to have the most significant impact on the actual use of ICTs in classrooms compared to other attitudinal factors such as perceived usefulness, perceived ease of use, and attitude towards ICT usage (Siyam, 2019). Chigona and Chigona (2010) contend that most South African educators often lack the confidence to integrate and teach with ICTs. While there is differential deployment of ICTs for pedagogical use as a cognitive ('generative') tools of instruction in South Africa's secondary schools, the effects of educators' ICT self-efficacy on their pedagogical use of technologies is yet to be fully grasped. Consistent with the foregoing discussion, this paper seeks:

- To determine the ICT self-efficacy of educators in the Gauteng province in South Africa.
- To find out the pedagogical use of ICTs by educators in Gauteng province.
- To determine the relationship between ICT self-efficacy and the pedagogical use of ICTs in the classrooms by Gauteng province educators.
- To determine if ICT self-efficacy predict ICT usage in the classroom by these educators.

## 2. Theoretical framework

### 2.1. The beliefs construct

The beliefs construct is a complex latent factor that encompasses several underlying sub-constructs. Hofer and Pintrich (1997:112) define beliefs "as psychologically held understandings, premises or propositions about the world that are thought to be true" by an individual. Thus beliefs are what an individual thinks to be true even without empirical evidence to factually prove with certainty. Like any human being, educators have beliefs about physical, social, spiritual or emotional matters. Specifically, they have general beliefs about their educational practice and how to be successful (Pajares, 1992). Beijaard (1998), and Hermans et al. (2008:1500) define educator beliefs as "the individual conceptions about desirable ways of teaching and conceptions about how students come to learn". The beliefs educators possess can influence how they approach educational tasks including lesson planning, choice of teaching strategies and methods, and whether to use ICTs or not in their classrooms for instructional and learning purposes. Again the conceptions encompass a wide facet of underlying factors which include educational beliefs (simplistically categorised as constructivist beliefs and traditional beliefs), beliefs about assessments, beliefs about how learners should learn, educators' teaching efficacy, attitudes about educational media including ICTs, and educators ICTs self-efficacy to name but a few.

The educators' beliefs have a capacity to shape educators' teaching practice and how they behave in class. According to Hermans et al. (2008) beliefs have a mediating influence on the educators' process of adoption of educational innovations. This includes framing how they arrive at certain academic decisions on lesson preparation, choice of method of delivery, assessment methods, and includes processes on integration of ICTs into the classroom. Studying the effects of educators' educational beliefs (i.e., traditional beliefs and constructivist beliefs) Hermans et al. (2008) found that these beliefs are significant in determining and explaining why educators adopt computers in classrooms. Further, they concluded that the constructivist beliefs had a positive effect on the use of computers in class, while the traditional beliefs had a negative bearing on the classroom use of computers. Similarly, Deng et al. (2014) maintain that educators inclined towards constructivist pedagogy tend to use ICTs as cognitive tools to support learners. Educators inclined towards traditional teaching would use ICTs mainly for drill-and-practice activities that merely support acquisition of knowledge by learners. This paper examines a specific form of pedagogical belief, namely, ICT self-efficacy. The underlying theory of ICT self-efficacy beliefs is Bandura's social cognitive theory.

### 2.2. Educators' self-efficacy beliefs

Self-efficacy is a psychological construct based on Bandura's social cognitive theory, in particular the *cognitive* component influenced by thought processes that affect human motivation, attitudes and actions. For educators, it serves as a self-belief construct that determines educators' level of confidence in engagement in technology supported teaching. Bandura (1997) defines perceived self-efficacy beliefs as one's personal judgement of capabilities to organise and execute a set of actions to achieve a desired goal. It is self-reported, thus it does not express actual competency to execute a task to successful completion. Therefore, self-efficacy is one's perception of his/her capability and motivation to execute a task successfully. Furthermore, individuals who have high self-efficacy would not hesitate to engage in more challenging tasks as they feel confident to take on the challenges, and they are willing to explore. In contrast, individuals with low self-efficacy beliefs prefer

stress-free and less challenging tasks, are not self-driven, and are discouraged by experiences which induce anxiety.

According to Bandura (1993), educators believing in their efficacy to promote and motivate learning would tend to affect the type of learning environment they create for their learners. These environments would in turn affect learners' achievement levels as they stimulate intellectual curiosity and engagement. Self-efficacy beliefs of educators are characteristics that have been shown to improve through experience and increased exposure to teaching practice (Junqueira and Matoti, 2013; Arsal, 2014) and through training and continuous professional development (Trauth-Nare, 2015). For instance, Junqueira and Matoti's (2013) study on pre-service educators in South Africa found that through exposure to the teaching process, student educators developed positive teaching efficacy beliefs by the time they were in their third year of study. Although favourable experiences are conceived to influence self-efficacy beliefs positively, the current study examines the influence of ICT self-efficacy on pedagogical uses of ICTs by Gauteng educators.

### 2.3. Educators' ICT self-efficacy beliefs

Since the conceptualisation of ICT self-efficacy beliefs is anchored in the self-efficacy beliefs (Bandura, 1997), ICT self-efficacy can be defined as an individual's self-perception of their own capabilities and competency to use ICTs effectively to perform academic tasks successfully. Educators with higher ICT self-efficacy are most likely to use ICTs in their classrooms and are least likely to suffer from ICT-related anxiety (DiGregorio and Liston, 2018). Thus ICT self-efficacy can be conceptualised as an adjunct construct to Bandura's self-efficacy beliefs. Compeau et al. (1999), and Kerckaert et al. (2015) contend that ICT self-efficacy is a perception of one's abilities to use ICTs. Investigating several perceptual factors, Celik and Yesilyurt (2013), and Teo et al. (2018) found that individuals with high perceived computer self-efficacy were more successful at using technologies and were more willing to take responsibilities than those with low perceived computer self-efficacy. It can be inferred that such individuals are more open to embrace innovative technologies and are keen to experiment with new pedagogical methods that integrate ICTs. This view can be extended to specific capabilities educators feel they have to deliver lessons that are mediated by ICTs. Sang, Valcke, van Braak and Tondeur (2010) argue that the level at which educators find themselves competent and confident in integrating ICTs is an important determinant of their use of ICTs. Furthermore, Baydas and Goktas (2017) studied Turkish pre-service educators' intentions to use ICTs in their future lessons and found that individuals with high ICT self-efficacy levels tend to have higher perceptions of the ease of use of ICTs. Their model included the following factors: perceived usefulness, perceived ease of use, and social influences. This implies that positive perceptions of one's capacity to effectively use technologies have a positive effect on how they perceive the lack of difficulty in the application of such technologies. Baydas and Goktas (2017) also found perceived ease of use and ICT self-efficacy to have a direct influence on the intentions of educators to use ICTs.

### 2.4. Constructivist learning environments

Constructivism denotes two dimensions: an epistemology domain, which is theory about knowledge that deals with the acquisition and origins of knowledge, and the second dimension which is a form of pedagogy that is a kind of instructional theories (Kwan and Wong, 2015) – this study is based on the later. Among other cognitive processes, the objectives of constructivist learning, and perhaps teaching are to promote reasoned judgement, critical thinking and conscious reflection (Çetin-Dindar et al., 2014). It can be argued that constructivist learning environments can contribute to the development of ICT self-efficacy can contribute to their increased experimentation with technology, leading to the fostering of the constructivist environments.

Wilson (1996) and Çetin-Dindar et al. (2014:480) define a constructivist learning environment as “a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities”. As such, a constructivist environment provides a space that enable learners to construct meaning and knowledge, in context, through active engagement in their own interpretation of the world.

Some of the instructional and learning strategies identified with constructivist learning environments include problem-based learning and authentic learning activities (Çetin-Dindar et al., 2014; Olusegun, 2015). The idea is to imitate real-life activities, and it is hoped learners would transfer the knowledge learned in constructivist classroom environments into the real-world. However, educators' technology-related factors including self-efficacy and ICT self-efficacy are pivotal for effective delivery of teaching and learning in these environments. These factors were found to predict educators' effective integration of ICTs into teaching and learning (Chigona and Chigona, 2010; Aslan and Zhu, 2016; Alt, 2018). Other educator variables such as epistemological beliefs have also been found to correlate with preferences to promote constructivist learning environments (Çetin-Dindar et al., 2014; Deng et al., 2014). However, other contextual variables such as lack of resources and unavailability of policy on use of technology undermine educators' effective adoption of ICTs. These factors may force educators to refrain from using ICTs in constructivist ways (Ramorola, 2013; Shin, 2015). Instead, educators will opt to default to ‘representational use’, using technologies to merely display and present learning content (Ertmer and Ottenbreit-Leftwich, 2010; Shin, 2015). This study views educators who are efficacious in the use of ICTs to have an inclination to create constructivist learning environments that promote deep learning processes (Entwistle and Ramsden, 1982; Tanriverdi, 2012), allowing learners to explore as they attempt to understand subject content.

## 3. Research method

This article reports on the effects of Gauteng educators' ICT self-efficacy on the pedagogical use of ICTs in the classrooms. A cross sectional survey was administered in the third term of the school calendar in September and October of 2017 to a purposefully selected 493 educators in 37 schools in the Gauteng province. Cross sectional survey designs emphasise the gathering of data at a point in time with the intention of describing the nature of existing conditions or determining the relations that exist between specific events (Cohen et al., 2010: 205). Since this study explored educators' perceptions of their possession of ICT self-efficacy at a particular time and its effects on their use of ICTs for teaching and learning, a cross sectional survey design was deemed appropriate for such an investigation. Gauteng province is large in terms of the number of schools within its 15 school districts. Furthermore, the Gauteng provincial government through its Department of Basic Education has deliberately invested millions of rands into what they term ‘paperless classroom’ project. For instance, the project is expected to cost R17 billion over five years, with refurbishing of classrooms in all public schools in the province, while providing these schools with tablets, laptops and Smartboards (Mail and Guardian, 2016). This has accelerated the adoption rate of ICTs compared to other provinces in South Africa. Therefore, Gauteng's technology rich background provides the best conditions for this study. Based on availability of information from district officials, nine out of the 15 education districts (Gauteng East and West, Ekurhuleni North, South and East, Johannesburg Central, East, and North, and Sedibeng West) were purposefully selected. However, five districts were eventually included in the sample because of accessibility challenges in other schools.

### 3.1. Sampling

Ordinarily, to avoid bias and to get a more representative sample in a survey study, sampling techniques that fall under the probability

sampling strategy are preferred in such research studies. But since most schools in Gauteng province do not use ICTs for pedagogical purposes, purposive sampling combined with simple random sampling technique was used as a sampling strategy. The purposive sampling process targeted only those schools with educators who use ICTs for teaching and learning in their classrooms. Random selection of individual educators at an identified school was then used. Another reason for opting to include purposive sampling approach was the lack of information to compile a complete sampling frame. As such, 493 questionnaires were administered to in-service educators in 37 schools that use ICTs in some of the classrooms, known as the 'classrooms of the future' by the Gauteng government. These were mainly at secondary schools, which are also known as 'smart schools'. While there is an estimated 2,205 schools in the province, it was deemed unnecessary to include all the schools in the study sample because the study focused on pedagogical uses of technology, and not all schools were using technology in their teaching. Following a selection method adopted by Liu (2011) to select the number of educators using ICTs at a particular school, 2 to 15 questionnaires were left at each of these 'smart schools' to randomly distribute to educators who teach using ICTs.

The Gauteng Department of Education granted ethical approval. Accordingly, all requirements and guidelines for conducting research in the province were followed. Letters with information explaining the study were presented to district officials, principals of target schools, and to educators. Furthermore, each educator was asked to sign a consent form if they agreed to voluntarily participate. For anonymity, the questionnaires, letters and consent forms were given to either the school principal or a representative appointed by the principal, such as the heads of departments to distribute to randomly selected educators who use ICTs for teaching and learning. Eventually, 163 educators filled-in and returned the questionnaires. This represented a response rate of 33.06%, which is, unfortunately, a low response rate. However, low response rates are considered a common phenomenon in study areas in developing countries where participants are often geographically distributed, questions are deemed to be sensitive, or the literacy rates are low (Lupu and Michelitch, 2018), and where the study population feels they have been over-researched. The sentiments expressed by some educators at these schools was that many research projects have been done where they have been requested to participate yet they do not see any improvements arising from these studies. For detailed analyses, collected data were captured into a spreadsheet, coded, and then exported to IBM's statistical package for social sciences (SPSS) version 25.

### 3.2. Instrument

A structured questionnaire with closed-ended statements with various scales on educators' self-efficacy beliefs about ICTs was developed based on instruments used in previous studies: Self-efficacy beliefs for technology integration (Wang et al., 2004; Al-Awidi and Alghazo, 2012), Self-efficacy for information and computer technology educators (Banoglu et al., 2015), and self-efficacy scale of teachers' intentions to integrate technology into their future classroom activities (Perkmen et al., 2016). The final study's instrument was an adaption and a consolidation of the instruments used in these previous studies. Unlike Bandura (2006) who discusses a 100-point confidence scale that ranges in intervals of 10 units from 0 ("Cannot do") to 100 ("Highly certain can do"), all the other reviewed literature above used either a 4-point or a 5-point scale, in which the validity and reliability tests were carried out on those instruments. Joshi et al. (2015:397) argue that in a symmetric Likert scale such as a 5-point one with neutral in the middle, between two extremes, participants are provided independence to choose any response in a balanced and symmetric way in either direction. Unlike symmetric scales such as a 4-points scale without a perceived value of

indifference, a 5-point scale offers a choice of indifference. Although a scale with more points is more sensitive and more reliable (Bandura, 2006) and would offer more options and reduce the dilemma of forced choices to the participants, a 5-point scale was adopted in this study in line with instruments from other studies. The language of some of the statements was changed to suit the South African context. The co-authors and the statistician refined the language of the questionnaire to ensure that respondents understood the statements in the questionnaire. The questionnaire sections covered educators' personal demographic data, and had a Traditional Pedagogical Use of ICTs (TPUIs) scale, Constructivist Pedagogical Use of ICTs (CPUIs) scale, and ICT self-efficacy (ISE) scale, each scale contained 8 items.

The participants were asked to respond to the foresaid scales by ranking their beliefs on a five-point Likert scale where 1 was equal to strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. A sample of some statements are, for TPUIs ("I use ICTs to represent different media (e.g. videos, pictures, audios) to improve the quality of content as compared to using textbooks only"), for CPUIs ("I use ICTs as cognitive tools that help to stimulate critical thinking", and for ISE ("I can easily teach classes in which I am required to use instructional technology").

### 3.3. Descriptive statistics

The descriptive statistics are shown in Table 1. A short description of some of the highlights is provided. In Table 1, missing values are indicated. Assigning missing values is deemed appropriate when the number of unsatisfactory responses is proportionately small or variables with such unsatisfactory responses are not the key variables (Sreejesh et al., 2014). For instance, in the collected data, 14 educators did not respond to the statement about their years of teaching using ICTs – this reduces the total cases considered for that variable by 14.

The age groups of the educators show a bimodal distribution. Generally, the demographics indicate that a high number of educators are young mature and middle-aged female adults. One of the goals of the South African Department of Education (DBE) is to increase the number of younger educators (Department of Basic Education, 2015) which is a possible reason for the high number of young and middle-aged educators. There is a deliberate policy to increase the enrolments of Bachelor of Education (B.Ed.) degree programmes at public South African universities. These B.Ed. degree graduates constitute a reliable supply of new educators for the public basic education system (Centre for Development and Enterprise, 2015). The higher number (45.6%) of those who indicated that they had 0–10 years of teaching experience, also reflects this. However, a drop in the 36–40 year group could be explained by the high attrition rate for educators nearing 40 years of age (Bantwini and Letseka, 2016). Bantwini and Letseka (2016) contend that educators who qualify to join the public education system may leave teaching because of difficulties and concerns about the profession such as the challenges of classroom teaching, safety problems and political barriers. A second peak and rise from the 41–55 age groups could be explained by the fact that there could be limited career choices at this stage in life, and these educators are getting towards their retirement age and thus choose to stay as educators to retain accumulated work-related benefits rather than switch to other professions.

In South Africa, townships describe densely populated, and predominantly low-income residential areas historically reserved for the black Africans and coloureds during the apartheid era. Gauteng's ICT's paperless classroom project mainly targets schools in the townships (iWeb, 2016) to elevate them from their disadvantaged resource background. This locational dynamic is reflected in the demographics in Table 1 where more educators (87.0%) who participated in this study came from township schools.



**Table 1.** Descriptive statistics.

Item	Category	Frequency	Percent	Valid Percent	Total <i>n</i>	Missing
Gender	Male	71	43.6	43.6	163	0
	Female	92	56.4	56.4		
Age groups	20–30 years	43	26.4	26.5	162	1
	31–40 years	34	20.9	21.0		
	41–50 years	55	33.7	34.0		
	51–60 years	29	17.8	17.9		
	61 + years	1	0.6	0.6		
Years teaching	0–10 years	73	44.8	45.6	160	3
	11–20 years	50	30.7	31.3		
	21–30 years	33	20.2	20.6		
	31–40 years	4	2.5	2.5		
Years teaching with ICTs	0–5 years	137	84.0	91.9	149	14
	6–10 Years	10	6.1	6.7		
	11–15 years	2	1.2	1.3		
School location	Urban/Suburban	21	12.9	13.0	162	1
	Township	141	86.5	87.0		
School type	Primary	17	10.4	10.4	163	0
	Secondary/High	140	85.9	85.9		
	Combined	6	3.7	3.7		

The type of school was also of interest. Gauteng uses ‘primary’, ‘combined’, and ‘secondary/high’ school types. Seventeen (10.4%) of educators came from primary schools, 140 (85.9%) came from secondary/high schools, and 6 (3.7%) were from combined schools. Most of the ICTs investment in Gauteng has generally been concentrated in secondary/high schools, hence the higher number of respondents from this school type.

#### 4. Data analysis

Using SPSS version 25, the analysis of data included a reliability test, a normality test, exploratory factor analysis, descriptive statistics, correlational analysis (Spearman's rho correlations), hierarchical sequential regression analysis, and comparisons of medians (Kruskal-Wallis H tests) to determine possible differences in groups of data.

##### 4.1. Reliability test

Please note for convenience, the discussion of reliability tests is included with the exploratory factor analysis (EFA) tests as the reliability tests are linked to these factors.

##### 4.2. Normality test

To ascertain the nature of data distribution on a scale of measurement used, normality tests are carried out (Bordens and Abbott, 2011). This helps in determining the appropriate statistical analysis to be employed in the study, i.e. whether to use parametric or nonparametric inferential

statistics. The distribution of data can be checked using Kolmogorov-Smirnov (K-S) goodness of fit test or Shapiro-Wilk test. Shapiro-Wilk test was used and Table 2 presents the results. Please note statements in the tables have been streamlined to save space.

Table 2 shows that all p-values (Sig.) on the Shapiro-Wilk test are below 0.05 significant level. This indicates that the data presented in the study are not normally distributed. Therefore, non-parametric statistical tests are used for further data analyses.

A brief explanation of the dependent variables in Table 2 is given below. The first three variables were derived from a set of questionnaire items referred to as ‘traditional pedagogical use of ICTs’ – see earlier discussion on how the instrument was developed. The focus of these variables is the use of ICTs to promote reproductive learning and under this learning type, activities such as rote memorisation for learners to reproduce knowledge are common:

1. *Content Presentation and Preparation*: This factor mainly describes educators' use of ICTs to project subject content and conduct demonstrations to assist learners to comprehend the concepts better. Also covered here is the use of ICTs in the planning stage, where educators prepare lesson documents and reproduce learning material.
2. *ICTs as Media/Content Representation*: Although transforming material into digital media format improves quality of material and allows learners to better interact and engage with content as compared to traditional media such as textbooks, the practice is still simply presenting content in better formats than textbooks and nothing more. Nkula and Krauss (2014) argue that content representation is synonymous with low level of ICTs use that corresponds to

**Table 2.** Normality test results.

Dependent variable	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk			Comment
	Statistic	Df	Sig.	Statistic	Df	Sig.	
TPUIs: Content Presentation and Preparation	0.126	127	0.000	0.961	127	0.001	Not Normal
TPUIs: ICTs as Media/Content Representation	0.274	127	0.000	0.864	127	0.000	Not Normal
TPUIs: ICTs for Learner Task Practices	0.135	127	0.000	0.956	127	0.000	Not Normal
Constructivist pedagogical use of ICTs (CPUIs)	0.126	127	0.000	0.939	127	0.000	Not Normal

TPUIs = Traditional pedagogical use of ICTs.

<sup>a</sup> Lilliefors Significance Correction.

behaviourist-based traditional pedagogical practices. This variable factor covers multimodal representation of learning material.

3. *ICTs for Learner Task Practices*: In this factor, educators expressed views that the role of ICTs is to help provide drill and practice activities. This helps learners to strengthen their current skills. Drill-and-practice and tutorial software are the type of technology used here. Furthermore, ICTs were seen as tools to assess learners and help provide remedial tasks.
4. *Constructivist pedagogical use of ICTs*: Constructivist pedagogy is a promising approach to using technology in teaching and learning. Under the constructivist pedagogical use of ICT factor, educators view ICTs as enabling a more learner-centred pedagogy where ICTs are used as cognitive tools. Learners are more engaged and work more autonomously in 'real-world' tasks. ICTs support the cognitive development of learners, and this is essential for deep learning (Jimoyiannis, 2010).

#### 4.3. Exploratory factor analysis

According to Tabachnick and Fidell (2014), exploratory factor analysis (EFA) is a statistical analysis technique that is used on sets of variables to establish variables that form coherent sub-sets, which are relatively independent of each other. Before deciding on whether to use orthogonal or oblique factor rotation during EFA, a factor analysis with oblique rotation was initially run for each of the reported scales. This is a recommendation that Tabachnick and Fidell (2014) provides to determine if proposed factors are highly correlated or not. Oblique rotation is recommended for highly correlated factors, while orthogonal rotation is recommended for factors which are unrelated and thus highly uncorrelated (Field, 2013). Cohen (1988) provides a statistical interpretation benchmark for correlation coefficients as follows – For  $r < 0.30$  this is interpreted as a weak correlation,  $0.30 < r < 0.50$  is interpreted as moderate, and  $r > 0.50$  is interpreted as a strong correlation.

When retaining variables after a factor analysis, Comrey and Lee (1992) and Tabachnick and Fidell (2014) recommend interpretation of variables with a factor loading of 0.32 and above as follows: a factor loading of  $r = 0.32$  – has 10% overlapping variance of variables within

the factor – is poor but indicates enough amount of variance overlap. However, consistent with Chan and Elliot's (2004) method, 0.40 was used as the factor loading cut-off for the extraction of factors in this report. Furthermore, according to recommendations by Kaiser (1960) and Field (2013), only factors with an eigenvalue of 1 and above are considered.

The following is a presentation and discussion of the EFA results. The guidelines for the interpretation of Cronbach's alpha follow those presented by Field (2013). An alpha ( $\alpha$ )  $\alpha > = 0.70$  is treated as excellent,  $\alpha > 0.50$  as moderate and respectable, while an  $\alpha$  below 0.50 is poor.

## 5. Results

### 5.1. Results of EFA on 'traditional pedagogical use of ICTs'

A principal axis factoring analysis with oblique oblimin rotation was attempted to extract factors, and SPSS failed to generate a final rotated matrix. It was then decided to opt for a principal component analysis with oblique oblimin rotation instead. The 'component correlation matrix' had two weak correlations ( $r = -0.16$  and  $-0.19$ ) and a moderate correlation ( $r = 0.37$ ) amongst the three generated factors. A principal component analysis with orthogonal varimax rotation for the TPUIs scale was then conducted, and Table 3 shows the results. The numbers in bold indicate the factor loadings for each variable on each extracted factor. As can be noted, all factor loadings were  $>0.50$  (values in bold), at item level, this constitutes an acceptable convergent validity (Deng et al., 2014).

The traditional pedagogical use of ICTs had 8 items with a combined total variance explained of 65.7%. The principal factor analysis divided these into three factors. The first factor was given a label of 'content presentation and preparation' (see earlier explanation of factors under normality test) is made up of items 6, 7, and 8 with an eigenvalue of 2.94 and explains 36.8% of total variance. The second factor labelled 'media representation' is composed of items 2 and 3, it has an eigenvalue of 1.29, and it explains 16.1% of total variance. Lastly, 'learner task practices' is composed of items 5, 4, and 1 and the eigenvalue is 1.03, it explains

**Table 3.** Traditional pedagogical use of ICTs for Gauteng educators: Orthogonal with varimax rotation.

Traditional Pedagogical Use of ICTs	Component		
	1	2	3
<b>Content presentation and preparation</b>			
TPUI7: I use computers mostly as a presentation tool to project information to learners in the classroom.	<b>0.876</b>		
TPUI6: I mainly use computers as a demonstration tool to help learners understand concepts in the subject(s) that I teach.	<b>0.789</b>		
TPUI8: I see ICTs (e.g. computers, Tablet PCs, photocopiers, printers, scanners, Microsoft Office, etc.) as just tools to help me prepare my lessons.	<b>0.539</b>		0.342
<b>Media representation</b>			
TPUI3: I use ICTs to represent different media (e.g. videos, pictures, audios) to improve learners' activities as compared to using textbooks only.		<b>0.886</b>	
TPUI2: I use ICTs to represent different media (e.g. videos, pictures, audios) to improve the quality of content as compared to using textbooks only.		<b>0.885</b>	
<b>Learner task practices</b>			
TPUI5: I use ICTs to measure and practice skills just learned by learners.			<b>0.759</b>
TPUI4: I use ICTs to give remedial tasks to learners to work on basic, uncomplicated concepts in the subject(s) that I teach.		0.301	<b>0.751</b>
TPUI1: The role of ICTs is basically to help provide drill and practice exercises for my learners.			<b>0.591</b>
Eigenvalue	2.94	1.29	1.03
Percentage of total variation explained (65.7%)	36.8%	16.1%	12.8%
Cronbach's Alpha	0.674	0.789	0.584

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

**Table 4.** Constructivist pedagogical use of ICTs for Gauteng educators: Orthogonal principal axis factoring with varimax rotation.

Constructivist pedagogical use of ICTs	Factor
	1
<b>CPUI5:</b> I use ICTs (e.g. computer software, ICT hardware, educational websites, etc.) as cognitive tools that help in learner-directed learning (such as active, cooperative and enquiry-based learning).	0.855
<b>CPUI3:</b> I use ICTs as cognitive tools that help to stimulate critical thinking.	0.847
<b>CPUI6:</b> I use ICTs to design or redesign various activities that cater for the different learners in my classes.	0.774
<b>CPUI4:</b> I use ICTs to create 'real-world' tasks for my learners.	0.765
<b>CPUI7:</b> I use ICTs to promote active learner-to-learner, and educator-to-learner interactions and discussions.	0.756
<b>CPUI2:</b> I use collaborative tools in which my learners work together in small groups to discuss among themselves and with me.	0.712
<b>CPUI8:</b> Technology allows my learners to work on their own with little input from me.	0.509
<b>CPUI1:</b> My learners use ICTs to work on their project activities.	0.451
Eigenvalue	4.17
Percentage of total variation explained	52.2%
Cronbach's Alpha	0.885

Extraction Method: Principal Axis Factoring.

12.8% of total variance. These factors had 0.64, 0.79, and 0.58 Cronbach's alpha values respectfully. Although the alpha values of the first and last were not satisfactory, they, however, were acceptable and adequate for further analysis to be performed. In comparison, [Deng et al. \(2014\)](#) obtained a Cronbach's alpha value of 0.92 on their 'traditional use of ICT' scale in their study of high school educators in China.

### 5.2. Results of EFA on 'Constructivist pedagogical use of ICTs'

The constructivist pedagogical use of ICTs (CPUIs) scale had 8 items in the questionnaire. Using a principal axis factoring analysis with orthogonal varimax rotations, only one composite factors of the scale was extracted.

The CPUIs questionnaire items explained 52.2% of total variance. As indicated in [Table 4](#), the principal axis factoring process yielded only one dimension with an eigenvalue of 4.17. All eight statements had factor loading values greater than the 0.40 cut-off. Additionally, the factor had an excellent Cronbach's alpha coefficient value of 0.89. This compares well with [Deng et al. \(2014\)](#) whose reliability test result was an alpha coefficient of 0.87 on the 'constructivist use of ICT' scale.

### 5.3. Results of EFA on educators' ICT self-efficacy beliefs

The results of a principal axis factoring analysis with orthogonal varimax rotations for the ICT self-efficacy beliefs scale is presented in [Table 5](#).

The ICT self-efficacy scale had 8 questionnaire items which explained 55.2% of total variance. [Table 5](#) shows that the principal axis factoring

**Table 5.** ICT self-efficacy beliefs for Gauteng educators: Orthogonal principal axis factoring with varimax rotation.

ICT self-efficacy (ISE) beliefs	Factor
	1
<b>ISE6:</b> I can easily teach classes in which I am required to use instructional technology.	0.839
<b>ISE5:</b> I can easily prepare lesson plans in which I am required to use instructional technology.	0.824
<b>ISE1:</b> I feel confident that I have the necessary skills to use instructional technology for instruction.	0.799
<b>ISE4:</b> I can design technology-based classroom activities in a way that my learners can learn by themselves under my guidance.	0.790
<b>ISE2:</b> I feel confident that I can help learners with instructional technology.	0.756
<b>ISE3:</b> It is easy for me to find instructional technologies that are relevant to my teaching.	0.697
<b>ISE8:</b> I can effectively manage my classroom when learners are using computers.	0.660
<b>ISE7:</b> I can learn to use computers for my teaching and learning process.	0.525
Eigenvalue	4.42
Percentage of total variation explained	55.18%
Cronbach's Alpha	0.906

Extraction Method: Principal Axis Factoring.

process managed to extract only one factor with an eigenvalue of 4.42. The Cronbach's alpha coefficient was excellent at 0.91. This compares well with previous studies. For instance, the seven self-efficacy factors in [Banoglu et al.'s \(2015\)](#) study ranged from 0.80 to 0.88, while those of [Pekmen et al.'s \(2016\)](#) three country samples were 0.83, 0.84, and 0.86, and [Al-Awidi and Alghazo \(2012\)](#) had Cronbach's alpha values of 0.91 and 0.93 for their pre- and post-surveys.

### 5.4. Descriptive statistics of TPUIs: content presentation, preparation and ICTs as media representation

As shown in [Table 6](#), 59.4% of surveyed educators use computers as presentation tools for the projection of information on to a screen for learners in the classroom; 58.2% use computers for demonstration to help learners understand subject concepts; while 56.3% view ICTs just as tools that help in preparation of their lessons.

[Table 6](#) results indicate item percentages ranging from 56.3% to 59.4%, which is close to 60% of educators claiming to use ICTs for content presentation and preparation. Albeit this form of use of ICTs showing a lack of sophisticated educational application, the result indicates that a fair percentage of Gauteng educators generally use ICTs for preparation of their lessons and presentations.

[Table 7](#) shows the descriptive statistics of the 'TPUIs: Media representation' factor. The results show that as high as 81.3% of respondents claim they use ICTs to represent different digital media such as videos, pictures, and audios as a way to improve the quality of information compared to the use of traditional textbooks. This implies classes that are rich in multimedia to enhance learners' understanding. Moreover, 75% used digital media to improve learners' activities.

**Table 6.** Descriptive statistics of TPUIs: Content presentation and preparation dimension.

TPUIs: Content presentation and preparation		Frequency Distribution						Means	
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree + Strongly Agree	Mean	SD
<b>TPUI7:</b> I use computers mostly as a presentation tool to project information to learners in the classroom.	Freq	0	25	40	71	24	59.4%	3,59	0,073
	%	0%	15.6%	25.0%	44.4%	15.0%			
<b>TPUI6:</b> I mainly use computers as a demonstration tool to help learners understand concepts in the subject(s) that I teach.	Freq	1	28	38	75	18	58.2%	3,51	0,074
	%	0.6%	17.5%	23.8%	46.9%	11.3%			
<b>TPUI8:</b> I see ICTs as just tools to help me prepare my lessons.	Freq	5	34	31	70	20	56.3%	3,41	0,083
	%	3.1%	21.3%	19.4%	43.8%	12.5%			
Cronbach's Alpha									0.674

**Table 7.** Descriptive statistics of TPUIs: Media representation dimension

TPUIs: Media representation'		Frequency Distribution						Means	
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree + Strongly Agree	Mean	SD
<b>TPUI2:</b> I use ICTs to represent different media (e.g. videos, pictures, audios) to improve the quality of content as compared to using textbooks only.	Freq	1	2	27	100	30	81,3%	3,98	0,054
	%	0.6%	1.3%	16.9%	62.5%	18.8%			
<b>TPUI3:</b> I use ICTs to represent different media (e.g. videos, pictures, audios) to improve learners' activities as compared to using textbooks only.	Freq	0	11	29	88	32	75,0%	3,88	0,064
	%	0%	6.9%	18.1%	55.0%	20.0%			
Cronbach's Alpha									0.789

The use of multimedia – which is an integration of two or more different media forms, has been shown to be more effective in improving the attitudes of learners toward a subject than traditional methods of teaching (Shah and Khan, 2015). Gauteng educators seem to perceive ICTs to be effective in their classrooms. Therefore, they have embraced the use of multimedia such as videos, audios, and images in their teaching practice. The majority of educators indicate they use different media to improve quality of content (81.3%) and to improve learners' activities (75%) explains this. Most Gauteng's 'paperless classrooms' are fitted with one or more Smartboards. These devices could explain the large number of educators who indicated that they use multimedia. Smartboards are multipurpose devices which can be used as whiteboards to write on, display information and perform simulations, and have interactivity features. Educators are also able to capture and store whatever is scribbled on them. Such capabilities allow learners to later revisit class proceedings at their own time.

However, studies have shown that educators do not use ICTs, in particular computers, as cognitive tools (Aslan and Zhu, 2016), in ways that enrich the learning experience, and facilitate deep learning processes of learners, which enables learners to construct their own interpretation of knowledge. For instance, Aslan and Zhu (2016) who investigated variables that predict Turkish pre-service educators' integration of ICTs into teaching found that educators confined their ICT use to demonstrative functions and had limited usage of these technologies as

cognitive tools. Findings presented in Tables 6 and 7 resonate with Shin's (2015) and, Aslan and Zhu's (2016) findings that technologies are not fully integrated into classroom teaching as they are merely used to represent and present subject content. The results in Tables 6 and 7 show that, despite having ICT devices that are capable of being used as cognitive tools, educators use the devices to simply present information in better and more attractive media formats. Nevertheless, such media formats are comparatively better than the traditional ones such as textbooks, which could explain the educators' attraction to their usage. However, as Table 9 indicates, educators also report using ICTs in more constructivist ways. Therefore, results in Tables 6, 7, and 9 reflect a situation where educators use ICTs for low level tasks such as representation, and simultaneously or switch to use the technologies as cognitive tools for higher level tasks. This can also manifest where educators espouse both traditional and constructivist beliefs (Çetin-Dindar et al., 2014) albeit being skewed towards one or the other. Thus, educators may use ICTs in both traditional and also in constructivist modes (Fives and Buehl, 2012; Tondeur et al., 2016) to achieve their planned lesson objectives.

##### 5.5. Descriptive statistics of 'TPUIs: learner tasks/practices'

As shown in Table 8, 47.8% of the respondents agreed/strongly agreed that the role of ICTs is basically to provide drill and practice

**Table 8.** Descriptive statistics of 'TPUIs: Learner tasks and practice'.

TPUIs: Learner tasks and practice		Frequency Distribution						Means	
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree + Strongly Agree	Mean	SD
<b>TPUI5:</b> I use ICTs to measure and practice skills just learned by learners.	Freq	3	25	44	76	11	54,7%	3,42	0,072
	%	1.9%	15.7%	27.7%	47.8%	6.9%			
<b>TPUI4:</b> I use ICTs to give remedial tasks to learners to work on basic, uncomplicated concepts in the subject(s) that I teach.	Freq	0	18	40	83	19	63,8%	3,64	0,066
	%	0%	11.3%	25.0%	51.9%	11.9%			
<b>TPUI1:</b> The role of ICTs is basically to help provide drill and practice exercises for my learners.	Freq	4	35	44	69	7	47,8%	3,25	0,074
	%	2.5%	22.0%	27.7%	43.4%	4.4%			
Cronbach's Alpha									0.584



**Table 9.** Descriptive statistics of 'Constructivist pedagogical use of ICTs' (CPUIs) dimension.

CPUIs	Frequency Distribution						Means	
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree + Strongly Agree	Mean SD
<b>CPUI1:</b> My learners use ICTs to work on their project activities.	Freq	7	22	43	73	12	54,1%	3,39 0,078
	%	4.5%	14.0%	27.4%	46.5%	7.6%		
<b>CPUI2:</b> I use collaborative technology tools in which my learners work together in small groups to discuss among themselves and with me.	Freq	8	29	35	70	15	54,2%	3,35 0,084
	%	5.1%	18.5%	22.3%	44.6%	9.6%		
<b>CPUI3:</b> I use ICTs as cognitive tools that help to stimulate critical thinking.	Freq	5	9	39	86	17	66,0%	3,65 0,070
	%	3.2%	5.8%	25.0%	55.1%	10.9%		
<b>CPUI4:</b> I use ICTs to create 'real-world' tasks for my learners.	Freq	5	11	47	79	15	59,9%	3,56 0,070
	%	3.2%	7.0%	29.9%	50.3%	9.6%		
<b>CPUI5:</b> I use ICTs as cognitive-tools that help in learner-directed learning.	Freq	4	13	46	81	12	59,6%	3,54 0,068
	%	2.6%	8.3%	29.5%	51.9%	7.7%		
<b>CPUI6:</b> I use ICTs including computers to design or redesign various activities that cater for the different learners in my classes.	Freq	2	10	46	79	20	63,0%	3,67 0,066
	%	1.3%	6.4%	29.3%	50.3%	12.7%		
<b>CPUI7:</b> I use ICTs to promote active learner-to-learner, and educator-to-learner interactions and discussions.	Freq	2	13	40	84	18	65,0%	3,66 0,067
	%	1.3%	8.3%	25.5%	53.5%	11.5%		
<b>CPUI8:</b> Technology allows my learners to work on their own with little input from me.	Freq	1	26	38	80	12	58,6%	3,48 0,070
	%	0.6%	16.6%	24.2%	51.0%	7.6%		
Cronbach's Alpha								0.885

exercises for learners; while 54.7% reported that they use ICTs to measure and practice skills just learned by learners. Furthermore, 63.8% of the respondents use ICTs to give remedial tasks to learners while they work on simple concepts in different subjects.

Table 8 shows relatively high values in the neutral category even though the values for the agree/strongly agree category are much higher than the disagree/strongly disagree categories. This indicates the polarity in educators' opinions ranging from indifferent to affirmative with regard to the 'learner tasks and practice' factor. Such use of ICTs only supports low level educational learning activities that promote surface learning strategies. This concurs with Ramorola's (2013) findings where Gauteng educators used ICTs in ways that only supported rote learning strategies. Interesting is that only 47.8% of educators agree/strongly agree that the role of ICTs is basically to help provide drill and practice exercises for learners. This is confirmed in Table 9 which shows that educators do not only use ICTs for low level drill and practice tasks but also for tasks that

demand higher order thinking – such as learners using ICTs to work on projects.

#### 5.6. Descriptive statistics of 'constructivist pedagogical use of ICTs (CPUIs)'

An exploratory factor analysis resulted in one factor of constructivist pedagogical use of ICTs (CPUIs). Table 9 illustrates the descriptive statistics of CPUIs. About 58.6% of respondents asserted that technology allows their learners to work on their own with little support from the educator. Therefore, these educators view technology as enabling some form of learner autonomy during task execution. Related to this, 59.6% of respondents claim to use ICTs such as educational websites as cognitive tools that help promote learner-directed learning using strategies such as co-operative and enquiry-based learning. Moreover, 66% of respondents agree/strongly agree that they use ICTs such as simulation software and interactive white boards (IWBs) as cognitive tools that help to stimulate

**Table 10.** Descriptive statistics of 'ICT self-efficacy' beliefs dimension

'ICT self-efficacy' beliefs (ISE)	Frequency Distribution						Means	
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree + Strongly Agree	Mean SD
<b>ISE1:</b> I feel confident that I have the necessary skills to use instructional technology for instruction.	Freq	1	10	42	83	22	66,4%	3,73 0,064
	%	0.6%	6.3%	26.6%	52.5%	13.9%		
<b>ISE2:</b> I feel confident that I can help learners with instructional technology.	Freq	1	13	40	80	23	65,6%	3,71 0,067
	%	0.6%	8.3%	25.5%	51.0%	14.6%		
<b>ISE3:</b> It is easy for me to find instructional technologies that are relevant to my teaching.	Freq	1	13	33	88	20	69,7%	3,73 0,066
	%	0.6%	8.4%	21.3%	56.8%	12.9%		
<b>ISE4:</b> I can design technology-based classroom activities in my classroom in a way that my learners can learn by themselves under my guidance.	Freq	0	15	50	71	21	58,6%	3,62 0,067
	%	0.0%	9.6%	31.8%	45.2%	13.4%		
<b>ISE5:</b> I can easily prepare lesson plans in which I am required to use instructional technology.	Freq	2	9	38	86	22	68,8%	3,75 0,065
	%	1.3%	5.7%	24.2%	54.8%	14.0%		
<b>ISE6:</b> I can easily teach classes in which I am required to use instructional technology.	Freq	1	10	35	85	25	70,5%	3,79 0,065
	%	0.6%	6.4%	22.4%	54.5%	16.0%		
<b>ISE7:</b> I can learn to use computers for my teaching and learning process.	Freq	0	3	19	98	35	85,8%	4,06 0,052
	%	0.0%	1.9%	12.3%	63.2%	22.6%		
<b>ISE8:</b> I can effectively manage my classroom when learners are using computers.	Freq	0	8	51	71	25	61,9%	3,73 0,064
	%	0.0%	5.2%	32.9%	45.8%	16.1%		
Cronbach's Alpha								0.906

**Table 11.** Relationship between PUIs and ICT self-efficacy beliefs.

Spearman's rho		TPUIs: Content Presentation and Preparation	TPUIs: ICTs as Media Representation	TPUIs: ICTs for Learner Task Practices	CPUIs
ICT self-efficacy	Spearman's rho	0.318**	0.373**	0.337**	0.624**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	150	150	148	146

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

critical thinking. This confirms our earlier assumption that, through the use of ICTs, Gauteng educators are practicing both traditional and constructivist pedagogies.

About 54.2% of respondents allude to using collaborative technologies such as IWB, social media platforms, and Google Docs to facilitate learners to work together in small groups to interact among themselves and with the educator. From Table 9, it is evident that most Gauteng educators are using ICTs in ways that promote constructivist learning activities such as allowing learners to work on their own and using technologies that promote collaborative work on social media and in small groups.

### 5.7. Descriptive statistics of ICT self-efficacy beliefs

Table 10 shows a majority (85.8%) of respondents affirm their ability to learn to use computers for teaching and learning processes. Accordingly, 70.5% of respondents claim that they can easily teach classes in which they are required to use instructional technology. Similarly, 69.7% report that it is easy for them to find instructional technologies that are relevant for their teaching purposes. About 66.4% claim that they have the necessary skills to use technology for instructional purposes.

Inspection of the mean score reveals that all scores for statements are above the mid-point score of 3.00. This indicates that respondents are quite confident with the application of ICTs in their classrooms. The majority (85.5%) indicate their willingness to learn how to integrate ICTs in their classrooms. Exposure to technologies has been found to increase the ICT self-efficacy of individuals and educators in particular (Efe, 2015). As stated earlier, Gauteng province is rolling-out a program to digitise primary and secondary classrooms. This exposes educators to the technologies and could lead into an increase in their ICT self-efficacy as they explore how to better use those technologies for instructional purposes. Consequently, this would increase the use of the ICTs in learner-centred practices (Ertmer and Ottenbreit-Leftwich, 2013).

### 5.8. The relationships between PUIs and ICT self-efficacy beliefs

Because the data is not normally distributed (see Table 2), Spearman's rho bivariate correlation analysis was used, and the results are shown in Table 11. The results indicate that ICT self-efficacy has a positive significant but moderate relationship with all the traditional pedagogical uses of ICT sub-factors – i.e., ICT self-efficacy with 'content presentation and preparation' ( $r = 0.32$ ,  $p < 0.01$ ); with 'ICTs as media representation' ( $r = 0.37$ ,  $p < 0.01$ ); and ( $r = 0.34$ ,  $p < 0.01$ ) with 'ICTs for learner task practices'. However, ICT self-efficacy has a positive significant and strong relationship ( $r = 0.62$ ,  $p < 0.01$ ) with 'constructivist pedagogical use of ICTs' (CPUIs).

Studies that investigate factors that influence intentions to use and the actual use of technology have found positive significant relationships between ICT self-efficacy beliefs and intentions to use ICTs (Baydas and Goktas, 2017; Teo et al., 2018). Although findings from these studies investigated behavioural intentions to use ICTs, they indirectly concur with the results in this study as positive behavioural intentions to use often leads to actual use of ICTs. The strong positive and significant relationship between CPUIs and ICT self-efficacy beliefs shows that as educators gained confidence in the use of ICTs, they would be more comfortable to introduce more innovative constructivist methods that

require the use of ICT tools in instructional activities that promote knowledge construction. Kim et al. (2013) and Krause et al. (2017) recommend pedagogical interventions in teacher education that promote teaching strategies such as problem-based learning and interactive platforms that are rooted in the constructivist approach. Such interventions help build educators' confidence in the use of ICTs for instructional purposes. The strong correlation of ICT self-efficacy and CPUIs in Gauteng is probably due to the opportunities educators have in daily use of ICTs provided through the project to digitise classrooms. The repeated use of ICTs could reduce clumsiness, increase experience and help educators gain confidence in handling and planning class activities where learners use ICTs to complete tasks. Furthermore, in order to use more technologies, educators must believe that ICTs are effective in the achievement of the learning goals they set for learners.

### 5.9. Results of a simple linear regression analysis

Simple linear regression analyses were conducted to determine the predictability of ICT self-efficacy beliefs on pedagogical use of ICTs. For linear or multiple regression analyses to be successful, a number of pertinent pre-tests are necessary for valid outcomes. For instance, a Durbin-Watson statistic test can be carried out to detect the presence of autocorrelations. It thus tests if the residuals from a multiple regression analysis are independent. According to Field (2013) the statistics' values range from 0 to 4, and values more than 3 or less than 1 are cause for concern. The second statistic considered was homoscedasticity test. This is to check if the variance of a variable is constant and remains the same at all values of the other continuous variable (Tabachnick and Fidell, 2014). The third assumption considered was that of sample size. One rule of thumb discussed by Field (2013) is that each predictor variable should have about 10 cases of data in the model. This was achieved in this study. According to Hair et al. (2017)  $R^2$  values of 0.25, 0.50 or 0.75 can be interpreted to be weak, moderate or substantial respectively.

The results of a simple regression analysis for the four dependent variables of ICT pedagogical uses, and ICT self-efficacy as the predictor variable are shown in Table 12. As indicated, the Durbin-Watson test for the four models safely ranged from 1.431 to 1.846. The ANOVA tests indicate that all regression models predict the PUIs well. That is 'TPUIs: Content presentation and preparation'  $F(1, 148) = 14.94$ ,  $p < 0.01$ , 'TPUIs: Media representation'  $F(1, 148) = 20.64$ ,  $p < 0.01$ , 'TPUIs: Learner tasks/practices'  $F(1, 146) = 20.64$ ,  $p < 0.01$  and 'constructivist pedagogical use of ICTs (CPUIs)'  $F(1, 144) = 70.57$ ,  $p < 0.01$ .

The results in Table 12 also show that ICT self-efficacy beliefs positively significantly predicted each of the four pedagogical uses of ICTs by educators (see the four models in Table 12). Therefore, ICT self-efficacy predicted the following – for 'TPUIs: Content presentation and preparation'  $R^2 = 0.092$  (9.2%), for 'TPUIs: Media representation'  $R^2 = 0.122$  (12.2%), for 'TPUIs: Learner tasks/practices'  $R^2 = 0.124$  (12.4%), and for 'Constructivist pedagogical use of ICTs (CPUIs)'  $R^2 = 0.329$  (32.9%) of total variance respectively, and all four are at  $p < 0.01$  significant levels.

The findings of this study resonate with those in mainstream ICT literature. For instance, in their study of Turkish pre-service educators, Baydas and Goktas (2017) found that perceived ease of use and self-efficacy beliefs had a direct positive significant influence on intentions to use ICTs. Of the four PUIs in this study, ICT self-efficacy

**Table 12.** Regression analysis results: pedagogical use of ICTs (DVs), ICT self-efficacy (IVs).

Regression Statistics		Dependent variables (DVs)			
		Model 1	Model 2	Model 3	Model 4
		TPUIs: Content Presentation & Preparation	TPUIs: Media Representation	TPUIs: Learner Tasks/Practices	Constructivist Pedagogical use of ICTs (CPUIs)
Predictor Variable	B	0.364	0.377	0.380	0.634
ICT Self-efficacy	95% CI for B	(0.178, 0.551)	(0.213, 0.541)	(0.214, 0.545)	(0.485, 0.783)
	SE B	0.094	0.083	0.084	0.075
	Beta ( $\beta$ )	0.303	0.350	0.352	0.574
	p (2-tailed)	p < 0.001	p < 0.001	p < 0.001	p < 0.001
	Durbin-Watson	1.846	1.913	1.431	1.503
	R <sup>2</sup>	0.092	0.122	0.124	0.329
	R	9.2%	12.2%	12.4%	32.9%

predicted a much higher percentage (32.9%) of variance in the CPUIs. This indicates that ICT self-efficacy beliefs are a good predictor of constructivist use of ICTs by Gauteng educators in their classrooms.

## 6. Discussion

This study was designed to find out the pedagogical use of ICTs by Gauteng educators, and determine their ICT self-efficacy. Furthermore, the goals included determining the relationship between ICT self-efficacy and the pedagogical use of ICTs in the classroom by these educators. Studies conducted on educators' (teachers') computer or ICT self-efficacy are predominately out of Africa (for instance, see Kerckaert et al., 2015; Teo et al., 2018; Li et al., 2019; Thongsri et al., 2019). Therefore, we contribute to research on educators' ICT self-efficacy in that there is no known study that investigates the relationship of the pedagogical use of ICTs by educators and their ICT self-efficacy beliefs in South Africa.

The first research goal was to investigate the ICT self-efficacy of educators in the Gauteng province. Analysis of the descriptive statistics shows that most educators feel confident using ICTs for teaching and learning. Judging from the percentage of educators confident with the use of ICTs for teaching and learning, one can conclude that they are confident that their behaviour would lead to successful attainment of their teaching objectives (Bandura, 1993; Kim et al., 2013). Thus the perceptions educators have about their ability to use ICTs in their classrooms contributes to the achievement of their teaching goals as they are likely to effectively use these technologies to teach.

The second goal was to establish the pedagogical use of ICTs by educators in Gauteng province. Gauteng educators indicated that their use of ICTs follows constructivist pedagogical principles such as creating 'real-world' tasks, learner-directedness, and collaboration in small groups. However, the results indicate that educators also apply ICTs in traditional ways to support activities such as drill and practice. Therefore, Gauteng educators seem to use ICTs in both traditional and constructivist ways. To achieve learning objectives which require mere recall and understanding, educators could be using ICTs in traditional modes. However, they would switch to constructivist modes to achieve objectives that require critical thinking, problem-based learning, and collaborative work. Studying perspectives of educators on differentiated teaching in South African secondary schools, De Jager (2017) established that educators used group work to motivate participation of learners in class sessions. The current study adds a traditional ICTs usage perspective that Gauteng educators are using in their teaching practice.

The third goal was to determine the relationship between ICT self-efficacy and the pedagogical use of ICTs in the classroom by Gauteng educators. The level at which educators use ICTs has been found to associate with self-efficacy (Turel, 2014; Li et al., 2019). Similarly, the results of this study emphasise the significant role of ICT self-efficacy in the pedagogical use of ICTs in the classroom. Self-efficacy had a positive

significant but moderate effect on the three traditional PUIs and a positive significant and strong relationship with the constructivist PUIs. Similarly, in relation to ICT self-efficacy, Hong et al. (2014) findings revealed that there is a low but positive significant relationship between educators' computer self-efficacy and their classroom use. Put differently, lack of ICT self-efficacy can be one of the obstacles that hinder the use of ICTs by educators. Conversely, findings of this study show that Gauteng educators are ICT self-efficacious. A strong correlation between ICT self-efficacy and a constructivist mode of use of ICTs supports this. As Sang et al. (2010) and DiGregorio and Liston (2018) contend, when ICTs for instructional purposes are introduced to educators in non-discouraging, constructivist learning environments, it can allow educators to experience successes in using them, and this may promote an increase in ICT self-efficacy. Kwan and Wong (2015) found constructivist learning environments to have a positive impact on learners' critical thinking. In these environments information technology including the Internet can be used as valuable learning mediating resources. Therefore, educators who create and deliver their lessons in constructivist environments demonstrate confidence in planning, execution and achievement of their goals.

To respond to the fourth goal, a simple linear regression analysis found that ICT self-efficacy significantly predicted all four PUIs factors. The results highlight the significant role played by ICT self-efficacy in the adoption of ICTs by Gauteng educators. Self-efficacy and in particular technological (ICT) self-efficacy has been found to have a strong impact on educators' use of ICTs for pedagogical purposes in the classroom. In this respect, the exposure to ICTs by Gauteng educators and the opportunity given to them to experiment new teaching methods in-situ appears to have produced positive gains in increasing ICT self-efficacy. Consequently, this resulted in heightened technology use for instructional purposes. These results resonate with Siyam's (2019) study where UAE educators' self-efficacy predicted 32.2% of variance in actual ICT use. The UAE is often postured as a middle income economy where ICT integration in classroom has recently emerged. South Africa is in a similar stage where it is only recent that some provinces including Gauteng have intensified the integration of ICTs in education programmes.

Furthermore, educators' response to the ICT self-efficacy beliefs scale indicates that most of them were confident in the use of ICTs in their classrooms. They believe ICTs to be relevant to their class activities and in achieving their set objectives. Therefore, their perceptions of ICTs are positive (Kim et al., 2013). The majority of educators indicated their willingness to learn how to integrate ICTs in their classrooms. This is a strong indicator that they are willing to explore new technology tools that are used to support innovative classroom instruction. This corroborates Teo et al.'s (2018) finding that individuals with high perceptions about computers and ICTs in general are more successful at using

technologies, are more willing to take responsibilities relating to use of ICTs, and have higher intentions to use ICTs in their classrooms.

## 7. Conclusions and recommendations

The main purpose of this study was to determine the ICT self-efficacy beliefs of Gauteng educators, their pedagogical use of ICTs, and how these two factors are related to each other. Further, the study sought to find out the effect ICT self-efficacy beliefs have on the pedagogical use of ICTs by Gauteng educators.

DiGregorio and Liston (2018) acknowledge that despite decades of research in computer-based education, and significant technological advances, most of the findings continue to be replicated. For instance, some parallels can be drawn between our findings and those of DiGregorio and Liston (2018) in terms of self-efficacy beliefs and the pedagogical use of ICTs. The key result is that ICT self-efficacy beliefs of Gauteng in-service educators positively and significantly correlate with their ICTs use in the classroom. Running a simple regression analysis revealed that there was a weak but positive significant effect of educators' ICT self-efficacy beliefs on ICTs use in the classroom. The value of variance explained is much higher for CPUs than the TPUs. This means ICT self-efficacy has a better predictive value of CPUs compared to TPUs. The results therefore indicate the importance of ICT self-efficacy in the effective and successful integration of ICTs in the classrooms by educators.

Gauteng educators are more inclined to use ICTs in constructivist than in traditional ways. Skills on how to use and integrate ICTs bolsters confidence of educators to integrate ICTs in constructivist ways. These skills can be bolstered during educators' initial teacher training through methodical exposure of trainee educators to ICTs as pedagogical tools. For instance, Barak (2014) contends that curriculum that promotes social constructivism and incorporates advanced technologies could be vital in helping pre-service educators to experience the constructivist environments early on in their careers. Furthermore, it would be important for school management and perhaps district and provincial education departments to provide, encourage and support the use of ICTs in the classrooms early on in an educator's career. These efforts are more likely to help educators gain confidence in the use of ICTs during their later years in-service. Such gains in confidence increase the levels of ICT self-efficacy of educators, and are more likely to experience less anxiety pertaining the use of ICTs. Consequently, educators are most likely to extensively use ICTs for instructional purposes (DiGregorio and Liston, 2018). South Africa, through the Department of Basic Education is deliberately increasing the number of educators with a B.Ed. degree (Department of Basic Education, 2015). However, the question that remain is how much the pre-service educators are exposed and prepared in their B.Ed. degree programmes for the eventual teaching with ICTs? Conversely, B.Ed. degrees with content that incorporates teaching of pedagogical use of ICTs could boost educators' perceived capabilities in the use of ICTs. This in turn could see more educators using technologies in their classrooms, thus addressing issues of low high-tech use identified by Krause et al. (2017). Furthermore, experience and professional development (PD) has been reported to enhance self-efficacy (Han et al., 2017). For instance Siwatu and Chesnut (2015) contend that PD that only stresses pedagogical knowledge and skills while neglecting self-efficacy beliefs will result in educators doubting their abilities in teaching with ICTs and thereby compromise their attempt at adopting technologies. Therefore, PD has a potential to enhance educators' ICTs competence and their knowledge for effective ICTs integration, and in turn has an opportunity to boost educators' confidence and develop their efficacious beliefs about the use of ICTs. Consequently, educators who are more competent tend to use ICTs more frequently in their daily teaching practice (Aslan and Zhu, 2016). Thus ICT knowledge tends to facilitate

the use of ICTs and would influence the educators' decision on whether to adopt ICTs or not (Lawrence and Tar, 2018).

Results presented here are important to educational practitioners, policy makers, department of education, school management and educator trainers, and the educators themselves. This mainly brings light to implications on initial and continuous professional development of educators. Aldunate and Nussbaum (2013) report that educators who do not employ the use of technologies in their teaching process early on in their career are less likely to adopt new technologies later in their career. Educators with a strong sense of ICT self-efficacy are less prone to frustrations and would persevere in efforts to overcome obstacles for them to succeed in using these ICTs in their classrooms (Teo et al., 2018). Intrinsic factors such as self-efficacy have a significant impact on educators' subsequent use of technologies in their classrooms. Therefore the results in this research imply that the design of future educators' professional development programmes require embedding of metacognitive approaches that assist pre- and in-service educators to understand their beliefs. Additionally, PD can embed strategies on how these beliefs may be revisited and revised to inform educators' practices in a dynamic educational environment. For example, in a B.Ed. degree programme, this can be undertaken through self-reflective exercises, use of micro-teaching, understudying and modelling exemplar-educators during extended practicum periods.

In summary, the study recommends that initial educator training emphasises exposure of trainee educators to extended periods of ICT integrated environments. Moreover, it recommends continuous ICT integration development of practicing educators with a focus on the "how to" integrate ICT tools as 'generative' mind tools. The implication is that educator training curricula are re-designed with an emphasis on practical lesson planning that seamlessly includes ICT integration into the classroom environment in all primary and secondary school subjects.

## 8. Limitations and future research

One major limitation of this study, as is the case with cross-sectional research designs, is that the data collection was once-off. This has an effect of only giving a snapshot of the phenomenon under study. In future, longitudinal studies that include qualitative forms of data collection would help understand what is going on with regards ICT usage by Gauteng educators with respect to ICT self-efficacy. Moreover, with a once-off survey, causal interpretations are not possible. Multiple factors such as educator, classroom environment, school level and leadership characteristics, and vicarious experiences have been found to influence educators' self-efficacy (Fackler and Malmberg, 2016). Future studies could investigate the predictive nature of these factors on educators' ICT self-efficacy. Besides, in this study, data was collected when educators were busy with mid-year national examinations, which could have affected their response as their attention was focused on completing the examination processes. This contributed to the low response rate which was about 33.1%. Such low response rates introduce biases and may undermine the sample's representativeness of the population (Owen, 2017). Consequently, this might have affected the overall interpretation of results in this study. In addition, the results cannot be generalised to the whole of South Africa as only one out of the nine provinces is represented here. Furthermore, the extent of ICTs usage has been linked to particular subjects' nuances, for instance in mathematics and science-related fields (Efe, 2015; Alt, 2018). Comparatively, future research of psychological variables of educators, including ICT self-efficacy, in relation to use of ICTs for teaching and learning could focus on these particular nuances. Thus, the sampling could target specific subject groups with the intention of understanding similarities or differences in educators' ICT usages and ICT self-efficacy by knowledge domain.



In terms of instrument design, the self-efficacy scale could follow recommendations given by Bandura (2006), and supported by Joshi et al. (2015). Bandura argues that response scales with more intervals are more sensitive and have stronger prediction strengths than scales with less intervals such as the 5-point scale used in this study. Therefore, future designs could consider Bandura's (2006) guidelines when constructing self-efficacy scales.

The above discussion of possible future studies focuses on rather internal factors' influences with respect to educators' ICT self-efficacy. Further studies may consider a more integrated comprehensive model that also investigate external influences on educators' ICT self-efficacy such as the role of school district officials, policies and procedures educators have to adhere to, and verbal persuasions from other influential members in the educational fraternity.

## Declarations

### Author contribution statement

S. Mlambo: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

P. Rambe, L. Schlebusch: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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