



DEMYSTIFYING DATA PROCESSING TEACHERS' PROCEDURAL, FUNCTIONAL, PEDAGOGICAL, AND CONTENT KNOWLEDGE IN AN ICT-BASED CLASSROOM IN SOUTH AFRICA

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ABSTRACT

The paper examines the level of Procedural, Functional, Pedagogical, and Content Knowledge (PFPCCK) competency needed by Data Processing (DP) teachers to effectively use Information and Communication Technology (ICT) tools in ICT-based classrooms. A descriptive survey research design was used in the study. Three research questions were raised, and one hypothesis was formulated to guide the study. 130 DP teachers randomly selected from 11 Technical Vocational Education and Training (TVET) colleges in Gauteng province in South Africa formed the sample population. The instrument used in the study was a self-developed questionnaire titled Data Processing Teachers' Competency of Procedural Functional Pedagogical Content Questionnaire (DPTCPFPCQ). Personal and observation checklists were also used in the study. The data were analyzed using mean scores and t-tests. The results showed that DP teachers possessed the necessary competency of PFPCCK needed to use ICT tools in the digital classroom. It was also revealed that there was a significant difference in the level of competency and acquisition of skills between the pre-service and in-service DP teachers in the use of ICT in the class. It was therefore recommended that the management of TVET colleges and other similar institutions should help to improve DP teachers' procedural, and functional knowledge in the use of ICT as a pedagogical tool in ICT-enhanced classrooms.

KEYWORDS: *ICT-based classrooms, Procedural, Functional Knowledge, DP teachers.*

INTRODUCTION

Information and Communication Technology (ICT) significantly influences the way we learn, communicate, and do business in any facet of our life. It is shaping the world economy, producing rapid changes in society at large. This has revolutionized modern digital classrooms influencing teachers in the process of imparting knowledge through the use of modern learning facilities such as ICT materials. Herein lays the challenges for teachers to use innovative strategies to spur varied potentials and abilities of teachers by equipping them with appropriate knowledge and skills; to function as highly motivated and conscientious teachers in the digital age.

However, the essential types of knowledge that can enhance effective teaching and learning in an ICT-enhanced classroom have been identified in the literature to include pedagogical, content, functional, and procedural knowledge as applied to Science, Engineering, and Technology (SET) (Nissen, 2006). Pedagogical knowledge refers to the knowledge of methods and strategies employed by teachers in the process of teaching and learning. This knowledge includes the fundamental knowledge of classroom management, sequential lesson preparation, student motivation, assessment, and evaluation. Declarative knowledge (Content) is defined by Ryle (1958) as "know that", which is a form of knowledge that is associated with representations of facts rather than assimilation of facts into constructs that guide effective actions. This is also referred to by some researchers as content knowledge (Shulman, 1986). Functional knowledge is defined by Ryle (1958) as "know-how" having the ability to describe the steps and rules to perform a function, but not to articulate the description of what is known and put it into practice effectively. Biggs (2003) describes this kind of knowledge as functional, which is also referred to by other researchers as technological knowledge (Mishra & Koehler, 2005).



THEORETICAL CONTEXT

In the digital classroom environment, technological knowledge is much more than just knowing about technology or having the orientation to use technology. Procedural knowledge, according to Biggs (1999), is the ability or skills of the knower to choose and perform some actions in an appropriate and effective manner. Nissen (2006) argues that knowing how to ride a bicycle can only be demonstrated by mounting and actually riding the bicycle. He made a clear distinction between having the ability to perform a function, which is functional knowledge and performing the action by effectively applying skills in practical terms, which is procedural knowledge. Hiebert and Lefevre (1986) defined procedural knowledge as rules or procedures for solving problems in that procedures are sequentially ordered deterministic instructions for how to perform a given task effectively. Hiebert and Lefevre (1986) argue that procedural knowledge denotes the dynamic and successful utilization of rules or procedures that require not only the knowledge of the object being utilized but also the knowledge of the format and the syntax for a representational system. Many researchers find that procedural knowledge confirms the mastery of content knowledge and that functional knowledge enables the development of content (Hiebert & Lefevre, 1986; Biggs, 1999). *Procedural knowledge* is assessed non-verbally by observing the execution of a procedure with dexterity in solving basic problems. Procedural knowledge means knowing the technique for implementing a task through certain skills we possess (Reber & Reber, 2001).

TECHNOLOGICAL KNOWLEDGE CONSTRUCTS

The knowledge related to the effective use of educational technologies has become widely recognized as an important aspect of the knowledge base of educators in the 21st century.

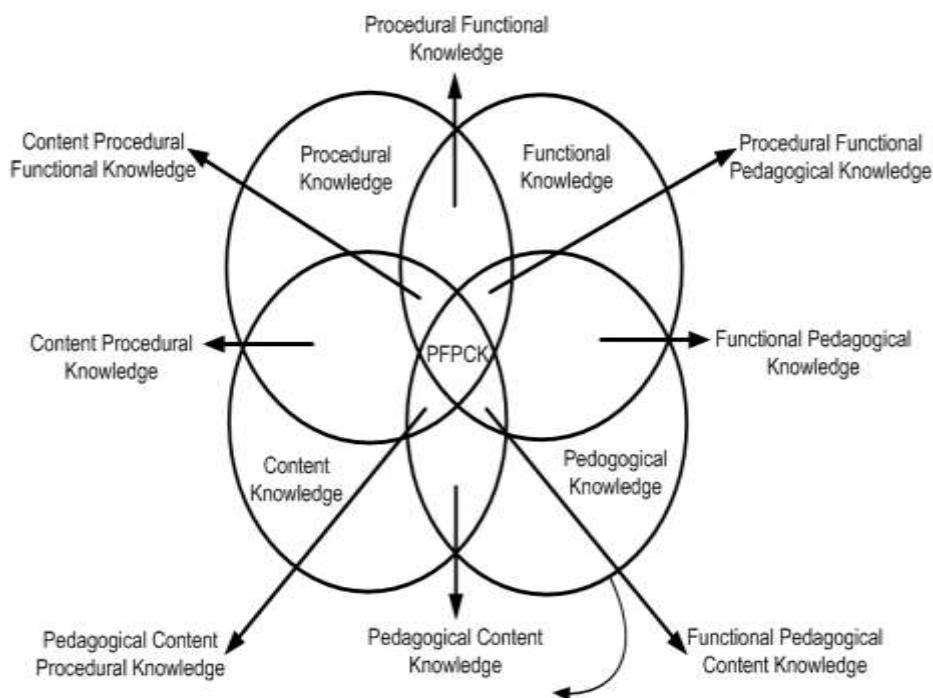


Figure 1: The PrFPACK theoretical framework (Adegbenro, Olugbara & Mwakapenda (2012))

The procedural, functional, pedagogical, and content knowledge (PrFPACK) is a theoretical framework proposed to holistically explore the technological knowledge and e-skills of teachers in an ICT-enhanced classroom. According to Adegbenro, Olugbara, and Mwakapenda (2012), this framework extended the classical TPACK by replacing "technological knowledge" with "procedural functional knowledge" to give the framework precise clarity. That is, the "T" (technological) in TPACK is replaced by "PrF" (procedural functional) to obtain an extended theoretical framework and, thus, the acronym TPACK-PrFPACK. In 2005 Mishra and Koehler (2005) updated and built on Shulman's idea of Pedagogical Content Knowledge (PCK), Shulman (1986). Mishra and Koehler proposed the necessity for the integration of technology with PCK and named the resulting amalgam knowledge Technological Pedagogical and Content Knowledge (TPACK). The strength of TPACK is that it provides a framework to examine what knowledge teachers need to



integrate technology into teaching and learning. Authors such as Yilmaz-Ozden, Mouza Karchmer-Klein & Glutting (2013) have confirmed the need to provide more clarity about the TPACK framework and to revisit measurement inventories built directly around the framework. The PrFPACK inventory consists of a set of 39 comprehensive measures that were organized into thirteen sub-domains of knowledge. We defined a measure as comprehensive if it is unambiguous and it directly measures what it intends to measure in clear terms. The knowledge sub-domains relate to specific theoretical constructs such as PK (pedagogical knowledge), CK (content knowledge), FK (functional knowledge), PrK (procedural knowledge), PCK (pedagogical content knowledge), PrPK (procedural pedagogical knowledge), PrFK (procedural functional knowledge), FCK (functional content knowledge), PrFCK (procedural functional content knowledge), PrFPK (procedural functional pedagogical knowledge), PrPcK (procedural pedagogical content knowledge), FPCK (functional pedagogical content knowledge) and PrFPCK (procedural functional pedagogical knowledge). Figure 1 shows the PrFPACK that was used in this study to empirically explore the nature of teachers’ knowledge and skills in the use of ICT as pedagogical tools. The PrFPACK framework specified a set of common items, which is outcome-based in scope, and measures specific technological proficiency and expertise with the computer and data projector for pedagogical practices.

RESEARCH QUESTIONS

Three research questions were raised to guide the study:

1. What is the level of Data Processing DP teachers’ content knowledge in the use of ICT as a pedagogical tool?
2. What is the level of DP teachers’ functional knowledge in the use of ICT as a pedagogical tool?
3. What is the level of DP teachers’ procedural knowledge in the use of ICT as a pedagogical tool?

RESEARCH HYPOTHESIS

1. There is no significant difference in the level of procedural functional content knowledge between DP teachers with 1-5 years of experience (pre-service) and 6 years and above experience (in-service) in the use of ICT.

METHODOLOGY

The study employs a descriptive survey research design to determine the conceptualization of procedural functional pedagogical content knowledge of DP teachers in digital classrooms in South Africa. The population of the study comprised 11 Technical and Vocational Education Colleges (TVET) in South Africa. The sample population consisted of one hundred and thirty (130) Data Processing Teachers (DPT) randomly selected from eleven (11) technical and vocational education colleges in Gauteng province in South Africa. The instrument used in this study was a self-developed questionnaire titled “Data Processing Teachers Competency of Procedural Functional Pedagogical Content Questionnaire (DPTCPFCKQ). It was a five-point scale questionnaire of highly incompetent, incompetent, competent, and highly competent with scores of 1,2,3,4,5 respectively. The instrument was validated by two experts in test measurements and evaluation. Cronbach. Alpha was used to establish the reliability of the instrument. The positive value of 0.82 was recorded and so the instrument was considered suitable to be used for the study. Personal interviews and observation checklists were also used. Data collected was analyzed using mean scores and t-tests.

Results:

Research Question 1:

What is the level of Data Processing Teachers’ DPT content knowledge in the use of ICT as a pedagogical tool?

Table 1 Level of DP Teachers’ Content Knowledge (CK) in the Use of ICT

S/No	Item	Mean	Std. Deviation
1	I know various concepts and applications of spreadsheet programs including MS Excel.	3.88	1.34
2	I know various concepts and applications of Internet and web technology including video conferencing, sending e-mail, web surfing, and business correspondence.	3.86	1.28
3	I know various concepts and applications of advanced information presentation systems including Interactive Teaching Box and Power Point Presentation.	3.76	1.21
4	I know various concepts and applications of Word processing, Audio Typing, and Data transcription systems.	4.01	1.04
5	I know various concepts and applications of advanced database management systems	4.32	1.36
Weighted Average		3.96	

Key: 1 = Highly Incompetent, 2 = Incompetent, 3 = Fairly Competent, 4 = Competent, 5 = Highly Competent



Decision Value: 0.00-2.94 = Low, 2.95-5.00 = High

Table 1 above shows that the DP teachers are competent in the content knowledge as follows: know various concepts and applications of spreadsheet programs including MS Excel ($\bar{x} = 3.88$), know various concepts and applications of internet and web technology including video conferencing, sending e-mail, web surfing and business correspondence ($\bar{x} = 3.86$), know various concepts and applications of advanced information presentation systems including Interactive Teaching Box and PowerPoint Presentation ($\bar{x} = 3.76$), know various concepts and applications of Word processing, Audio Typing and Data transcription systems ($\bar{x} = 4.01$) and know various concepts and applications of advanced database management systems ($\bar{x} = 4.32$). Based on the value of the weighted average (3.96 out of 5.00 maximum value that can be obtained), which falls within the decision value for high, it can be inferred that the level of DP teachers' content knowledge in the use of ICT as a pedagogical tool is high.

Research Question 2:

What is the level of data processing teachers' functional knowledge in the use of ICT as a pedagogical tool?

Table 2 Level of DP Teachers' Functional Knowledge in the Use of ICT

S/No	Item	Mean	Std. Deviation
1	I know how to use Interactive Teaching Box (IBOX) and Data Projector to teach various concepts of spreadsheet programs.	4.06	1.03
2	I know how to use the internet and web technology to perform various information communication tasks such as sending e-mails, surfing the web, and establishing network connections.	2.72	1.06
3	I know how to use word processing, window media, audio typing, and data transcription systems to perform various document preparation tasks such as note taking, minutes reporting, file storage, retrieval, and printing.	3.50	1.04
4	I know how to use IBOX, Data Projector to teach various concepts of advanced information presentation systems to solve content delivery problems.	2.50	1.01
5	I know how to use Data Projector and IBOX to teach various advanced database management systems concepts to solve file management problems.	4.41	1.00
Weighted Average		3.44	

Key: 1 = Highly Incompetent, 2 = Incompetent, 3 = Fairly Competent, 4 = Competent, 5 = Highly Competent

Decision Value: 0.00-2.94 = Low, 2.95-5.00 = High

Table 3 above, shows that the DP teachers are competent in the functional knowledge as follows: know how to use Interactive Teaching Box (IBOX) and Data Projector to teach various concepts of spreadsheet programs ($\bar{x} = 4.06$), know how to use word processing, window media, audio typing, and data transcription systems to perform various document preparation tasks such as, note taking, minutes reporting, file storage, retrieval and printing ($\bar{x} = 3.50$) and know how to use Data Projector and IBOX to teach various concepts of advanced database management systems to solve file management problems ($\bar{x} = 4.41$). The table further shows that the DP teachers are fairly competent in the following: know how to use the internet and web technology to perform various information communication tasks such as, sending e-mail, surfing the web, and establishing network connection ($\bar{x} = 2.72$) and know how to use IBOX, Data Projector to teach various concepts of advanced information presentation systems to solve content delivery problems ($\bar{x} = 2.50$). Based on the value of the weighted average (3.44 out of 5.00 maximum value that can be obtained), which falls within the decision value for high, it can be inferred that the level of DP teachers' functional knowledge in the use of ICT as a pedagogical tool is high.

Research Question 3: What is the level of DP teachers' procedural knowledge in the use of ICT as a pedagogical tool?



Table 3 Level of DP Teachers’ Procedural Knowledge (PK) in the Use of ICT Tools

S/No	Item	Mean	Std. Deviation
1	I can effectively demonstrate the right steps to use a data projector and IBOX to teach Spreadsheet programs and solve all minor technical troubleshooting problems when the need arises without disrupting the lessons.	3.98	1.44
2	I can effectively demonstrate the right steps to use IBOX and data projector to teach web technology, internet, and window media player to solve various information communication problems.	4.21	1.58
3	I can effectively demonstrate the right steps to use a Data projector to teach word processing, audio typing, and data transcription systems and solve minor technical troubleshooting problems as the need arises without disrupting the lesson.	3.76	1.35
4	I can effectively demonstrate the right steps to use a Data projector and IBOX to teach various concepts of advanced database management systems and solve technical troubleshooting problems as the need arises without disrupting the lessons.	4.01	1.49
5	I can effectively demonstrate the right steps to use IBOX and data projector to teach advanced information presentation systems and address minor technical troubleshooting problems without disrupting the lessons.	4.42	1.62
Weighted Average		4.08	

Key: 1 = Highly Incompetent, 2 = Incompetent, 3 = Fairly Competent, 4 = Competent, 5 = Highly Competent

Decision Value: 0.00-2.94 = Low, 2.95-5.00 = High

Table 3 above, shows that the DP teachers are competent in the procedural knowledge as follows: effectively demonstrate the right steps to use data projector and IBOX to teach Spreadsheet programs and solve all minor technical trouble shooting problems when the need arises without disrupting the lessons ($\bar{x} = 3.98$), effectively demonstrate the right steps to use IBOX and data projector to teach web technology, internet and window media player to solve various information communication problems ($\bar{x} = 4.21$), effectively demonstrate the right steps to use Data projector to teach word processing, audio typing and data transcription systems and solve minor technical trouble shooting problems as the need arises without disrupting the lesson ($\bar{x} = 3.76$), effectively demonstrate the right steps to use Data projector and IBOX to teach various concepts of advanced database management systems and solve technical trouble shooting problems as the need arises without disrupting the lessons ($\bar{x} = 4.01$) and effectively demonstrate the right steps to use IBOX and data projector to teach advanced information presentation systems and address minor technical trouble shooting problems without disrupting the lessons ($\bar{x} = 4.42$). Based on the value of the weighted average (4.08 out of 5.00 maximum value that can be obtained), which falls within the decision value for high, it can be inferred that the level of ODP teachers’ procedural knowledge in the use of ICT as a pedagogical tool is high.

Test of the Hypotheses

Ho 1: There is no significant difference in the level of procedural functional content knowledge between data processing teachers with 1-5 years of experience (preservice) and 6 years and above experience (Inservice) in the use of ICT tools.

Table 4 Summary of T-test showing Difference between pre-service and in-service DP Teacher’s Procedural Functional Content Knowledge

KNOW LEDGE	Year of Experience	N	Mean	Std. D	df	t	Sig (p)	Remark
	Preservice (1-5)	74	40.91	7.99				
Inservice (6years & above)	56	53.68	9.52	98	6.692	.000	Significant	



Table 4 above, shows the difference in the level of procedural functional content knowledge of DP teachers. The table shows that the mean score of Data processing teachers with 1-5 years of experience (preservice) is 40.91 while that of those with 6 years and above (in-service) is 53.68. Therefore, there is a significant influence of procedural functional content knowledge PFCK between data processing teachers with 1-5 years of experience (preservice) and 6 years and above experience (in-service) in the use of ICT. This implies that the in-service DP teachers possessed a high level of procedural functional content knowledge PFCK to use ICT tools for classroom instruction. Therefore, the hypothesis states that “there is no significant difference in the level of procedural functional content knowledge PFCK between data processing teachers with 1-5 years of experience (preservice) and 6 years and above experience (in-service) in the use of ICT is not accepted.

DISCUSSION

The result of the analysis of research question one revealed that DP teachers demonstrated a high level of content knowledge in using ICT tools in the classroom. It was revealed in the study that DP teachers are competent to use internet facilities and e-mail for effective teaching in the class. This finding agrees with SAIDE (2009) who find out that content and ICT knowledge are essential for enhancing teaching and learning in the digital age.

On the level of competency of DP teachers’ functional and procedural knowledge in the use of ICT as a pedagogical tool, the finding of the study revealed that DP teachers are competent. The study is in agreement with the submission of Pavlova (2005) who claimed that technology knowledge has been strongly associated with the application of scientific knowledge ie ICT knowledge in effective teaching and learning.

On the significant difference in the level of procedural functional content knowledge between data processing teachers with 1-5 years of experience (preservice) and 6 years and above experience (in-service) in the use of ICT, a significant difference was found between the in-service and preservice. The reason for this could be attributed to the fact that in-service had enough working experience and they were able to possess all the necessary knowledge and ICT skills to teach effectively in the ICT-based classroom. The results of this study are in conformity with the findings of (SAIDE, 2009) that learning to use ICT in a pre-service teacher education class is not as compelling as learning to use ICT as you teach in the classroom. In-service and preservice teachers were able to use ICT infrastructure to a certain degree in their DP classrooms and they demonstrated the understanding of some basic concepts, steps, and principles that guide the use of ICT for the teaching of DP. In general, in-service DP teachers were more able to effectively use all available ICT tools in their ICT-based classrooms and they exhibited technological knowledge with dexterity in solving basic technical troubleshooting problems more than the preservice Data processing teachers.

CONCLUSION

Procedural, functional, and pedagogical knowledge are essential types of knowledge that are quite imperative in effective teaching and learning, especially in ICT-based classrooms. The classroom observation and interview afterward made a clear indication of the differences in the procedural functional knowledge of in-service and pre-service teachers based on their years of experience. The study has established the rationales to differentiate between functional and procedural knowledge when considering the technological knowledge of teachers.

Technology is re-defined in this study as the application of knowledge and skills in the astute use of practical instruments to solve problems and enhance effective performance.

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