2017

Investigating the impact of ICT tutorial strategies to promote improved database knowledge acquisition

Aaron Bere
RMIT University, aaronbere@gmail.com

Elspeth McKay
RMIT University, elspeth.mckay@rmit.edu.au

Investigating the impact of ICT tutorial strategies to promote improved Database knowledge acquisition

Aaron Bere
School of Business IT and Logistics
RMIT University
Melbourne, Australia
Email: aaron.bere@rmit.edu.au

Elspeth McKay
School of Business IT and Logistics
RMIT University
Melbourne, Australia
Email: elspeth.mckay@rmit.edu.au

Abstract

Retention of students in IT courses has become a problem in South Africa. This paper employs a Rasch item response model to examine the effectiveness of utilising ICT tutorial tools in database knowledge acquisition within the South African higher education context. The study applied a 2X2 factorial quasi-experimental design. Data was analysed quantitatively using the QUEST Interactive Test Analysis estimate. Results indicate that utilisation of ICT tutorial tools positively impacts on students' performance. Furthermore, instructional support using the Blackboard learning management system was more effective than mobile learning using WhatsApp instant messaging. The significance of this paper lies in its potential to provide insights for possible alternatives that have potential to improve Science, Technology, and Engineering (SET) instructional outcomes. Such enhanced cohort retention could reduce persistent SET skill job market shortages. The major implication of the study involves encouraging adoption of ICT tutorial tools.

Keywords ICT tutorial, database systems, knowledge acquisition, participation, quasi-experimental design.

1 Introduction

Database related fields have experienced unprecedented growth in recent years (Morabito, 2015; Olsen & Dupin-Bryant, 2016). Harrington (2016) argued that the acceptance and use of digital databases has grown to the extent that almost every organisation uses them; unlike prior mid-twentieth century when data processing and storage was based on traditional approaches that relied on manual methodologies. Although digital databases require specialised knowledge involving their development, maintenance and support, these technologies' ability to efficiently process, store and retrieve data have led to their high diffusion in business (Harrington, 2016; Kreie & Hashemi, 2012).

There is a growing demand for experts in Structured Query Language (SQL) related contexts such as: big data; data analytics; and database design and development. Yet Lotriet, Matthee, and Alexander (2010) acknowledged the dilemma in South Africa's ICT skills shortage. Consequently, database associated professions are listed among the government scarce skills. Skills shortages in these high-demand professions are forecasted globally (Mills, 2017; Morabito, 2015). Thus, higher education (HE) should focus on training more qualified database specialists in order to meet this skills' demand (Kreie & Hashemi, 2012; Mills, 2017).

Despite the South African HE sector's eagerness to increase students throughput of the Science, Engineering, and Technology (SET) (including database graduates); it still remains that the students' academic participation is unsatisfactory (Murire & Cilliers, 2017). To this end, South African HE is characterised by high dropout and failure rates (Council on Higher Education, 2013; Department of Higher Education and Training, 2013). Only 15 percent completes a three year qualification within the minimum timeframe (Department of Higher Education and Training, 2013). The Council on Higher Education (2013) revealed that 35 percent of South African HE students registered for either a three or four-year qualification graduates within five years while approximately 55 percent of the intake never graduate. Although indigenous people constitute the majority of enrolled students, their throughput rate is estimated at 5 percent. The lowest performance was reported on SET and the government has increasingly raised concerns of skills shortages in SET occupations (Council on Higher Education, 2013; Department of Higher Education and Training, 2013).

The causes of this low academic participation that leads to poor performance in South African HE are blurry (Department of Higher Education and Training, 2013). Due to the increased demand of information technology (IT) skills (especially database expertise); SQL has become a SET interdisciplinary course. Therefore, we believe that improved performance in database skills acquisition could improve the overall SET student throughput. Olsen and Dupin-Bryant (2016) claimed that a fundamental component in providing market with qualified database graduates was to limit reliance on traditional instructional delivery techniques yet focus should rather be placed on innovative instructional processes. Apparently, Department of Higher Education and Training (2013) expressed the government's support to promote digital inclusion in HE especially the use of mobile technologies. Additionally, the Department of Higher Education and Training (2013) encouraged stakeholders to develop ICT integration pedagogical frameworks dedicated to the South African HE context. Thus, we feel that the South African HE should examine the effectiveness of ICT tutorial strategies in improving database knowledge acquisition. Therefore, the study is guided by the following research question: What is the impact of ICT tutorial tools in promoting database knowledge acquisition?

The remainder of the paper is structured as follows: following this introduction, the second section provides an overview of SQL. The third section presents the methodology used in our study. The fourth section presents data analysis using the QUEST Interactive Test Analysis estimate and presentation of preliminary results. The discussion is deliberated in section five, and section six provides the implications. Finally, the conclusion of the study is given in section seven.

2 Database Using SQL

In this research, a module on database knowledge acquisition with a topic in SQL was selected as the basis of the work. SQL was selected because it is the major programming language used in relational databases systems (Soflano, Connolly, & Hainey, 2015; TechRepublic, 2002). Melton (1996) corroborates the importance of SQL in relational database although he argues that SQL is not a programming language but a relational database data sub-language. While contradictory views on whether or not SQL is a legitimate programming language prevailed before the new millennium, there was consensus that it is a fourth generation language (Melton, 1996; Soflano et al., 2015). Fourth-generation languages are computer programming languages, which use syntax that is closely related to

English language (TechRepublic, 2002). Therefore, these programming languages are easier to understand especially to users with high English language proficiency, since they have similar structure to English expressions (Rawlings, 2014; Soflano et al., 2015).

Moreover, SQL refers to a database definition and database manipulation language that runs in relational databases (Harrington, 2016). The SQL was endorsed by ANSI (the American National Standards Institute) and ISO (International Standards Organization) as a standard query language for relational databases (Harrington, 2016; Melton, 1996). The IBM technologies developed SQL in the 1970s at the San Jose Research Laboratory and named it Structured English Query Language (SEQUEL). It was pronounced as 'sequel' and later changed to Structured Query Language (Harrington, 2016).

SQL's central concept is the database table, composed of at least one named column, each having a data type. Tables store data records in rows having columns corresponding to the table's columns. Each column is constrained to a single data type for all rows (Melton, 1996). Soflano et al. (2015) indicated that the major SQL components are:

- Data Definition Language (DDL): Examples include CREATE TABLE, ALTER TABLE and DROP TABLE.
- Data Manipulation Language (DML): Processes covered include data retrieval, update, delete and insert.

DDL deals with the structural design of the database while DML is used to manage the data flow from and into the database (Soflano et al., 2015). Thus the tutorial objectives for this research were as follows:

For the students to develop SQL database query commands, that utilised conditional filtering clauses and other related commands. The specific objectives included:

- SELECT; FROM and DISTINCT clauses defined and their applications explained;
- aggregate functions defined and examples given;
- conditional filtering using the WHERE clause was explained and their application explained;
- logic operators defined and the application of a WHERE clause was explained; and
- Example problems with associated instructional scaffolding applied.

3 Research Methodology

The purpose of this methodological approach was to outline the experimental procedure for the study. In order to reach this purpose, the development of both experimental instructional material and data collection instruments are deliberated.

Developing instructional prescriptions for designing problem solving strategies that engage learners has long been recognised as necessary to achieve vital learning outcomes (Jonassen, 1997). The instructional pedagogies developed by Bagley (1990) that were extended by McKay (2000) were adopted in this study; as such, they were converted for use as the ICT tutorial strategies. The paper-based instructional materials developed by Bagley (1990) were designed for investigating the structured versus discovering instructional formats, for improving the learning of programming concepts by novice and experienced adult learners. While the McKay (2000) thesis investigated the interactive effect of instructional format (text/graphics) and cognitive preference (verbal/imagery) to facilitate the learning of complex programming concepts. This study however, involves investigating the effectiveness of using ICT tutorials to enhance the acquisition of database concepts by novice learners. To this end, the McKay (2000) Tutorial-1 Familiarisation with Data Types booklet, formed the basis of the ICT tutorial strategies that were used in this research.

3.1 Instructional Format Booklet Development Strategies

Conducting a thorough task analysis and developing the subsequent learning hierarchy were the two main courseware design strategies that were used in the development of the pedagogical content employed in the Instructional Format Booklet. These strategies are discussed below.

3.1.1 Task analysis

The scope of the task analysis was limited to introductory to SQL knowledge acquisition concepts. The main aim of developing the test-items was to assess students' ability to develop SQL queries that utilises aggregate functions and conditional filtering statements. In order to achieve this aim, knowledge regarding the use of SELECT clause; FROM clause; WHERE clause; logic operations; and aggregate functions were deemed essential.

Procedural or information-processing analysis and learning-task analysis are the two major categories of task analysis (Gagné, Briggs, & Wager, 1992). In this paper, we show the procedural task analysis that was employed. Gagné et al. (1992) to describe the steps in performing a task. It involved breaking the task into steps to be performed by an individual (student) to complete the task. This analysis was chosen because it resulted in a clear description of the target objective (Gagné et al., 1992). Also, by conducting this procedural task analysis, it resulted in the revelation of sequencing of individual steps that did not seem obvious to the researcher as described by (Gagné et al., 1992).

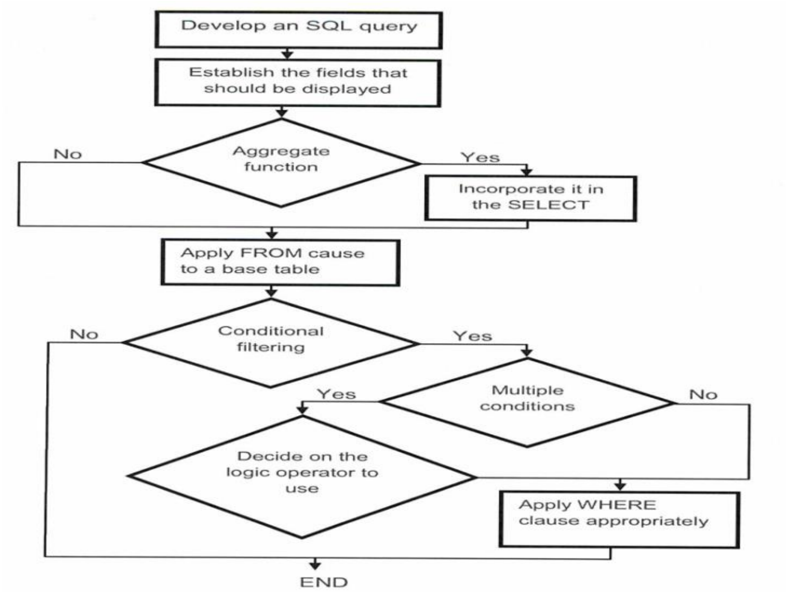

Figure 1: Task analysis for introduction to SQL query development

3.1.2 Learning hierarchy

It was essential to develop a learning hierarchy during test-item development process. According to (Gagné et al., 1992) there is a bi-folding of the learning hierarchy's value. 1) it was used as a guide in the design of a sequence of instruction, and 2) as a guide for the instructional designer in the planning of the test-items. In this study a learning hierarchy was developed following the (Gagné et al., 1992) recommendation that it should be an outcome of the task-analysis that is to be displayed in form of a hierarchical diagram that is composed of boxes describing the successively identified subordinate skills. As such, SQL query development concepts were fragmented into smaller and simpler skills. These skills were then presented to inform the experimental learning hierarchy design, using the top-down design principle. In this structure, subordinate and entry skills were presented at the bottom of the diagram.

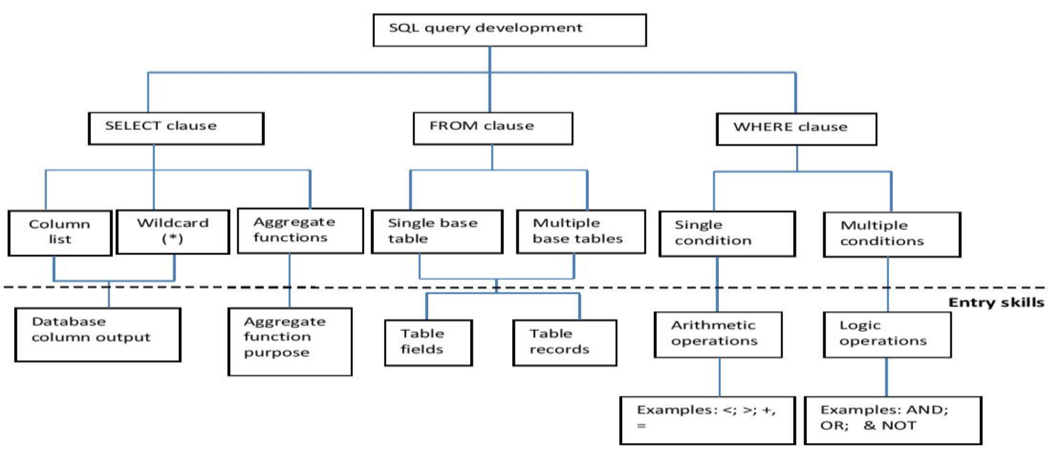

Figure 2: Learning hierarchy for introduction to SQL query development

3.2 Pre and Post-test Instrument Development

Gagné et al. (1992) listed the five kinds of learned capabilities which include intellectual skills; cognitive strategy; verbal information; motor skills; and attitude. The test-items developed in this study were limited to three kinds of learned capabilities stipulated by (Gagné et al., 1992). The learned capabilities applicable to this study included: intellectual skills; cognitive strategy; and verbal information. In order to construct a valid and reliable test-item measurement instrument, an instructional matrix initially developed by (R. Gagné, 1985) and later improved by McKay (2000) was employed.

3.2.1 Instructional matrix

An instructional matrix (McKay, 2000) was employed in the development of test-items. It was directly used to guide the development of a pre-test which was developed to test 10 learning domains associated with the acquisition of database SQL query concepts. The database SQL query learning domains were listed vertically on the left-hand side of the instructional matrix (the y-axis), while the five instructional objectives were listed horizontally (the x-axis) from band-A to band-E. The level of instructional objectives complexity increased from band-A to band-E. The nine learning domains included: database terms; database operations; database types; components of SELECT clause; FROM clause; conditional filtering; logic operations; aggregate functions; and developing queries.

The development of the nine learning domains was also guided by the R. Gagné (1985) instructional sequence theory, which included: verbal information (basic skill); intellectual skill (intermediate skill); and cognitive strategy (advanced skill). The declarative and procedural knowledge constituted the two classes of the instructional objectives. The declarative knowledge consisted of either verbal information (Band-A) or intellectual skill (Band B). The verbal information skills addressed basic knowledge that was associated in understanding concrete concepts (Merrill, 2001). According to R. Gagné (1985) intellectual skills involve understanding concepts and principles. The procedural knowledge consisted of (Band C), cognitive strategy (Band D) and cognitive strategy (B and E). The intellectual skills (Band-C) supported those tasks/concepts that had higher order problem solving skills and were applicable in new situations. Individuals capable of identifying sub-tasks and having the ability to recognise instated assumptions were categorised in the cognitive strategy (Band-D). Cognitive strategy (Band-E) accommodates individuals with the ability to recall simple prerequisite rules and concepts and having the ability to integrate learning from different areas into a plan for problem solving.

		Instructional Objectives: Introduction to SQL knowledge acquisition					
		Declarative		Procedural			
		Band-A	Band-B	Band-C	Band-D	Band-E	
		Verbal information skills Concrete Concept Know Basic Terms Know "that"	**Intellectual skills** Basic Rule Discriminates Understands Concepts & Principles	**Intellectual skills** Higher-order Rule Problem Solving Applies Concepts & Principles to new situations	**Cognitive strategy** Identify sub-tasks Recognises instated assumptions	**Cognitive strategy** Knowing the "how" Recall simple prerequisite rules & concepts Integrates learning from different areas into a plan for problem solving	
Task #:	**Learning Domain:**						**Totals**
9	Developing queries					22,23,25,27,28,29,30,31,34,35,38	11
8	Aggregate functions		12,13				2
7	Logic operations		15	16,18			3
6	Conditional filtering		14	26,32,36	17, 19, 20, 21, 33, 37		10
5	FROM clause		9	24			2
4	Components of SELECT clause		8,10,11				3
3	Database types		4,5				2
2	Database operations	1					1
1	Database terms	2,6	3,7				4
	Totals	3	12	6	6	11	**38**

Table 1. Instructional matrix for the 38 test-items on introduction to SQL concepts adapted from McKay (2000)

Table 1 represents the test-items that were included in the pre- and post-test instruments developed for this study (Bagley, 1990; McKay, 2000). They were both designed to measure introduction to database knowledge acquisition. Further details about test-item instruments development are discussed next.

Pre-Test: This instrument was developed to establish prior domain knowledge, hence a paper based pre-test was completed based on participants' knowledge gain during their normal lectures. This implies that, a pre-test was conducted before accessing treatments. To avoid pressure and stress, the pre-test items were ordered from easiest to the most difficult.

The pre-test instrument consisted of 38 test-items. It had 18 dichotomous and 20 partial credit test-items. Dichotomous refers to a scoring technique that utilises either a '0' or '1'. A test-item is scored '0' if the answer is either incorrect or blank (left unanswered), while a score of '1' is allocated when a correct answer has been given. Therefore, the dichotomous scoring system is applied for test-items that require clear and easy understanding questions. However, partial credit scoring technique was used for complex questions that required an ordered sequence of steps to be followed to get to a solution and could not be answered by a distinct response. These item-tests could not be scored by assigning either a '0' or '1' because partially correct responses could be obtained. For example, writing an SQL query constrained by two mandatory conditions. A partial credit score was utilised with values ranging from '0' to '5'. Even in this case, a score of '0' implied that the response was either incorrect or blank. While a score of '5' signified a correctly completed solution. Scores between '1' and '4' indicate that the solution is not fully correct but part marks have been awarded for correct parts. However, other test-items received a score of either a '0, or a 1 or a 2'; '0, or a 1, or a 2 or a 3';while another received a score of either a '0, or a 1, or a 2 or a 3 or a 4' with the maximum of a '5'.

Post-Test: Just like the pre-test, the post-test instrument consisted of 38 test-items. Also, it has 18 dichotomous and 20 partial credit test-item sores. The post-test instrument was developed based on the instruction matrix principles (see table 1). This instrument was designed in such a way that its content is closely related to that of a pre-test. However, the test-items in the post-test were randomly ordered and the wording for the two instruments was not identical. The rationale behind such differences was to reduce memory effects on post-tests. The researcher carefully rephrased post-test test-items keeping in mind that they should measure the same learning content with the pre-test test-items.

However, five test-items were kept identical in both pre-test and post-test instruments. The identical test-items appeared on question 7, 9, 14, 22, and 25, in both instruments. The rationale for keeping these test-items identical was to enable easy identification of knowledge acquisition occurrence in post-test based on the Item Response Theory (IRT) data analysis results.

3.3 Instrument validation

The instruments' testing was conducted prior to the classroom experiment. This process involved participants who were not students; they were database experts in South Africa. The purpose for conducting this instrument testing was to calibrate and validate the reliability of the research questions, using the QUEST Interactive Test Analysis System (Adams & Khoo, 1996).

Sixteen database experts including university lecturers in South Africa were contacted by e-mail and requested to participate in the instrument testing process. Fourteen participants agreed to take part in the study but ten completed both pre- and post-test. The pre-tests and post-test for the ten participants who completed and returned both instruments were scored and data was saved in notepad. The dataset was analysed using the QUEST Interactive Test Analysis System (Adams & Khoo, 1996). Quest uses the Rasch measurement theory to effective analyse datasets comprised of dichotomous and polytomous test-items.

Participants took between 25 to 35 minutes to complete each data collection instrument. Adams and Khoo (1996) recommended an internal consistency of 0.7. However, internal consistency for the pre and post-test were 0.7 and 0.78 respectively. The post-test recoded a higher standard deviation of 9.32 while the pre-test recoded 6.75. The mean score for the pilot study were 38.7 and 48.6 and the post-test had a higher score once again. Both pre- and post-test had four items each that did not fit the Rasch model.

3.4 Experiment procedure

The following steps were followed to ensure a smooth flow of the data collection process.

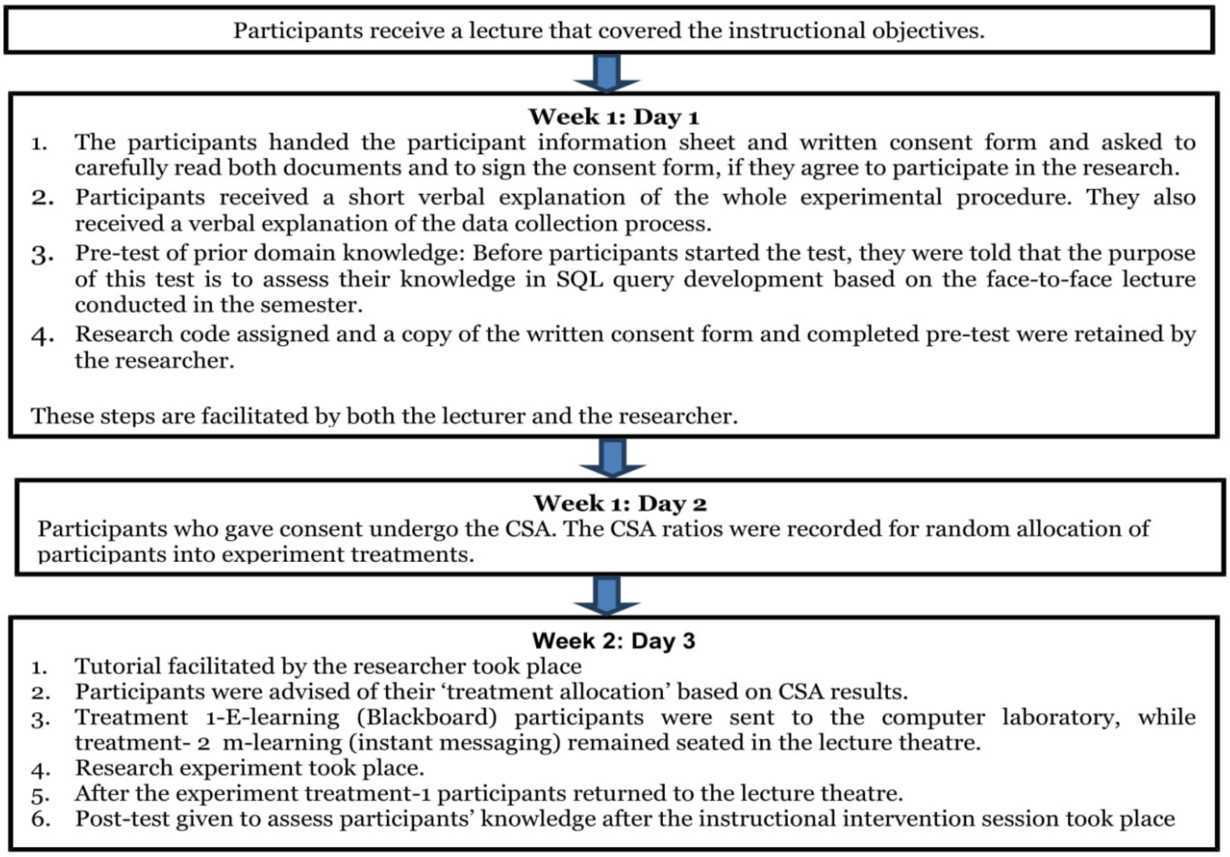

Figure 3: Experimental procedure

3.5 Participant demographics

This 2x2 factorial quasi-experimental study took place at the Central University of Technology, South Africa. A total of 97 students were enrolled in Database systems in the Information Technology (IT) department. These students where registered in either Web applications or software systems class. The students were novice SQL developers. Database systems course was chosen because it is a required course for all IT related, and Engineering majors at the research site. Additionally, the persistent increase in demand of database skills motivated for the consideration of database systems course in this study. Data was collected during the 2017 first semester; during this period engineering majors were not offering database systems course. Therefore, IT students were considered for the study.

The Web applications class constituted of 43 students while the software systems had a total of 54 students. However, 14.43% of the population did not give consent to take part in research. Data was collected using pre and post-tests. A total of twenty participants who consented to take part in the study did not complete both the pre and post-test; hence, their data was rejected. Data from a total of 63 participants was analysed using QUEST interactive estimate (khoo,1996). To this end, 28 and 35 participants whose data was analysed belonged to Web applications, and software systems class respectively. Female participants were the majority constituting 56 percent of the population. Participants' age ranged from 19 to over 30 years. The age group ranging from 21 to 25 was the most popular with 30 participants, followed by 19 to 21 that had 21participants. Only two participants were above 30 years while 10 participants were within the 26 to 29 age group.

4 Data Analysis

The Quest estimate was used to assess the extent to which the data fits the Rasch model by ensuring that the test-items were within the 'threshold range' of 0.77 and 1.33 (the fit statistic). A test-analysis was conducted similar to the test-items analysis process followed in the pilot-study. The process was repeated until the final set of test-items satisfied the requirements of the Rasch item response theory (IRT) model. Both the pre-and post-test had two test-items each that did not fit the Rasch IRT model; consequently these test-items were excluded until a proper 'fit' was produced. Figure 4 below presents a ‘unidimensionality’ of test-items. Adams and Khoo (1996) defined ‘unidimensionality’ as the test-items’ ability to measure a single construct.

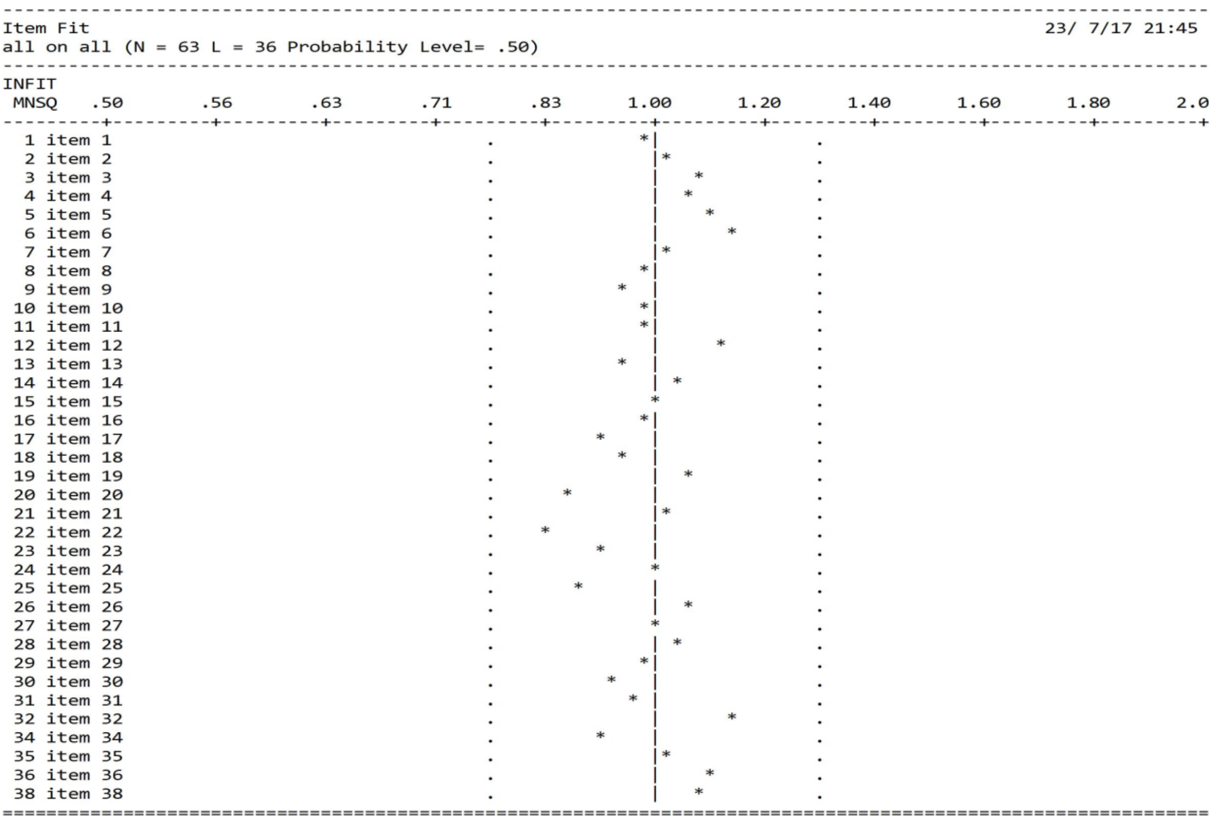

Figure 4: Test-items fit map

The internal consistency of the pre- and post-test items in this study surpassed the recommended figures Adams and Khoo (1996). The mean test scores and standard deviation were satisfactory. Table 2 below presents the details of these statistics.

	Internal Consistency	**Mean Test Score**	**Standard Deviation**
Pre-Test	0.86	35.40	11.19
Post-Test	1.91	47.19	12.60

Table 2. Internal consistency, mean, and standard deviation

Participants involved in this study were IT students belonging to either the web applications or software systems specialisation. The study applied two experiment treatments: Treatment 1 (T1) - participation using Blackboard learner management system; and Treatment 2 (T2) - participation using WhatsApp mobile instant messaging application. Participants were randomly allocated into treatments using the cognitive style analysis (CSA) ratios. Thirteen participants were randomly allocated to the T1 web applications cohort, while 20 were allocated to software systems. The T- 2 was composed 15 participants each in both web applications and software systems. The pre- and post-test mean score and standard deviation (SD) for each category are presented on a table 3 below.

Group	**T1**					**T2**				
	N	***Mean***		***SD***		***N***	***Mean***		***SD***	
		Post	Pre	Post	Pre		Post	Pre	Post	Pre
Web Applications	13	35.38	37.00	8.37	7.34	15	40.40	34.87	15.84	12.66
	Mean/SD Difference	*-1.62*		*1.03*			*5.53*		*3.18*	
Software systems	20	43.48	38.45	15.39	15.05	15	29.67	31.93	7.76	11.11
	Mean/SD Difference	*5.03*		*0.34*			*-2.26*		*-3.32*	

Table 3. Descriptive statistics

4.1 Performance analysis

The results reveal that pre-test scores ranged from 8 to 72 while post-test ranged from 20 to 87. One participant obtained a perfect score in the post test. About 32 percent of the participants scored over 50 percent in the pre-test and the figure doubled in post-test. Although the majority obtained higher scores in the post-test, a small number maintained the same score while a few participants' performance worsened. To this end, performance of about 11 percent of the participants did not improve. Thus, 8 percent of the participants' scores degenerated, whereas, 3 percent obtained the same score in both pre and post-test. The results reveal that 89 percent of the participants' performance improved. The results show that one participant's performance improved by a factor of 275 percent having a score of 8 in pre-test and 30 in post-test. Nearly 6.4 percent of the participants showed over 100 percent performance enhancement. Overall, there was improved students' performance after the ICT tutorials intervention was applied. Figure 5 below shows the performance distribution in this study.

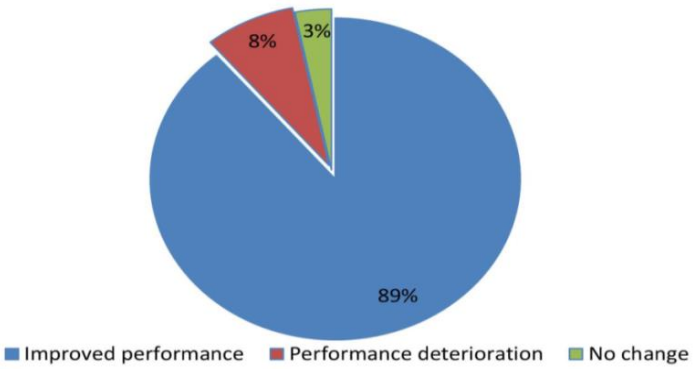

Figure 5: Academic performance

The results reveal that only 7.94 percent of the web applications participants obtained at least 50 percent score in the T1 pre-test, while software systems achieved 30 percent. However, the percentage scores sharply increased in post-test. Consistent with pre-test results, software systems scored a higher percentage in post-test in T1. Yet, a higher post-test and pre-test difference was obtained web applications (61.29 percent); and post-test and pre-test difference of 45 percent was recorded for software systems. On the other hand, T2 post-test for web applications and software systems were almost equal; the software systems pre-test percentage score doubles the web applications percentage mark. Once again, the web applications recorded a higher post-test and pre-test percentage score difference than software systems. Figure below presents SQL knowledge acquisition in T1 and T2 within the two IT specialisation involved in this study.

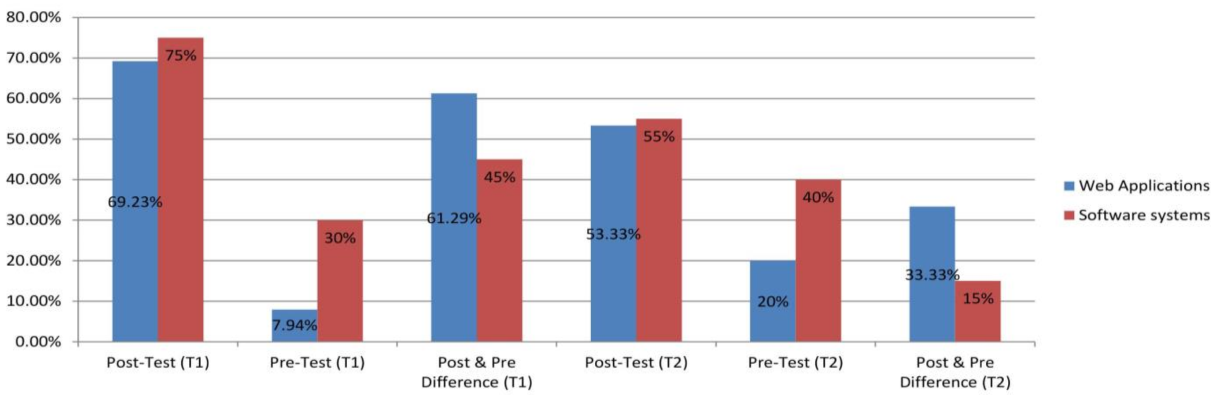

Figure 6: Knowledge acquisition

These results show that 93.33 percent and 84.4 percent performance improvement were recorded for T1 and T2 respectively. Additionally, 6.06 percent of T2 participants' performance did not change after using the ICT tutorials intervention. Therefore, T1 was more effective in promoting database knowledge acquisition than T2.

5 Discussion

The study used quasi-experiment design to investigate the effectiveness of using ICT tutorial strategies to promote improved instructional performance of IT students at a South African University of Technology. The following findings were obtained.

Findings of this study reveal that novice SQL programmers perform better with ICT tutorials. Interventions using both T1-Blaboard; and T2-mobile instant messaging facilitated improved academic participation. Possible reasons for this enhanced performance could be associated to Ward and James' (2015) claims that instructional participation leads to improved motivation and thought processing resulting in the acquisition and creation of significant knowledge; and skills that includes better knowledge of course content; and greater critical thinking skills. These findings are consistent with literature, which suggests that, instructional ICT strategies that support student-centred tutoring approaches diminish the formality of the learning experience (Hrastinski, Edman, Andersson, Kawnine, & Soames, 2014; Kadirire, 2007). Consequently, these instructional methods encourage interaction among unwilling students resulting in the development of self-confidence and learning outcomes (Kadirire, 2007).

Another finding of this study is that novice SQL programmers perform better with (T1) Blackboard tutorial compared to (T2) mobile instant messaging instructional platform. This phenomenon could be a result of lack of usability guidelines associated with emerging technologies like mobile instant messaging for instructional purposes (Dubey, Gulati, & Rana, 2012; Wiredu, 2014), unlike the provision of eLearning through a learner management system which is well researched (García-Peñalvo, Conde, Alier, & Casany, 2011; Sun, Tsai, Finger, Chen, & Yeh, 2008).

6 Implications of the study

The outcomes from this research highlight that application of ICT tutorial tools contribute significantly to student performance. Therefore, university stakeholders like lecturers and administrative management should advocate for more use of ICT tutorial tools that promote student participation. To this end, HE stakeholders should discourage traditional instructional participation activities such as classroom hand raising (particularly in South African classrooms). Secondly, study findings suggest that potential of mobile instant messaging to support South African HE learning outcomes despite the limited time these technologies have been in use. The HE stakeholders must promote awareness of these technologies and their potential in promoting students' performance.

7 Conclusion

Overall, ICT tutorial strategies examined in this 2x2 quasi-experimental design were effective in improving knowledge acquisition in database systems at a South African university of technology. Although, a learner management system has proved to have more positive knowledge acquisition effects than m-learning using mobile instant messaging; researchers should develop frameworks that should guide usage of mobile instant messaging for South African HE learning purposes. Data analysis was conducted using the Quest estimate, which assessed the extent to which the data fits the Rasch model by ensuring that the test-items stay within the 'threshold range' of 0.77 and 1.33. The 'unidimensionality' of test-items was achieved by repeatedly applying Quest estimate to data until the final set of test-items satisfied the requirements of the Rasch IRT model. This study adopts the instructional pedagogies developed by Bagley (1990) that were extended by McKay (2000); as such, they were converted for use as the ICT tutorial strategies

8 References

Adams, R., & Khoo, S. (1996). Quest: The Interactive Test Analysis System.

Bagley, C. A. (1990). *Structured versus discovery instructional formats for improving concept acquisition by domain-experienced and domain-novice adult learners*. Unpublished PhD's thesis, University of Minnesota, Minnesota.

Council on Higher Education. (2013). *A proposal for undergraduate curriculum reform in South Africa: The case for a flexible curriculum structure*. Retrieved from Pretoria:

Department of Higher Education and Training. (2013). *White paper for post-school education and training: Building and expanded, effective and integrated post-school system*. Retrieved from Pretoria:

Dubey, S. K., Gulati, A., & Rana, A. (2012). Integrated Model for Software Usability. *International Journal on Computer Science and Engineering, 4*(3), 429-437.
Gagné, Briggs, L. J., & Wager, W. (1992). *Principles of instructional design* (4th ed.): Holt, Rinehart & Winston.
Gagné, R. (1985). *The Conditions of Learning and Theory of Instruction* New York, NY: Holt, Rinehart and Winston.
García-Peñalvo, F. J., Conde, M. Á., Alier, M., & Casany, M. J. (2011). Opening learning management systems to personal learning environments. *Journal of Universal Computer Science, 17*(9), 1222-1240.
Harrington, J. L. (2016). *Relational database design and implementation*: Morgan Kaufmann.
Hrastinski, S., Edman, A., Andersson, F., Kawnine, T., & Soames, C.-A. (2014). Informal math coaching by instant messaging: Two case studies of how university students coach K-12 students. *Interactive Learning Environments, 22*(1), 84-96.
Jonassen, D. H. (1997). Instructional design models for well-structured and III-structured problem-solving learning outcomes. *Educational Technology Research and Development, 45*(1), 65-94.
Kadirire, J. (2007). Instant messaging for creating interactive and collaborative m-learning environments. *The International Review of Research in Open and Distributed Learning, 8*(2).
Kreie, J., & Hashemi, S. (2012). Microsoft Enterprise Consortium: A Resource for Teaching Data Warehouse, Business Intelligence and Database Management Systems. *Information Systems Education Journal, 10*(6), 84.
Lotriet, H. H., Matthee, M., & Alexander, P. (2010). Challenges in ascertaining ICT skills requirements in South Africa. *South African Computer Journal, 2010*(46), 38-48.
McKay, E. (2000). *Instructional strategies integrating cognitive style construct: A meta-knowledge processing model.*, Deakin University, Victoria.
Melton, J. (1996). Sql language summary. *ACM Computing Surveys (CSUR), 28*(1), 141-143.
Merrill, M. D. (2001). Components of instruction toward a theoretical tool for instructional design. *Instructional Science, 29*(4-5), 291-310.
Mills, R. J. (2017). Using Analogical Problem Construction As An Advance Organizer To Teach Advanced Database (SQL) Nomenclature. *Review of Business Information Systems (RBIS), 21*(1), 1-8.
Morabito, V. (2015). *Big data and analytics: strategic and organizational impacts*: Springer.
Murire, O. T., & Cilliers, L. (2017). Social media adoption among lecturers at a traditional university in Eastern Cape Province of South Africa. *SA Journal of Information Management, 19*(1), 6 pages.
Olsen, D. H., & Dupin-Bryant, P. A. (2016). Integrating Data Cleansing With Popular Culture: A Novel SQL Character Data Tutorial. *The Review of Business Information Systems (Online), 20*(1), 13.
Rawlings, N. (2014). The History of NOMAD: A Fourth Generation Language. *IEEE Annals of the History of Computing, 36*(1), 30-38.
Soflano, M., Connolly, T. M., & Hainey, T. (2015). An application of adaptive games-based learning based on learning style to teach SQL. *Computers & Education, 86*, 192-211.
Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*(4), 1183-1202.
TechRepublic. (2002). Is SQL a legitimate programming language? *Data management*. Retrieved fromhttp://www.techrepublic.com/article/is-sql-a-legitimate-programming-language/
Ward, T. J., & James, K. L. (2015). Student Participation and Performance in a Graduate Accounting Theory Class. *Academy of Educational Leadership Journal, 19*(2), 143.
Wiredu, G. O. (2014). *Mobile Computer Usability An Organizational Personality Perspective*: Springer Heidelberg New York Dordrecht London.