RESEARCH TITLE

Statistics education for a developmental economy: The development of a coherent reasoning and thinking intervention

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ABSTRACT

South Africa implemented a new curriculum in secondary schools known as Curriculum and Assessment Policy Statement (CAPS) which was examined for the first time in November 2014 (DoBE, 2011). This curriculum includes new topics in statistics and probability. The emerging importance of statistical knowledge has led to statistics being introduced into school curricula internationally. South Africa, recognising this importance, has also introduced statistics into the secondary school system. The aim of this research is to examine areas of concern in the development of statistical knowledge as students move through the secondary school education system, concentrating on grades 10 to 12.

The introduction of new and unfamiliar topics in a curriculum is often accompanied by a variety of challenges. The challenges that most schools face, in South Africa and internationally, is providing teachers who can effectively teach for the development of statistical understanding, rather than merely doing some calculations.

The purpose of this study is to identify the cognitive levels of statistical knowledge that students attain as they progress through the secondary school system, and then develop a teaching framework to help teachers approach the teaching of statistics in a manner that would enhance statistical reasoning and thinking.

A mixed methods methodology was used in this research. Data were collected in two stages. The first stage involved quantitative data collection. Three written assessment instruments (one each for Grades 10, 11 and 12) were developed, checked for reliability and administered to about 400 learners. The objectives of these instruments were to establish concepts and skills that learners had successfully mastered, concepts that they had been unsuccessful in and concepts that they had failed to apply successfully.

Data analysis was done, and 13 students were selected for interviews, representing the second stage of data collection. The interviews provided qualitative data for the study. Deeper insight into students' understanding and misconceptions was obtained during the interviews.

The overall findings from Grade 10 to Grade 12 reveal that most students managed to achieve statistical knowledge at the basic level of statistical literacy. This cognitive level does not equip learners with tools to reason and think statistically. The results also revealed that learners used formulae to learn statistics, without understanding their foundation. In most cases students have achieved at this level by simply demonstrating their ability to use calculators and/or some given formula to determine statistical values. Most students have not yet successfully achieved at the level of statistical reasoning and statistical thinking. The results also indicate that students do not have a coherent and connected knowledge of statistical concepts. Students lack knowledge of the relationship between statistical concepts. The statistical skills and concepts learned are all isolated from one another.

Modern technology makes calculations instant and more accurate, minimising the importance of the ability to perform manual calculations. This implies that the focus on statistical knowledge should be on reasoning and thinking. From these results, it is recommended that statistics teaching that enhances development of reasoning and thinking needs to include the importance of context, computing, comparing, contrasting and connection between statistical concepts.

The limitations of the study were that the findings of the study could have been influenced by the cross-sectional studies approach that was applied to the study rather than longitudinal studies. A further limitation was that the choice of the participating schools could have had an influence on the results of the study. Schools were selected due to their proximity to the researcher in order to make access to the students during the school day possible for both the researcher and the students. The schools were limited to schools in the Johannesburg area. The proximity to Johannesburg could also have influenced the level of teachers' statistical content and pedagogical knowledge. This would then have had an impact on the level of statistical knowledge attained by students.

The value of this study is multi-faceted. Theoretically, this research can therefore contribute to theories of teaching and learning statistics. The results of the study can pinpoint the areas that need more attention in teaching and learning statistics. Of special note in the findings of this research is that the concepts of standard deviation, graph interpretations and grouped data are a cause for concern. The findings also indicate that students have acquired statistical concepts in isolation from each other. These results can be used to structure alternative and appropriate interventions in statistics pedagogy that would be more effective in enhancing the learning of statistics to the expected cognitive levels.

The value from a methodological perspective is that methodology and the research instrument of this research study could also be used by many educational institutions to assess teachers' statistical content as well as pedagogical knowledge as they progress through the training process. Knowledge of teachers' level of cognition can assist the specialist training personnel plan effective intervention programmes for the trainees, so that after training they are better equipped for effective teaching of statistics in their classrooms.

The practical significance is that the study provided the necessary information about the concepts that students struggle with in understanding as well as in application. The study also provided deeper insights into why students have difficulties in understanding and applying particular concepts.

Another immediate practical result of the research findings is the formulation of a teaching framework

that can be used by teachers to help them plan lessons that develop understanding of statistical concepts and the required statistical cognitive levels. The findings of this study were used to design a framework consisting of five components. The 5C-PST framework was created to move statistics learning from statistics literacy to statistics reasoning and statistics thinking. The 5C-PST framework is founded on the basis that the use of these five components will provide teachers with a focus on teaching strategies that will promote understanding of statistical concepts. The framework is designed to also help inexperienced teachers understand statistics deeply and flexibly so that they, in turn, can help their students relate ideas in statistics and form cognitive maps of statistics.

Keywords: statistical cognitive levels, statistical literacy, statistical reasoning, statistical thinking, statistics pedagogy

The full thesis can be found at http://www.openthesis.org/documents/Statistics-education-South-Africa-literacy-603373.html