Using TPACK framework to Examine Economics Teachers' Integration of Technology in the Teaching of Market Dynamics.

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ABSTRACT

Integrating technology in South African educational settings like many other countries has enhanced the teaching and learning of different topics in different subjects. In Economics Education, however, integrating technology in the teaching of Market Dynamics (MD) graphs has received little attention. Learners find it challenging to understand MD graphs, hence the need to examine how economics teachers use key skills regarding technology usage in teaching MD graphs. While technology per se may not necessarily transform the teaching of MD, a good understanding of the theoretical framework behind technology integration is necessary. Technological Pedagogical Content Knowledge framework (TPACK) is used as a framework to examine Economics teachers' integration of technology in the teaching of MD graphs. This case study used a purposeful sample of three 10th, 11th, and 12th economics teachers. Data were collected through a semi-structured interview and analysed thematically. Findings drawn from the case of the three economics teachers in South Africa suggest that, to a certain extent, economics teachers integrate technology in the teaching of MD graphs. Another finding showed that economics teachers' integration of technology had not improved learners' understanding of MD graphs. The study recommends that technology should be integrated into the school curriculum.

Keywords: Economics teachers, graphs, technology Integration, TPACK, Market Dynamics

INTRODUCTION

Integrating technology in South African educational settings like many other countries has enhanced the teaching and learning of different topics in different subjects. The South African government implemented an e-education policy goal in 2004 (Department of Basic Education RSA [DBE], 2004), which signalled the initial policy directive to integrate ICT into South African schools. The e-policy, as stipulated in the Department of Education's draft white paper on e-education, reads thus:

> Every South African manager, teacher, and learner in the general and further education and training bands will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need as lifelong learners to achieve personal goals and to be full participants in the global community) by 2013. (DBE, 2004, p. 17)

This implies that integrating technology in teaching and learning in South Africa's educational system has been a feature for a long time. Indeed, integrating technology into the teaching and learning process in South Africa is unavoidable in this modern age. The value of integrating new technologies in the South African educational field to support teaching and learning outcomes in different subjects is well recognised.

As the need for the use of technology increases, the issue of how teachers in South Africa effectively integrate Information Communication Technology (ICT) into teaching and learning practices becomes critical. Technology integration in the context of this study refers to ICT integration. We define ICT as those technologies that focus on communication technologies that provide information through telecommunication. These technologies include media, the Internet, cell phones, smart boards, projectors in classrooms, laptops for teachers and tablets for learners, and other modes of communication.

The Gauteng Department of Education has argued that the installation of ICT tools will help in effective teaching of difficult topics in every subject. However, the researcher argues from the perspective of economics teaching that mere technology per se may not necessarily translate into effective teaching of topics such as MD graphs. Instead, examining and understanding teachers' ability and skills to use technology to teach MD graphs is paramount.

Considerable research (Jackson, 2017; Ogundana, Ibidunni & Jinadu, 2015; Mailiza & Fan, 2020; Rienties & Townsend 2012) has proven that teachers' ICT integration has improved learners' understanding in many subjects. However, there is still a significant research gap to be filled with ICT integration in economics education. Learners find the topic of MD challenging, specifically MD graphs. There is limited knowledge about how economics teachers integrate ICT to support the teaching and learning of MD graphs. It, therefore, becomes critical to investigate further how economics teachers integrate technology into the teaching of Market Dynamics graphs and how this integration influences teaching and learning. This study aims to examine economics teachers' technology integration (ICT) in teaching Market Dynamics graphs.

In other countries, research studies (Baser, Kopcha, & Ozden, 2015; Billici, Gazey, Yamak, 2016; Karakaya, 2017; Kartal & Afacan, 2017; Tunjera & Chigona, 2020) proved that teachers' integration of technology in teaching different topics enhanced students' understanding of the subjects. Some studies have used Technological Pedagogical Content Knowledge (TPACK) as a framework to investigate teachers' integration of technology. For example, Henriques and Gutierrez-Fallas (2017) examined potential teachers' beliefs and TPACK for teaching statistics and found that the integration of technology can provide useful information about learners' understanding of statistics. Kim (2018) investigated the relationships between TPACK and pre-service teachers' belief in the teaching of mathematics and found that pre-service teachers that had student-centred beliefs about technology use, learning, and the nature of mathematics displayed a higher level of mathematical knowledge than those with teacher-centred beliefs and technology use.

Nordin, Davis, and Ariffin (2013) and Williams (2017) investigated how teachers keep up with new technologies. Their findings indicated that teachers keep up with new technologies and that improve learners' understanding of topics being taught. Other research findings (Gon & Rawekar, 2017; Nyika & Ogbonnaya, 2016; Ogbonnaya, 2019) showed that using technology such as WhatsApp was a helpful technology widely used by teachers to enhance teaching and learning. Some studies have integrated different software in teaching and learning. For example, Henriques and Gutierrez-Fallas (2017) and Ogbonnaya and Mushipe (2020) integrated technological software such as GeoGebra, Excel, and Clickers in the

teaching and learning of graphs and found that it enhanced learners' ability to draw graphs.

Using technology in teaching some aspects of economics has received attention in the literature. The nature of these technological platforms may differ. For instance, social media appeal to learners because of their social and interactive ways of life, which catalyse engagement and familiarity. Research has proven that such technology has contributed immensely to improving teaching and learning in some aspects of economics topics. Al-Bahrani, Patel and Sheridan (2015) recommend that social media platforms like Twitter, Facebook and Instagram could be used to share economics ideas and deliver economics lectures to students and learners.

Some economics apps have also emerged that help to improve the teaching and learning of economics. However, the strategic selection of an app that engages students is important. Cochran, Velikova, Childs and Simmons (2015) concur with the importance of using economics apps and maintain that bringing apps into the classroom capture and sustain student interest. Cochran et al. (2015) argued that apps provide students with learning on demand that is unbound by the time and space constraints of the traditional classroom environment. Such apps (simulations, study aids, events, calculators, feedback, quizzes, data, etc.) capture and sustain learners' interest and help learners retain learning as they play with them (Cochran et al., 2015). Other innovative strategies that have been developed to improve the teaching and learning of economics include Blogs and Wikis. Recent additions have been a website, Starting point, teaching and learning economics providing teaching material for economics (https://serc.carleton.edu/econ/index.html), and ComLabGames learning game theory. These technologies are active learning methods that help learners in constructing their knowledge (http://www.cmu.edu/comlabgames).

Despite extended research on technology integration to improve the teaching and learning of economics, teachers' integration of technology in teaching economics tools has received little or no attention. This is principally true for such a challenging topic as MD graphs. This study acknowledges that there might be other intermediate factors that may not directly link to technology and the use thereof contributing to learners' poor understanding of MD graphs. However, our focus is on one of the factors, teachers' knowledge of technology integration in MD graphs. One closely related study on the integration of technology in economics education was conducted by Talreja (2018), who developed the TPACK instructional module for preservice economics teachers, but his study did not focus on MD graphs

Research Purpose

This study used TPACK framework to examine economics teachers' integration of technology in teaching Market Dynamics graphs.

Research Questions

The research questions addressed in this study are:

1 To what extent do economics teachers integrate technology in the teaching of Market Dynamics graphs?
2 Does economics teachers' technology integration improve learners' understanding of Market Dynamics graphs?

Technological Pedagogical and Content Knowledge (TPACK)

Teachers' knowledge required to incorporate technology into teaching has

been a concern for teacher educators and a focus of extensive research. Researchers and educators have proven that effective technology integration in teaching involves teachers' knowledge of technology, content, pedagogy and their intersection (Koehler, Mishra, Kereluik, Shin, & Graham, 2014; Koh, Chai, Tay, 2014; Mishra & Koehler, 2009). Mishra and Koehler (2006) assert that the problem associated with technology "*has been a tendency to only look at the technology and not how it is used"*. They (2006) emphasised that ICT integration does not always translate into effective teaching and learning as it sometimes may not happen at all, it may happen too slowly or may happen without affecting teachers' or students' learning. Researchers argue that technology integration into education should be studied through a theoretical lens. This study does so by applying the theoretical lens of Technology Pedagogical Content Knowledge (TPACK) by Mishra and Koehler (2006).

Building upon Shulman's (1987) Pedagogical Content Knowledge (PCK, which he described as an intersection of content and pedagogy, Mishra and Koehler (2006) developed a Technological Pedagogical and Content Knowledge (TPACK) as a framework for understanding teachers' knowledge. In its synthesised form, TPACK represents a new paradigm of knowledge required for the successful pedagogical integration of ICT (Mishra & Koehler, 2006).

TPACK consists of three central elements of teachers' knowledge: Technological knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The model is equally composed of four compound elements intersecting among the body of knowledge; Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK) (Koehler et al., 2014). According to Debbagh and Jones (2015), TPACK is a transformation of PCK as it illustrates the combination of subject and topic specifics activities with technology to facilitate learners' understanding, see Figure 1.

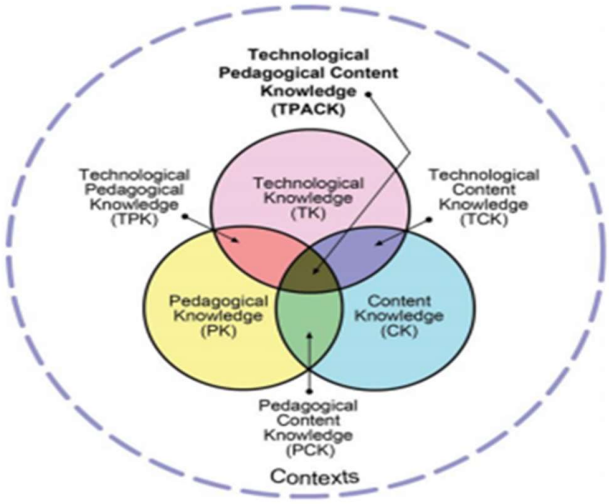


Figure 1: TPACK Framework by Koehler and Mishra (2009).

Mishra and Koehler (2006) defined Technology Knowledge (TK) as knowledge of basic and more advanced technology tools for teaching. It involves knowledge of operating systems and using software tools such as emails and word processors. TK also includes knowledge of staying up to date with the changing technologies and of installing and upgrading software and hardware (Rahmadi, Hayati & Nursyifa, 2020). Pedagogical Knowledge (PK) was defined by Mishra and Koehler (2006) as the processes and practices of learning which involve classroom management, learners' evaluation, teaching strategies, methods and techniques and development of a lesson plan and its

implementation. They also defined CK as knowledge of central facts, theories, concepts and procedures of the subject matter to be learned or taught. PCK involves the kind of instructional strategy to be employed for each discipline. In other words, it involved how best to facilitate learners' learning process using the most effective teaching strategy. TCK indicates the application of technology in teaching a specific topic or subject matter (Henriques & Gutierrez-Fallas, 2017). TCK involves teachers' knowledge of the specific technology being used for specific content or specific subject matter. Technological Pedagogical Knowledge (TPK) refers to how teaching and learning change with the application of technology. This involves knowledge of limitations and affordances of the technology to be used and the context of the discipline in which it could be applied.

Technological Pedagogical and Content Knowledge (TPACK) is the intersection of these three elements: PCK, TCK and TPK, and these elements' interaction with one another. The interaction explains what makes a topic difficult or easy to teach or learn. The interaction helps to understand learners' prior knowledge, provides knowledge of the curriculum and an understanding of how examples, analogies, or activities are used to represent concepts in a specific topic. These elements also explain knowledge of which technology must be used and how it could be used to facilitate learners' understanding. According to Işik and Yılmaz (2012), technology such as computer-assisted teaching and training has affected learners' economics learning abilities. Therefore, the TPACK framework is in line with technology for economics teaching; and integrating TPACK into the teaching of graphs in the topic of Market Dynamics becomes necessary.

Technology Integration

In this context, technology integration refers to the integration of ICT. Generally, in the educational setting, ICT integration means a technology-based teaching and learning process closely related to utilising learning technologies in school (Ghavifekr & Wan Athirah, 2015' Ratheeswari, 2018). The need for ICT integration in schools, specifically for teachers and students, cannot be overemphasised, especially as a pedagogical tool for teaching and learning. From the teachers' perspective, ICT is not a replacement for quality teachers but is a complementary tool needed for better teaching and learning (Ghavifekr & Wan Athirah, 2015). ICT helps teachers alternate teaching methods with the use of different ICT tools. For example, using videos, databases, simulations, the World Wide Web, WhatsApp, Microsoft PowerPoint, etc., makes teaching and learning fulfilling. Teachers, however, need sufficient ICT skills to implement the technology and enough confidence to use ICT in a classroom setting (Ghavifekr & Wan Athirah, 2015). In designing lesson plans, teachers use ICT to make a particular subject interesting (Arumugam, 2013). Conversely, ICT helps students stimulate their understanding of the subject by using hands-on activities in a technology-based course. Grimus (2000) showed that students with a good understanding of ICT skills rather than just the usual traditional teaching method find it easier to face challenges associated with teaching with slides and videos.

Other researchers have advocated the integration of ICT in teaching and learning. For example, Viberg, Grönlund and Andersson (2020) concluded in their studies that teachers must engage more with and work much more on technology integration. When teachers do not use the tool actively,

they do not fully understand how students can learn from them.

In addition, Nowfeek, Farwis and Nowzath (2021) investigated the contribution of integrated ICT in teaching and learning practice and found that teachers reported that students could easily report content using ICT as it uses concrete and real-world examples that are easily identified by students. Their study concluded by suggesting that more focus should be placed towards building pedagogical skills connected to ICT during teacher training for more effective practice of ICT in the classroom.

Teachers' knowledge of Technology

Teacher knowledge of technology in the form of ICT is generally assumed to play an important role in affecting students' learning in technology. Earlier research conducted by Hennessy, Ruthven and Brindle (2005) on teachers' knowledge of ICT in Canada showed that some teachers were reluctant to use ICT because they were worried, they might get embarrassed as they believed students knew more about the technology than they did. Other researchers (Debbagh & Jones, 2018; Owusu, Lindsey & Chris, 2015) have conducted studies on teachers' ICT knowledge and have proved that teachers' knowledge of ICT plays a significant role in integrating technology in the classroom settings. One study by Ghavifekr, Athirah and Rosdy (2015) pointed out that teachers need sufficient ICT skills to implement the technology and a high confidence level to use the technology in a classroom. A study by Rohaan, Taconis and Jochems (2012) reported that teachers need to be more confident in the use of technology, and more positive attitudes are expected from teachers to increase the frequency of technology use in their schools. Winzenried, Dalgarno and Tinkler (2010) found that teachers who have gone through ICT courses are more effective in teaching with technological tools than those with no experience in such training. Other studies (Agyei & Voogt, 2011; Namome & Moodley, 2021; Stoilescu, 2015) have also reported that teachers lack sufficient knowledge about ICT and its use in teaching.

Research Studies on the use of Graphs

This study focuses on one economic concept: Market Dynamics (MD), one of the fundamental aspects of microeconomics. MD remains one of the key elements used in modelling essentially all economic theories. It consists of general knowledge of "Demand and Supply", which is a well-known economics term used by the general public in everyday economic activities. Demand and supply are mostly illustrated using graphical representations. Graphs are a common method to illustrate data relationships visually; thus, MD graphs are used to present data that are too numerous or complicated to be described adequately when explaining the concept of Market Dynamics. MD graphs are used to represent relationships between quantities and to represent market forces. They are used in modelling information such as economic knowledge, economic growth, statistical information, etc. For example, most media data in the 4th industrial revolution are presented in graphs such that it requires good graphical knowledge to interpret most of the statistical information. Hence, understanding MD graphs is important because they provide daily information about the economic situation and fluctuations in market structures (inflation, price changes, unemployment rates), etc. Furthermore, economics analyses are usually represented by the use of graphs. MD graphs help learners in critical thinking, such as identifying and interpreting graphical information, decoding and encoding to interpret information, analysing information and evaluation of evidence, and making

arguments. It could also be used in two or three-dimensional space to represent relationships between two variables or among three variables.

In teaching and learning, MD graphs represent economics concepts such as movement along the demand curve, a shift of the demand curve, movement along the supply curve, shift of the supply curve, equilibrium price, etc. These aspects of MD graphs tend to pose a challenge to many learners. Strong evidence in the literature proves that MD graphs are challenging to learners. Besides, understanding the nature of the difficulties associated specifically with MD graphs as opposed to the general nature of graphs as data representation tools is crucial.

As far back as the 90s, research into understanding MD graphs had begun. Strober, Cook, and Fuller (1997, as cited in Fong 2016) found that in the graphical analysis of a simple Demand and Supply (DD-SS) problem, students mistakenly assume that economics graphs were like mathematics graphs. This adversely affected their interpretations of measurement and directional terms like "increase" and "decrease" or "up" and "down." Fong (2016) also observed that students found economics courses more difficult than other subjects because of the extensive use of graphs in economic analysis. Glazer (2011) identified graphic interpretation competence in a science class and found that reading and making sense of graphs is hard, and learners experience significant difficulties associated with given tasks. Similarly, in understanding MD graphs, Albert, Arnold & Maier-Rigaud (2012) pointed at the tautology and interpretational problem with MD graphs, the so-called "ceteris paribus" (all other things being equal) problem associated with the graphical representation of demand and supply curves, that poses a severe limitation on a type of Market Dynamics.

Arsaythamby and Julinamary (2015) also commented on the similarities and differences found in graphs between economics and mathematics subjects and suggested that attention should be given to studying graphs in both subjects. Arsaythamby and Julinamary (2015) pointed out that while using symbols and graphs in mathematics and economics have some related features, there are also differences. The assumption for a non-economics specialist is that the MD graph should be based on the same principles as mathematical graphs. For example, supply and demand graphs cannot be equated with the graphs of other mathematical functions because the dependent variables in mathematics are on the vertical axis, while in the demand and supply diagram, the dependent variable is on the vertical axis. Furthermore, while economics requires the ability of the learner to decode and encode to interpret information, mathematics requires decoding, the interpretation of graphs of mathematical statements and encoding, and the translation of mathematical statements to graphs.

A study conducted by Pérez-Echeverría, Postigo and Marín (2018), using two groups of psychology students and economics students to demonstrate their graphical representation and interpretation of a report, showed that both groups of students had difficulty in interpreting the graphs of the report. Perez-Echeverria et al. (2018) also reported that mistakes were made in students' understanding of important aspects of the graphs. Cohn, Cohn, Balch and Bradley (2001) experimented to determine whether student performance in the principles of an economics course is affected by the use of graphs as part of a lecture. Students were assigned to either a non-graph lecture or a lecture with graphs. Their study found that

students in the lecture with graphs had significantly lower scores than those in the no-graphs lecture though this finding could also be explained by other factors such as the use of technology and the likes.

Market Dynamics Graph in SA curriculum

In South Africa, MD graphs are formally taught in the Further Education and Training (FET) phase (grades 10-12), according to the economics Curriculum and Assessment Policy Statement (CAPS). MD graphs are strongly represented in the CAPS curriculum. Understanding MD graphs is critical in understanding the MD topic as a whole. A scan through the FET CAPS curriculum shows that graphical representation is generally central in teaching economics. In the CAPS curriculum, it was stated in the Grade 10 curriculum, for example, that a teacher is expected to *"Explain the market as a phenomenon and make use of graphs to illustrate the establishment of prices and quantities"* (Department of Basic Education, 2011). This instruction requires the economics teacher to demonstrate competence in teaching basic concepts of MD and to analyse the market dynamics represented in graphical forms using technology.

The Diagnostic report for the Matriculation examination question analysis showed that learners had not performed well on questions related to MD graphs in Microeconomics Paper-2 over the years (DBE, 2020). Some extracts from the 2019 diagnostic reports are as follow:

"Graphs should already have been discussed in the necessary detail in Grades 10 and 11 to ensure a full understanding thereof in Grade 12" (DBE, 2020. p. 82).

"Graphs in Microeconomics always appear to be a challenge as questions relating to graphs are either avoided or answered poorly" (DBE, 2020. p. 83)

"Over the years there has been an improvement in the writing of essays, but the 8-mark higher-order questions and the drawing of graphs still present a challenge to learners" (DBE, 2020, p. 81).

"In Section C, Q5, which was based on graphs was the worst-performing question with a 30% average" (DBE, 2020, p. 93)

"Candidates performed poorly on questions related to microeconomics… the supply curve is not covered explicitly in the content but rather the demand curve" (DBE, 2020, p. 95).

The above reports from the Department of Basic Education report analysis (2020) proved strongly that learners have underperformed in MD graphs in the matriculation examination over the years.

The issues associated with learners' understanding of MD graphs can be multifaceted, e.g., the inability of students to deal with multimodal representations of information; the text-centrism of teaching economics etc. Another possible reason for learners' challenge in understanding MD graphs could be teachers' inability to integrate technology into the teaching of MD graphs. To support learners' understanding of MD graphs, many researchers advocate the integration of technology in teaching those economics concepts that require the use of technology. Hence, this study looks at teachers' knowledge of technology in teaching MD graphs.

METHODOLOGY

A qualitative case study was used to examine economics teachers' integration of TPACK in the teaching of MD graphs. A case study helps to accurately identify, describe and examine each economics teacher

thoroughly within the TPACK framework. The case study approach was chosen to gain an in-depth understanding of how the three participant teachers demonstrated their use of TSPCK in teaching MD graphs, thus presenting a description of each case within the context (Rahman, 2017).

Three female economics teachers were selected using a purposive sampling technique for the research. The choice of female teachers was not intentional; instead, it was due to the criteria and procedure adopted for selection. These criteria were: the teachers should possess at least five years of teaching experience in economics at secondary school level and must have at least tertiary education qualification in economics. The teachers' names were replaced with pseudonyms such as Joy, Edith and Agnes. These teachers respectively taught Grade 10, 11 and 12 in three secondary schools in the Tshwane North District of South Africa.

Being a case study of three female teachers, the researcher is aware of the limitations of case studies, which could affect this study. The results from this study may not be generalised and transferable (Rule & John, 2011) to other economics teachers in the Tshwane North District of South Africa or all economics teachers generally.

This research used a semi-structured interview protocol as an instrument for data collection. The researcher constructed the interview protocol, and it was validated by some experts in economics to check if critical questions that cover the topic of the research study were asked. All questions covered the TPACK components (TPK, TCK, TPCK, CK, PCK, and TCK) in the teaching of MD graphs.

Data were collected using a semi-structured interview. Consent forms were given to each participating teacher to obtain their consent to participate in the research. The teachers gave consent of their willingness and availability to participate in the research. The three participating economics teachers were interviewed at the school premises at times convenient to them after school hours. Each participant's interview was audio-taped.

After the interview process, all audio recordings of the three participant teachers were separated and transcribed verbatim by the researcher. Member checking was adopted after the data was transcribed. Interview data were analysed thematically. The thematic analysis followed the process steps recommended by Creswell et al. (2016) for a case study: (1) An "initial coding'' or "open coding" process whereby the researcher retrieves all data and text that show commonalities to group them in thematic ideas. (2) "Axial coding", which entailed putting data in new ways, making explicit connections between categories and searching for relationships and patterns. (3) "Selective coding", involving selecting and identifying the core category, contrasting and comparing categories. (4) Making sense of the data is the last step in the process of data analysis. It involves interpreting and presenting data and abstracting the findings from the categories. The analyses of the interview were done according to the themes derived from the seven categories of TPACK: TPK, TCK, TPCK, CK, PCK, TCK, and TPCK.

A letter of approval was first obtained from Tshwane University of Technology, South Africa. The letter consisted of approved letters obtained from the research committee of the university and the Department of Education (GDE) in the province. A consent letter informing the participant teachers that they would be interviewed and that the interview would not take more than an hour was noted. They were also informed that participation was

voluntary. The purpose of the research was as well explained to the participants, and assurance of anonymity and confidentiality were provided.

RESULTS

The findings from the interview were reported based on six TPACK categories: TK, TPK, CK, PK, PCK, and TCK, to understand how economics teachers integrate technology into the teaching of graphs in market dynamics.

Technological Knowledge (TK)

For an economics teacher to integrate technology in the teaching of graphs in MD, it is assumed that the understanding of basic computer technology is one of the pre-requirements. Economics teachers' TPACK was analysed under the category of TK, and the following themes emerged: keeping with new technologies, learning platforms and knowledge of Excel.

The teachers were asked how conversant they were in keeping up with new technologies. Joy's and Edith's responses showed that they were conversant in keeping up with new technologies. They commented as follows:

> *Joy: "I like technology-related things and I am always on the lookout for new technologie*s.".
>
> *Edith: "yes, I do keep up with new technologies for knowledge's sake even though it's something not so much demanding from the department."*

Another finding of this study showed that all the teachers were good at using WhatsApp as a learning platform. The teachers commented as follows:

> *Joy: "WhatsApp is a common learning platform for teaching…I use it always."*
>
> *Edith: "I made sure all my learners have WhatsApp … so, we all communicate and share ideas."*
>
> *Agnes: Among other technologies, it seems I only understand WhatsApp very well … I*
>
> *see that the use of WhatsApp as a learning platform is effective for me."*

When the teachers were asked to identify the software tool that they were familiar with in teaching MD, all the teachers mentioned Microsoft Excel as a technology tool. The teachers (Joy and Edith) further explained that because they have a fair knowledge of Microsoft Excel and access to the software, they could teach MD graphs with Microsoft Excel if they were permitted to use it. Their responses were contrary to Agnes, who did not have good knowledge of Microsoft Excel. Although Joy and Edith expressed fair knowledge of Microsoft Excel, they admitted insufficient knowledge to use Excel to teach MD graphs in the classroom. According to them, they have low confidence in using Excel as a technological tool because they have not used it in the classroom before. The teachers, however, indicated their eagerness to use excel to improve their teaching of MD graphs in the future when the opportunity allows.

On using digital media as a learning platform, the teachers were more familiar with Facebook (social media) and WhatsApp (instant messaging tools) regardless of other instant messaging tools such as WeChat, LINE, Viber, Telegram, IMO, etc. As a result, WhatsApp is accepted as the technology in this context. Teachers use WhatsApp to discuss graphical content with their learners but admitted that WhatsApp is limited in drawing graphs. Instead, they posted YouTube videos to learners via WhatsApp.

Joy: "I noticed that learners like belonging to a particular WhatsApp study group, so I download some stuff, even YouTube videos that I feel are important in this topic and send it through the group WhatsApp group."

Edith: "WhatsApp makes it easier for me to communicate the content of MD to learners. I remember once sending to learners a video on how to use Excel to draw the demand and supply curves, although it is recommended in the curriculum."

Agnes: "I created a WhatsApp group, and all my learners belong to that group. I send assignments via WhatsApp ...so, it [WhatsApp] has been a useful technological tool for teaching MD."

In conclusion, our findings show that teachers' knowledge of technology is most pronounced in their knowledge of Excel and WhatsApp for communication. WhatsApp was seen to facilitate synchronous communication between the teachers and the students and among students.

Content Knowledge (CK)

CK examines teachers' knowledge of MD concepts and their ability to use graphs to represent those concepts. The themes that emerged under the category of content knowledge are Knowledge of the key market dynamics concept "Price equilibrium" and Excel software.

The teachers were asked about the technology tool that could illustrate the concept of price equilibrium. All the teachers tried to avoid the question but rather used an analogy to explain the concept of price equilibrium. In their explanations, Joy and Agnes displayed adequate content knowledge of price equilibrium in MD and could represent it graphically. They could also explain this concept using a real-life analogy, but Edith could not find a good life example to explain the concept.

> Joy used a *seesaw* as an analogy to explain the concept of price equilibrium. She said: *Assuming see-saw is a technological tool ... Price equilibrium is likened to children of the same weight sitting at the opposite edges of a seesaw while making sure the distance from the fulcrum is the same, the see-saw will remain at the state of equilibrium.* (Joy)

Agnes also mentioned a balanced scale with equal weights as an analogy to describe the concept of price equilibrium. On the other hand, Edith could not find a specific analogy to describe the concept of price equilibrium and said*, "it is not easy to find an analogy to describe some of the concepts in Market Dynamics because they are abstract in nature".*

The teachers were also asked to explain how to plot a demand and supply graph given a data set using any software of their choice. This task was given to understand economics teachers' knowledge of what they knew about the use of any of the software in teaching graphs in MD. All the teachers opted to explain how to plot the demand and supply graph in MD using Excel software.

In their words:

> *The first thing I do is to open a new Excel spreadsheet and enter the data; three rows: Price (P), Quantity demanded (Qd) and Quantity supplied (Qs). After entering the data, I go to the Insert tab, then to the 'chart tab' and then to 'scatter'. I go to the icon for 'scatter' with straight lines, there the graph of the usual demand and supply curve will appear. Noticing that the price values are shown on*

the x-axis by default, my problem is how to change the price value to the y-axis. (Joy)

Edith commented**: "***On the Excel sheet, the given data are entered. I still remember you go to insert and chart group and choose straight line charts. You will see that the graph is plotted. Umm, I have forgotten what follows".*

Agnes added: *"I have to enter the data first in Excel, which I know for sure and begin to do all the manipulations that follow…(laughing). Honestly, I don't know it very well."*

Joy, to an extent, showed good knowledge of how to plot a demand and supply graph in an Excel spreadsheet given a set of data. Joy described the steps of plotting a graph to the point of changing the price values to the y-axis and noticed that the price is on the X-axis by default instead of at the Y-axis. However, she could not proceed from there. Edith attempted to enter the data into the excel spreadsheet and plotted the data given but could not go further. Agnes could go no further than knowing that the data would be entered in the Excel spreadsheet. Agnes displayed knowledge of using Excel to teach MD graphs at a complete novice level. This finding suggests that teachers need to be encouraged to use technology to teach in the classroom, and that has to start by first integrating technology into the curriculum.

Pedagogical Knowledge (PK)

PK in this context refers to teachers' teaching strategies and procedures for teaching MD. The following themes emerged under the PK category: *Lecture method* and *Freehand sketch*. The teachers were asked about the technology teaching strategies they use in teaching MD graphs. The finding shows that all the teachers predominantly use the "lecture method" to teach MD graphs. Teachers feel they adopted lecture methods because it is the most effective method for learners to understand the topic as they claim the topic is dry and needs to be demonstrated. Besides, the teachers said it is one of the methods stipulated in the curriculum.

The following were their responses:

Joy: "Because learners struggle to understand graphs in MD, other methods that I have tried seeming not to have worked…so, I prefer lecture method…combined with YouTube videos via WhatsApp".

Edith: for me, I use lecture method…it seems to be the most effective so far though

sometimes in the class, I display with a projector a lesson from the Internet on how DD and SS could be drawn using excel … I equally send some YouTube videos via WhatsApp … but Ummm … I would like to try other methods in the future to improve my teaching strategies.

Agnes commented: *"I only use the lecture method if learners have to understand this topic."*

While Agnes uses the lecture method only, Joy and Edith supplement their lecture method teaching strategy with YouTube videos. With the use of YouTube videos, both teachers said that they perceive learners come to study graphs in MD with differing pre-conceptions and misconceptions brought from other subjects, making the topic difficult to learn. Agnes also admitted that she understands common learners' pre-conceptions and misconceptions about MD graphs.

Another finding from this study showed that all the teachers prefer to use freehand sketches to draw MD graphs. When asked about the use of Excel, which they have

a fair knowledge of, the teachers responded that the curriculum did not support its use in the classroom, and they lack the confidence to use it to teach in the classroom. They commented as follows:

> *Joy: "You know these learners' learn these technologies more than us (teachers) ... Umm [Laughing], I wouldn't even want to embarrass myself, I use a freehand sketch."*
>
> *Edith: "Although these learners struggle to draw these graphs with a freehand sketch, I bet you if you introduce technology they will do it better….they understand this technology very fast…"*
>
> *Agnes: "I prefer to use a freehand sketch to draw the graphs when teaching MD because it is easier for me to use in the class."*

Teachers' pedagogical knowledge when teaching MD graphs was mostly seen in their use of lecture methods supplemented with YouTube videos. Teachers also prefer to use a freehand sketch to draw MD graphs rather than Microsoft Excel. Teachers' lack of confidence could be said to be technological anxiety fuelled by a perceived lack of TK compared to that of learners.

Pedagogical Content Knowledge (PCK)

In this context, PCK is the knowledge of pedagogy for specific content and how the pedagogy of teaching MD connects to other related subjects. Two themes emerged from this category: Connecting MD graphs within and outside field topics and solving problems in MD graphs.

Teachers were asked to explain the best way learners learn to solve problems related to MD graphs. All the teachers described the teaching procedures for drawing the graphs. Joy said: *"You have to look at the problem given first to determine how the graph will look like, then you make connections between the data given and the graph to be drawn."* Joy saw learners solving MD graph problems as a process that had to be done repeatedly before they could solve it. Edith believes learners learn how to solve MD graphical problems by understanding how the teacher solved similar graph problems. On the other hand, Agnes believes that learners learn how to solve MD graphical problems by trial and error because each problem has a different approach.

Teachers were asked how they draw connections of MD graphs to other topics within the subject of economics. The teachers all admitted that although MD graphs are linked to other graphs in other topics in the same subject, graphs in MD require specific pedagogical knowledge for learners to understand the topic. The teachers also indicated that it is challenging to connect MD graphs to other graphs in other fields because MD graphs are different from graphs in other subjects like mathematics:

> *Joy: "For example, I really need to explain to the learners why supply and demand graphs should not be equated with the graphs of mathematical functions."*
>
> *Edith: It is difficult for learners to understand that the dependent variable in mathematics is on the vertical axis while in the demand and supply diagram, the dependent variable is on the vertical axis.*
>
> *Agnes: You know, a novice teacher may think all graphs are drawn the same way…the Demand and Supply graphs are not the same as that of mathematics.*

Although all the teachers had the same answer on connecting MD graphs to other graphs in other subjects, they all had divergent views on them within topics in the same subject. Joy said: "*sometimes it does not apply though it depends on the topic at hand.* "Agnes added, *"Yes, in some cases, I recall the MD graph when teaching other topics.* Agnes added, *"somehow, all the topics are connected to one another".*

In this context, economics' teachers' pedagogical content knowledge of MD graphs was demonstrated in their ability to connect MD graphs within and outside field topics and solve problems in MD graphs.

Technological Content Knowledge (TCK)

TCK is knowledge of the interaction between technology and content in the teaching and learning environment in this context. Internet usage emerged as a theme in this category.

The findings of this study show that all the participating teachers acknowledged the use of the Internet as learning resources required for searching how to teach MD graphs. All the teachers admitted that although they improve their teaching of MD graphs using the Internet, drawing the MD graphs with computer technologies is still a challenge. Joy said she understands how to draw MD graphs using computer technologies but indicated that she needs more skill to improve her performance. Joy and Edith, in particular, stressed that the use of the Internet gives them more understanding about how to draw graphs in MD using Excel and helps them to work faster when drawing a freehand sketch. Agnes said that although she uses the Internet to enhance her content knowledge about MD, she does not have much to do with the Internet and drawing MD graphs. According to Agnes, learning to draw graphs with the Internet consumes her time since she will not use it to teach in the classroom. Agnes sees internet usage as a tool to help improve her lesson notes and perhaps her content knowledge of MD but not for MD graphs.

Technological Pedagogical Knowledge (TPK)

TPK in this context is the interaction between technology and pedagogy in the teaching and learning environment. Technology integration with teaching strategies and specific technology emerged as themes. When the teachers were asked for the most appropriate technology to be integrated with their teaching strategy to teach MD graphs, the teachers were unsure of the most appropriate technology to be integrated with the teaching strategies they were currently using to teach MD graphs. They did not know other technologies or software to use in teaching MD. The teachers commented:

Joy: If we are permitted to use excel to teach graphs in MD, the lecture method the teaching strategy we are used to will no longer be appropriate to use…Umm, so it is a challenge."

Edith: Like I said before, Umm, a specific technology will surely go for a specific teaching strategy because graphs in MD are also specific, for now, I don't know any."

Agnes: "I really cannot say of the most appropriate technology I can integrate with my teaching strategy for now, maybe in the future."

The teachers also admitted that they were all thinking of how technology could influence their strategy for teaching graphs in MD. They also concurred that they were thinking critically of specific technology to use in teaching graphs in MD. When the teachers were asked to define what they meant, they showed inadequate knowledge to

elaborate on what they were referring to as specific technology.

DISCUSSION

This study used the TPACK framework to examine technology Integration in the teaching of MD Graphs. Addressing the first research question, which seeks to understand the extent to which economics teachers integrate technology in the teaching of MD graphs, the researcher looked into teachers' technology integration concerning teachers' responses to four specific TPACK components: Technological Knowledge, Content Knowledge, Technological Pedagogical Knowledge (TPK) and Pedagogical Knowledge.

The findings from this study showed that the teachers integrate technology into the teaching of MD graphs to a certain extent. Except for Agnes who did not keep abreast of new technologies, the other economics teachers did keep up with new technologies and also showed a willingness to use technology to teach MD if the curriculum permits it. This finding is in line with the findings of Nordin et al. (2013) that pre-service teachers can keep up with the important new technologies and can learn to use new software easily but contrary to the findings of Erişti, Kurt & Dindar (2012) and Williams (2017) who found that teachers do not keep up with new technologies.

Another finding from this study was that all the teachers were good at internet usage and WhatsApp as a learning platform. Although the teachers admitted that WhatsApp was useful for teachers to communicate the graphical content of MD to learners via YouTube videos, WhatsApp's functionality is limited as demand and supply graphs cannot be drawn using WhatsApp. The result corroborates with previous studies (Gon & Rawekar, 2017; Nyika & Ogbonnaya, 2016; Ogbonnaya, 2019) that found that the teachers derive advantages from the use of WhatsApp in teaching and learning. According to Mistar and Embi (2016), when WhatsApp is implemented in academics, it increases students' motivation to learn, and they perform better. Besides, a more engaging environment is created using WhatsApp (Abaido & El-Messiry, 2016).

Another finding was that the teachers used the lecture method and freehand sketch in teaching MD graphs. Although the teachers argued that lack of pressure from the department to adopt technology in teaching MD graphs poses a challenge, teachers were not enthusiastic about using technology such as Excel to teach MD graphs due to a lack of confidence. The teachers commented that learners master these technologies faster than they (the teachers) did. This implies that teachers are threatened by their lack of skills and confidence in using technology to teach MD graphs. One of the teachers said, *"I wouldn't even want to embarrass myself. I use a freehand sketch."* This finding is in line with that of Morris (2010), who suggested that the continuing professional development needs of teachers in the use of technology will benefit more if the learning community is configured in such a way that learners are teachers and teachers become learners. However, he considered that while learners will gladly embrace this kind of role, teachers will resist it because they feel threatened as they lack confidence in using technology.

The second research question that seeks to understand if economics teachers' integration of technology improved learners' understanding of MD graphs was addressed regarding the other three TPACK components: Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) and Technological Knowledge (TK).

One of the findings showed that teachers were most familiar with Excel

software; however, their choices of Excel seemed to be related to accessibility and availability and not necessarily based on the idea of using it to teach graphs in MD. It suggests that the choice the teachers made in selecting Excel software exhibited variability in the extent of curriculum prescriptions and instructional strategies, and therefore they did not express any conscious choice for the technology being used in teaching graphs. This finding is in line with that of Henriques and Gutierrez-Fallas (2017), who found that prospective teachers use Excel because of the teachers' ability to use the software and the limitations they expect to face while using other technologies in the classroom rather than because Excel has the potentials to help understand the content.

Except for Edith, our findings showed that the teachers displayed adequate content knowledge of MD. However, it seems unclear how the teachers could integrate their knowledge of MD content with technology. This finding is similar to Sampaio and Coutinho (2013), who found that the effective integration of technology into lessons is complex as it should focus on the technology or content itself and the interactions of the three components rather than just on the pedagogy.

Another finding on teachers' content knowledge showed that except for Agnes, the teachers could explain how to plot a demand and supply graph in Excel software to an extent but have not used it in the classroom for teaching. The teachers express that most of their learners use technology better than they do and could plot the demand and supply graphs with Excel if asked to study material on it. The finding corresponds to that of Erişti et al. (2012), who found that students tend to be more familiar than the teachers with the use of technology tools.

The study found that economics teachers mostly practice learner-centred teaching using a freehand sketch to draw MD graphs. This finding shows that since the teachers were not permitted to use software technology such as excel where learners could be allowed to participate and do it by themselves, teachers are only left with the option of using a freehand sketch to draw MD graphs. If the teachers were permitted to teach MD with the Excel software, they might not have preferred to use a freehand sketch to teach MD graphs. Henriques and Gutierrez-Fallas (2017) also found that teachers prefer using a freehand sketch when elaborating on graphs rather than using the provided software though they claimed that they use technology to support whole-class discussion after teaching. Again, a freehand sketch always involves a teacher-centred approach as the lecture method.

Lecture methods have been criticised in many ways, including encouraging passive learning since it is a one-way teaching method. Lecture methods do not encourage learners to reason fast and engage in discussions and interactions, although most researchers' views are contrary to this assertion. Marmah (2014) found that students preferred the lecture method and concluded that the lecture method would continue to be the dominant teaching method since students believe that they pay fees to be taught and not for them to go and look for information on their own. However, the choice of the best teaching strategy between teacher-centred and learner-centred instructional practices remains controversial. According to Walstad and Watts (2015), no one instructional practice has been proven more effective than others when teaching economics topics. The finding is also in line with Becker and Watt (2001) and Van Wyk (2015), who proved that the teaching of economics has remained dominated by the traditional use of "chalk-and-talk" lecture methods over the past two decades and the majority of teachers are stuck on these methods.

The study finding that it is challenging to connect graphs in MD to other graphs in other subjects like mathematics is in line with the finding of Cook and Fuller (1997, as cited in Fong 2016), who argued that teachers ought to help learners to understand that the dependent variables in mathematics are on the vertical axis while in the demand and supply diagram, the dependent variable is on the vertical axis. The finding is also in line with that of Arsaythamby and Julinamary (2015), who commented that symbols and graphs in mathematics and economics have some related features. This study also found that economics teachers were all thinking of how technology could influence the strategy for teaching graphs in MD; however, they were unsure of the most appropriate technology to use in teaching MD. This finding simply shows that technology has not been properly integrated into the teaching of learning of MD in South Africa.

Another finding from this study shows that the teachers use the Internet as a learning resource for improving their content knowledge in MD graphs but not necessarily for the teaching of MD graphs. The results correspond with Chirwa (2018), who found that the majority of the teachers used the Internet for academic purposes.

Finally, the implications of the findings show that economics teachers in South Africa need to be equipped with ICT knowledge. Again, economics teachers should be provided with ICT training on the use of graphs to teach Market Dynamics. These teachers need to connect pedagogy to the economics content of ICT integration.

CONCLUSION

In conclusion, the study results reveal that there is still a disparity in economics teachers' integration of technology in the teaching of MD graphs. This study showed that, to a lesser extent, the economics teachers integrate technology in the teaching of graphs in MD. WhatsApp seems to be the technological tool the teachers themselves mainly engage in the teaching of MD graphs. Although the teachers are aware of Excel as technological software that could be used in the teaching of MD graphs, Excel software has not been approved in the school curriculum to be used in the teaching of MD graphs. The findings also show that the teachers were unsure of any other technology they could use to teach graphs in MD and therefore are still thinking of how technology could influence the teaching strategy they use for teaching graphs in MD.

Economics teachers use the Internet to improve their content knowledge of graphs in MD. They also use YouTube videos via WhatsApp to communicate with learners on the said topic; however, the teachers admitted that WhatsApp does not allow them to draw MD graphs. Consequently, rather than using a freehand sketch in drawing graphs in MD, the teachers would have preferred using technology like Excel, which they were familiar with, to teach MD graphs. It could be said that economics teachers' integration of technology has not improved the teaching of MD graphs.

Although the TPACK framework guided the effective integration of technology in teaching MD graphs, the implementation of the seven TPACK components remains a complex process. This integration needs teachers' time and practice to learn how to use technology to transform the teaching of graphs in MD and other specific topics in economics. Therefore, the Department of Education should look critically at how technology integration into the curriculum could prepare economics teachers to establish pedagogical connections between the affordances of technology and the teaching of MD graphs. They should redesign the curriculum with technology integration.

The results of this study will help economics teachers to reflect on their extent of technological know-how because we are now in the 4th industrial revolution that requires technology integration in every sphere of life and therefore makes a demand of technology integration in teaching topics that need to be taught with technology.

This study raises concern that in future studies, rather than interviewing teachers, practically observing the teachers teaching MD graphs will enhance effective integration of technology in the teaching of MD.

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