Research Article https://doi.org/10.12973/eu-jer.13.3.1247

European Journal of Educational Research
Volume 13, Issue 3, 1247 - 1262.
ISSN: 2165-8714
http://www.eu-jer.com/

Teachers' Topic-Specific Pedagogical Content Knowledge: A Driver in Understanding Graphs in Dynamics of Market

Ijeoma C. Ogbonnaya*
University of the Free State, SOUTH AFRICA

Received: August 27, 2023 ▪ Revised: November 15, 2023 ▪ Accepted: February 7, 2024

Abstract: Understanding graphs in the dynamics of market (DM) is a challenge to learners; its teaching demands a specific kind of teacher's knowledge. This study aims to examine the topic-specific pedagogical content knowledge (TSPCK) of experienced economics teachers in teaching graphs in DM to enhance learners' understanding of the topic. It reports using a qualitative approach underpinned by the TSPCK framework for teaching specific topics developed by Mavhunga. Data were collected through classroom observations and analyzed thematically using a case study of two economics teachers. The study revealed that adopting a step-by-step approach and the use of worked graphical examples promote an understanding of graphs in DM. It also established that active learning is preferable to the predominant chalk-and-talk (lecture) method of teaching graphs in DM. The study proposed a Dynamics of Market Graphical Framework (DMG-Framework) to enable teachers, particularly pre-service teachers in lesson delivery, to enhance learners' understanding of graphs in DM. The result of this study will broaden the international view in the teaching of graphs in DM.

Keywords: *Dynamics of market, economics teachers, graphs, topic-specific pedagogical content knowledge.*

To cite this article: Ogbonnaya, I. C. (2024). Teachers' topic-specific pedagogical content knowledge: A driver in understanding graphs in dynamics of market. *European Journal of Educational Research*, *13*(3), 1247-1262. https://doi.org/10.12973/eu-jer.13.3.1247

Introduction

Despite considerable research in science education (Aydin et al., 2014; Rollnick & Mavhunga, 2016) that modelled teachers' topic-specific pedagogical content knowledge (TSPCK) in enhancing learners' understanding of specific topics, its implementation in the teaching of specific topics in economics education has not been well investigated. TSPCK focuses on transforming teachers' comprehension of content that translates into how a teacher teaches a particular topic (Mavhunga, 2012).

Research in economics education (Mukeredzi, 2017; Mukeredzi et al., 2015; Thorsen, 2016) has generally focused on comparing economics teachers with novice teachers, mentoring experiences, and professional teachers' identity on subject-specific and domain-specific topics for pre-service economics teachers' development. These studies could not address the problem of learners' challenges in understanding specific topics, such as dynamics of market in economics education.

Dynamics of market (DM) is a specific topic in economics education that includes graphs as one aspect of the topic. However, learners experience challenges understanding graphs in DM. This could imply that teaching graphs requires a specific kind of teacher's knowledge. Malyshkin (2016) describes DM as a disbalance of demand and supply that is typically considered the driving force of the markets. Hence, the concepts that quickly come to mind in DM are demand and supply, equilibrium prices and all the fluctuations in the market structure.

In the school context, DM is a specific topic in economics education that has been of interest to various stakeholders across the globe, including South Africa (Khoo & Fitzgerald, 2017; Manzi et al., 2021). The interest is based on the premise that the topic comprises a wide range of graphical concepts such as equilibrium price, the demand and supply graphs, the interactions of the demand and supply, etc., which requires some sort of critical thinking and analytical skills that hold a crucial role in understanding all the elements of the dynamics of market structure, thus making the topic very popular though challenging for learners (Ayers, 2015; Burdina & Sauerb, 2015).

* **Correspondence:**
Ijeoma C. Ogbonnaya, University of the Free State, South Africa. ✉ OgbonnayaICE@ufs.ac.za

Research (Alacacı et al., 2011; González et al., 2011; Ozmen et al., 2020) emphasizes that graphs are powerful tools that help learners present complex data to make it concise, precise, and easy to interpret. Knowledge of a graph is the ability to determine the type of graph appropriate for the context, the ability to read, interpret, compare, create, and evaluate the graphs and to comment on the changes regarding data in the graph (Bursal & Polat, 2020; Gan et al., 2010). Although learners need to acquire graphical skills and the ability to execute them, literature shows that they experience various difficulties (Güven et al., 2015; Hafiyusholeh et al., 2018). Considering teachers' roles in helping learners overcome the difficulties posed by understanding graphs, teachers' topic-specific PCK must be modelled for this purpose. As such, the integration of graphs into the school curriculum and its teaching should be paramount in the educational curricula.

In the South African curricula, graphs are one of the important concepts in the teaching of the topic "Dynamics of Market' (DM). Dynamics of Market is positioned in Term 2 curricula in all the Further Education and Training (FET) Bands. The FET levels consist of Grade 10 to Grade 12, while Grade 12 is the exit level that writes the final Matric exams. A cursory check shows that DM occupies topical positions in the school economics curriculum in most volumes. As important as the topic is in the curriculum, learners have not performed well in the topic over the years in the final exit exams. For example, the Diagnostic Reports from the Senior Certificate Reports by the Department of Basic Education (DBE) show that learners have performed poorly in the areas of graphs in DM. It was reported that "candidates found it difficult to relate the impact of one variable to another" (DBE, 2021). Further reports express concern over learners' poor graphical interpretation and drawing skills "Teachers should equip learners with interpretation skills whilst taking them through the steps of drawing graphs … Learners still lack the skill of interpreting graphs they have drawn" (DBE, 2022, p. 83). From the foregoing, it is evident that learners still struggle to get a grip on graphs in DM in the South African context.

Globally, the report is not different. Ayers (2015) reported that "teachers needed to expose students multiple times to the supply and demand content … because their students often considered the content dry and overly mathematical". Likewise, other economists (Mankiw, 2015; Zuidhof, 2014) argue that although students tend not to understand economics models, understanding the 'demand and supply' model is necessary because it is an economic reasoning tool that enables economics students to "think like an economist".

Given the above overview, it can be deduced that learners' challenges in understanding DM are not a uniquely South African problem but a global one. As such, scholars (Burdina & Sauerb, 2015; Khoo & Fitzgerald, 2017; Manzi et al., 2021; Ng & Chan, 2014; Ogbonnaya, 2023; Zhang, 2017) have argued and presented evidence that learners' challenges in understanding DM, especially the aspect of graphs, is because learners lack critical skills developed in economics. This paper argues that there is a gap in the literature which fails to account for the Topic Specific Pedagogical Content Knowledge (TSPCK) required by experienced economics teachers to teach the topic to improve learners' understanding. This argument is foregrounded by researchers such as Loughran et al. (2012), who contend that there is a dearth of research providing actual classroom practices in teaching specific topics that improve learners' understanding. Thus, this paper seeks to investigate the TSPCK kind of knowledge required from experienced economics teachers to teach graphs in the dynamics of market.

The research question posed to address the problem of this study is: How do economics teachers' TSPCK manifestations improve learners' understanding of graphs in Dynamics of Market?

Literature Review

This section discusses the literature review of this study. The theoretical framework on which this study is underpinned is first presented and then followed by the scientific literature.

Topic-Specific Pedagogical Content Knowledge (TSPCK)

Topic Specific Pedagogical Content Knowledge (TSPCK), developed by Mavhunga (2012), is a Pedagogical Content Knowledge (PCK) construct from Shulman's (1987) model. The TSPCK is teachers' knowledge needed to transform the content of a particular topic into teachable form using pedagogical reasoning (Loughran, 2019; Mavhunga, 2012; Rollnick et al., 2017). Although PCK has been widely used in education research to understand teachers' knowledge, it is generic and has not helped enough to identify the observed competency specific to each topic. Unlike the PCK model, TSPCK is associated with reasoning through a particular topic and focuses on the transformation of the understanding of the content of a particular topic (Rollnick & Mavhunga, 2016). Given the critical role that TSPCK plays in understanding specific topics, this study argues that teaching is complex and that teachers require not only the knowledge domain advocated by Shulman but a topic-specific type of knowledge for a specific topic like Dynamics of Market.

Mavhunga's (2012) TSPCK is a transformative model divided into five domains, as shown in Figure 1. Curricular saliency is the teachers' ability to analyze and organize a topic to plan for teaching; representations are unique ways of representing subject matter with examples, illustrations, analogies, simulations, diagrams, tables, and models specific to a topic; conceptual teaching strategies are defined as effective instructional strategies for particular misconceptions, for known areas of difficulty to learn, and for known importance of concepts; Content knowledge, which Mahvunga prefers to call 'what is difficult to teach', is the knowledge of understanding of difficult concepts in a specific topic while

knowledge of students is the ability to identify and have an understanding of students (learners) misconceptions or preconceptions in a specific topic. However, this study focuses on these last two knowledge domains.

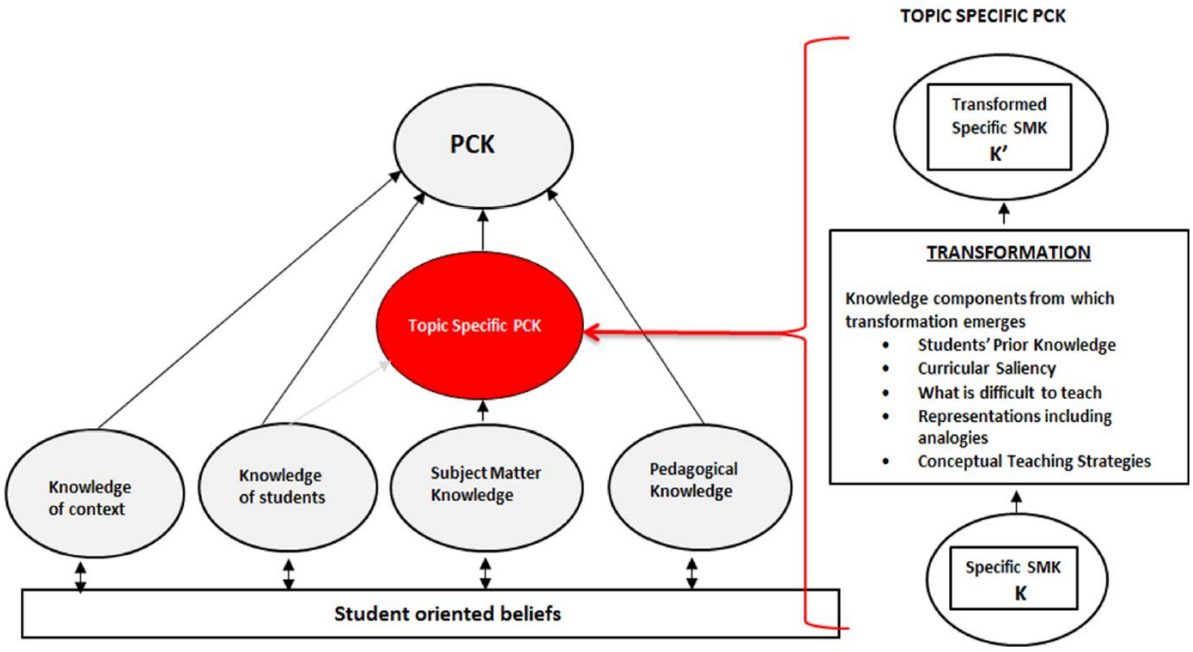

Figure 1. Topic-Specific Pedagogical Content Knowledge (TSPCK) Content Knowledge (CK): Common Content Knowledge (CCK) (Mavhunga, 2012)

Common content knowledge (CCK), according to Ball et al. (2008), is the knowledge of the subject known and common to most educated adults and to others who know and use the subject. In the context of this study, we go along with Balls' definition of CCK, which also includes teachers' knowledge of the basic concepts of graphs in Dynamics of Market presumed to be known by learners.

Some studies have investigated the CCK of teachers in specific topics. For example, Van Steenbrugge et al. (2014) found that not all teachers are competent in their basic knowledge of the concepts in some specific topics and that the limitations found in teachers' CCK may not help to predict success in teaching the topic in their future profession. Ndlovu et al. (2017) found that pre-service teachers are incompetent concerning their CCK in correcting learners' errors and misconceptions in school mathematical concepts.

In trying to understand why most teachers' CCK tend to be low, Bansilal et al. (2015) explored the CCK of mathematics high school teachers and found that the teachers' CCK were low due to low engagement with the concepts of the topic. Shongwe (2022) compared the CCK of two groups of pre-service teachers on the concept of spatial visualization and found that the CCK of one of the groups was thin, indicating that misconceptions hindered the performance of the group. A study by Rahman et al. (2022) emphasized the need for teachers to use their CCK to make connections across fields and to the everyday lives of students. The study indicated that such practice has significant positive effects on students' learning.

Content Knowledge (CK): Specialized Content Knowledge (SCK)

Specialized Content Knowledge (SCK) is teachers' specific and detailed knowledge of the subject required to teach it (Ball et al., 2008; Chinnappan & White, 2015). In this context, the above SCK definition applies and includes the knowledge or ability to recognize and address specific errors or mistakes in the teaching of DM.

Although studies on SCK are limited in economics education, studies from other domains have proved that teachers' SCK enhances the understanding of specific topics; hence, we rely on literature from another subject domain.

Patahuddin and Lowrie (2019) examined teachers' ability to interpret line graphs and found that the teachers do not possess the SCK to answer high-level questions about interpreting the line graphs. In another study, Uyanik et al. (2023) investigated teachers' specialized knowledge in the evaluation of graphs and found that more than half of the teachers presented either incomplete or incorrect evaluations. Ozmen et al. (2020) found that students could not identify the incorrect graph types and the errors in the graph. They attributed it to teachers' inability to identify the correct graph types and errors. Similarly, Makar and Fielding-Wells' (2011) findings support those of Ozmen et al. (2020), who opine that teachers lack sufficient SCK of graphs. Bursal and Yetiş (2020) suggest student teachers have skills in reading graphs but have more difficulty in drawing and interpreting the graphs. Ndlovu et al.'s (2017) research findings revealed that

while the participants were competent solvers of school mathematics problems, they could not analyze and interpret learners' errors from graphs for diagnostic purposes.

Further studies (Güven et al., 2015; Hafiyusholeh et al., 2018) investigated students' difficulties in drawing graphs and concluded that teachers need specialized content knowledge to help students improve in creating graphs. Bolch and Jacobbe (2019) examined teachers' specialized knowledge in reading graphs and found that they were competent in reading graphs, and with their specialized knowledge, the students were able to read graphs. Studies by (Agustyaningrum et al., 2018; Diaz et al., 2020) attest that learners tend to show conceptual improvement reading graphs after a procedural approach is adopted by competent teachers with specialized knowledge. Contrary to these findings, Patahuddin and Lowrie (2019) found that teachers were found incompetent in reading graphs and reading beyond the data.

A study by Ghanaguru et al. (2013) that links theory and practice among teachers found that the planning and execution of lessons provided an assessment level for teachers' specific knowledge. Chinn and Brewer (2001) and Glazer (2011) also found that teachers often provide interpretations and explanations for the data that contradict the theories.

Some studies have also examined the SCK of pre-service teachers in other topics. For example, Arnal-Palacián and Claros-Mellado (2022) examined the SCK of pre-service teachers on the infinite limit of a sequence and found that the teachers do not have adequate SCK of the topic, which defect will undoubtedly be transmitted to their students. In their study, Özel et al. (2022) examined pre-service teachers' SCK and found that most pre-service teachers showed specialized knowledge on the topic. Ding (2016) found that pre-service teachers' SCK helped them generate abstract number sentences but could not reason about the contexts of word problems. While Zembat and Bayram (2019) modelled mathematics teachers' ways of operating with an SCK and found that their SCK necessitates a special kind of questions linked to the required mathematical knowledge, Khoule et al. (2017) proved that conceptual understanding of such questions decreases learners' anxiety and increase their performance.

Musliha et al. (2021), on the other hand, found that the test questions created by the teachers lacked Higher Order Thinking-type of questions, which demonstrates inadequate teacher's SCK. However, Sekwena (2023) argues that teachers' SCK develops from their knowledge of active learning strategies, which help their students respond better to higher-order thinking questions than the more unconventional pedagogy in Economics teaching. Teachers must make use of a variety of strategies if meaningful learning is to take place.

Knowledge of Learners: Knowledge of Learners' Misconceptions (KOLM)

Teachers' Knowledge of learners is discussed with respect to teachers' knowledge of learners' misconceptions. Teachers' understanding of learners' misconceptions is a crucial element of a teacher's skill (Keller et al., 2017). Misconceptions are described as misunderstandings and misinterpretations based on incorrect meanings caused by 'naive theories' that hinder rational reasoning of learners. Misconceptions are tough and resistant and are difficult to replace with new knowledge (Ojose, 2015).

As part of the early work in this body of knowledge, Sadler et al. (2013) held the belief that students cannot correct their misconceptions on their own and that even with a solid subject matter knowledge of the teacher, only students whose teachers know student misconceptions can do so. Ní Shúilleabháin (2015) supported this assertion by emphasizing the importance of lesson plans. According to Ní Shúilleabháin, planning serves as a mechanism for checking teachers' effectiveness and competencies during lesson delivery. Moreover, Asikhia (2010) confirms this assertion by affirming the importance of lesson plans and argues that poor academic achievement in economics is partly attributable to the ill-preparedness of teachers.

Some studies have adopted a variety of strategies to tackle students' misconceptions. Scholars like Yong and Kee (2017) made use of concept cartoons. Heng and Karpudewan (2017) utilized cooperative learning; Ramnarain and Moosea (2017) used simulation, while Çalik et al. (2009) and Jonane (2015) used analogy activity. Earlier studies (Gudyanga & Madambi, 2014; Treagust et al., 2003) found that even with different strategies adopted, learners have misconceptions because teachers themselves have misconceptions, especially in cases where teachers present abstract concepts inappropriately. Other researchers (Ada & Kurtuluş, 2010; Karaoglan Yilmaz et al., 2018) found that the use of analogy supports learners' conceptual understanding and help learners understand the meaning. Thus, teachers should use visualization or analogy to help students understand the concepts.

A further review of literature shows that knowledge of learners' misconceptions helps to predict teachers' use of effective pedagogies. For example, Ramnarain and Moosea (2017) used simulation learning, while Riga et al. (2017) used enquiry-based learning and found that these teaching pedagogies decreased students' misconceptions. A study by Sadler et al. (2013) found that teachers who could identify learners' misconceptions had larger classroom gains, much larger than the teachers who knew only the correct answers. However, in another study, Chen et al. (2020) investigated whether teachers' knowledge of students' misconceptions of a concept is associated with students' performance and found that teachers' ability to predict students' misconceptions of an item results in better student performance.

Misconceptions can inhibit learning, which poses a serious problem to learners even in their daily lived experiences. Interactions with everyday life experiences, in the view of Agnes et al. (2015), if not checked, contribute to students'

misconceptions. Teachers should, therefore, understand some exposures to daily used concepts that could interfere with students' learning.

Methodology

Research Design

This study is located within an interpretive paradigm that helps understand the situation from the participants' perspective (Ary et al., 2010). A qualitative research approach was employed following a case study design that sought to explain how economics teachers' TSPCK enhanced the teaching of graphs in DM. A case study is used to manage the data effectively, while a qualitative approach is used since it involves social and human problems in a natural setting (Roller & Lavrakas, 2015).

Data Collection

The lesson observation for this study began with the researchers' initial two visits to the classroom to become familiarized with the teacher, learners, and classroom setting. The two lessons taught during these visits were outside the topic of the Dynamics of Market and, hence, were not video recorded. Actual lesson observations for the topic at hand was conducted over five weeks of the visit. In other words, the researchers' first two visits came before the teaching of the Dynamics of Market. The scheduling was done to take into account the note by Salazar Noguera (2018) that the presence of an observer in the classroom tended to influence the nature of lesson presentation, thus making it untypical of the teachers' usual teaching style. While Dynamics of Market as a topic was expected to be taught in under six weeks, including the test according to the school curriculum, the five weeks of lesson observations covered all sub-topics in Dynamics of Market, ensuring data collection adequacy. The last week of class test was not observed. The lessons were video recorded using a classroom observation protocol. The study adopted a non-participant observation technique, allowing the researcher to gain an in-depth understanding of the phenomena (Creswell, 2017).

Sample

Two teachers, one female and one male teacher, were purposely selected from a population of 36 economics teachers in the Tshwane North District, South Africa. While pseudonyms were used to represent the names of these two teachers, both teachers *(Mary & John)* hold a bachelor's degree (BSc) in economics education and had teaching experience of 15 and 18 years, respectively. In this study, we assume that experienced teachers are those who had teaching experience in the field of economics for at least ten years. These teachers were recommended by one of the staff members in the DBE based on the outstanding Matric results from the schools where they have taught for more than eight years. Purposeful sampling holds that the researcher desires to discover, understand, and gain insight into the phenomenon and from whom most could be learnt (Etikan et al., 2016). Both teachers use the same economics curriculum and syllabus coverage; they followed the same pace in teaching the topics in Term 2 for the 10^{th} graders. The two selected schools came from a population of 33 government schools that offer economics in Secondary schools in Northwest District in South Africa. These schools were selected due to their physical proximity and because the learners come from different socio-cultural backgrounds and races.

Data Analysis

Following a thematic data analysis procedure, the study was guided by the TSPCK framework. Two components from the TSPCK framework, content knowledge and knowledge of learners, guided the data analysis as themes emerged. Data analysis brought about themes related to TSPCK components discussed under two categories. Under Content Knowledge, we have the Specialized Content Knowledge (SCK) and Common Content Knowledge (CCK) and under Knowledge of Learners, we have the theme, Knowledge of Learners' Misconceptions (KOLM). Our results will later be presented under these emerging themes.

Trustworthiness

Being a qualitative study, trustworthiness was ensured in terms of credibility, dependability, transferability, and conformability. To ensure credibility in this study, prolonged engagement with the participants, well defined purposive sampling, detailed data collection methods and persistent observation, triangulation and member checking were established. Creswell (2017) contends that good recording and transcription of observations can improve dependability. Therefore, dependability in this study was ensured through the good recording of the lesson observations. The researcher was also careful to keep an audit trail by clearly describing the research process from the beginning of the research to reporting the results. While an economics specialist in a university ensured conformability in this study through a review of the study, Creswell asserts that rich and thick descriptions are used to obtain external validity (transferability) in qualitative research. The researcher ensured transferability by providing not only a thick description of the participants, the research design, the setting, and background information but also the study context to give clarity and meaning to the readers so they could make comparisons.

Ethical Clearance

Ethical clearance was obtained from the ethics committee of the University and the Department of Education in Gauteng Province. Permission was also sought from the principal of the school; learners were given consent forms and were assured of voluntary participation as the class was being observed.

Findings/Results

The findings from this study are discussed under the themes that emerged from our TSPCK constructs. Common Content Knowledge and Specialized Content Knowledge emerged as themes under Content Knowledge, while Teachers' Knowledge of learners' misconceptions is the theme that emerged under Knowledge of Learners.

Common Content Knowledge

We observed teachers' manifestation of their Common Content Knowledge (CCK) when teaching different aspects of graphs in Dynamics of Market. We found that while John believed that learners should have basic knowledge of graph terminologies such as 'cost' and 'revenue' from previous grades, Mary demonstrated that learners ought to have basic knowledge of concepts such as 'price', 'quantity', and 'profit and loss' to understand graphs in Dynamics of Market. Mary emphasized the different meanings of the concept of 'profit' and explained that though the concept of 'profit' is common knowledge, there is a difference between economic profits (normal profit, zero economic profit, accounting profits) and other forms of profit. Consequently, John emphasized the common errors learners make, which he termed 'common knowledge among learners' to assume the concept of zero economic profit to mean no profit. However, he explained to learners that the economics profit is the economics way of saying that the firm earns just a little profit that keeps it afloat in the business. These findings reveal that both teachers were certain of the basic knowledge and concepts learners ought to have been familiar with graphs and were able to point them out. According to the teachers, as common as these concepts seem to be, if neglected, they could hinder learners' understanding of the topic.

Another finding is learners' problem with the daily use and common knowledge of the commonly used terms in understanding graphs in DM. For example, 'demand' and 'supply'. Learners needed to differentiate between the supply that meant providing something that is needed from supply, which meant an amount of specific goods and services that are available in the market at a particular time. The latter is the definition of supply in economics. Both teachers knew that these terms are common knowledge to learners and, as the basic concepts in learning the Dynamics of Market, hinder learners' understanding. It was observed how both teachers differentiated these two economics concepts from the layman's understanding.

John commented: "while these concepts seem 'common' to you guys, I need to clearly differentiate these concepts from the usual demand and supply that you knew."

While the findings showed that both teachers possess the CCK skills to identify basic common terms in the dynamics of market that hinder learners from understanding the topic, we also found that while John was good at picking up common errors that learners make in understanding the topic, Mary provided enough explanations of the basic key concepts about Dynamics of Market that seem common to learners but could hinder the understanding of the topic. It is important to note that both skills improve learners' understanding of dynamics of market. As such, the application of CCK skills from both teachers was evident in learners' learning as they began to use economics terminology properly and could differentiate economics terms from daily common terms.

These findings show that Common Content Knowledge is the basis for teachers' Specialized Content Knowledge (SCK) to develop and that deepening teachers' SCK has the potential to extend their mastery of the topic.

Specialized Content Knowledge (SCK)

The findings in this study showed teachers' manifestations of Specialized Content Knowledge in the teaching of graphs in dynamics of market in different dimensions.

One of our findings was on drawing and reading the demand and supply curves. We found that both teachers mostly taught with worked examples and adopted a step-by-step approach to teaching, which they followed up with activities (Activity based learning). For example, Mary demonstrated a step-by-step procedure for drawing and reading the supply curve graphs on the chalkboard and emphasized the need for learners to master the procedure for the matric exams. She explained why the dependent variables in mathematics are on the vertical axis, while in the demand and supply diagram, the dependent variables are on the vertical axis. Mary gave the learners similar activities on drawing and reading and asked the learners to follow the same procedure. Our findings showed learners improvement in following the step-by-step procedures in subsequent activities that they carried out. It was observed that without the SCK of Mary, it wouldn't have been easy for a novice teacher to explain why supply and demand graphs should not be equated with the graphs of mathematical functions. It was also found that John followed a similar procedure, though it was more of a drill and practice in his case. His SCK of drawing graphs was also demonstrated by repeatedly interacting with the learners on the same drawing. We also found that John demonstrated competence in reading graphs, and he read even beyond the data.

This was evidenced when John transferred some data sets from the supply schedule to the supply curve and explained how the data reflected the law of supply.

We also found that Mary demonstrated her SCK in interpreting and analyzing the movement along the demand curve as drawn. Mary used the data from the demand schedule to draw the demand curve. She illustrated with emphasis on the given points A and B on the drawn graph.

Mary commented: "guys, note this arrow in a blue color, from point A to B on the same demand curve."

Mary employed a step-by-step approach as she interpreted and analyzed the graphs conceptually. For example, she told learners that the first step when drawing is to use 'dots' before connecting the points. We found that learners could absorb how MD graphs are drawn systematically, which was obvious as learners' anxiety in drawing MD graphs was reduced. We also found John manifesting his specialized content knowledge when interpreting and analyzing the negative slope of the demand curve. Learners queried the reason the demand curve has a negative slope as they could not relate it to the downward sloping of the demand curve. John explained the learners' question extensively, which a non-economist may not have been able to do in the manner he did. The explanation made by John showed his ability to transform the content knowledge he had on general knowledge of graphs into specialized content knowledge, which aligned to pedagogically powerful forms.

We also observed that John demonstrated competence in identifying the correct graph from the incorrect graphs drawn from the textbook. This was obvious when John evaluated a solved example from a textbook and noticed an error in the graph drawn. Without his specialized knowledge of graphs on the topic, such an error wouldn't have been noticed.

Another finding observed was on John's explanation of the ceteris paribus assumption. It was observed that it takes the specialized content knowledge of an economics teacher to explain the concept "all other things being equal." John used an analogy to illustrate this. John said, "a master's degree holder should earn more income than a high school certificate, all things being equal." He further explained that it means if no other factors affect the situation. After his explanation, it was observed that learners seemed to have a better understanding of the concept. Further findings show that Mary demonstrated her SCK with the use of analogies during their illustration of some difficult concepts. For example, Mary demonstrated her specialized knowledge using the 'Nike sign' as an analogy to explain the concept of marginal cost and a 'smiling face' to explain the concept of average cost. John likewise illustrated the price equilibrium using a 'sea-saw.'

Another finding was our observation of John's ability to link theory to practice. It was observed that even before learners came to class, they had already developed mental frameworks about how the world works, thus failing to relate theory to practice. Learners were unable to relate the law of demand to the real-life scenario. One of the learners challenged the theory of demand with a familiar and personal scenario and said, "As the prices of cars drop, the quantity demanded will not rise because his father just bought a new car". As this raised a debate in the classroom, John carefully explained to the learner that he failed to factor in the general market demand rather than only considering the household demand and family consumption behavior.

Another finding was that both teachers showed their SCK when asking learners questions. Both teachers predominantly used the SCK with a Higher Order level (HOL) of questioning. According to Bloom's taxonomy, the HOL of questioning requires critical thinking skills. For example, Mary has asked a few learners to come to the chalkboard to analyze a given graph about the economy of South Africa. Addressing these questions prompted active learning and participation in the class, as learners need to think critically about how the question relates to the country's economy. Our finding shows that learners found these questions challenging. However, Mary applied her SCK to teach learners how to address such analytical questions. On the other hand, it was observed that John had used a case study where he analyzed the demand for gas cylinders and candles due to the country's persistent power outages. Our finding shows that the two teachers employed different teaching strategies when the occasion demanded getting learners to understand graphs in Dynamics of Market.

To summarize this section, our findings indicate that both teachers demonstrated adequate procedural knowledge in teaching with worked examples and adopting a step-by-step approach to teaching. Both teachers also demonstrated the skills of predominantly asking higher-order levels (HOL) questions, according to Bloom's taxonomy. However, one unique skill that is evident in John was his ability to link theory to practice, while Mary had an exceptional skill of using analogy to explain difficult concepts to the learners. These skills have implications for the learners. It was found that learners showed better understanding when a step-by-step approach is used to teach the dynamics of the market, most particularly when treating higher-order level questions.

Teachers' Knowledge of Learners' Misconceptions

From the lessons observed, we found that both teachers had planned well in advance before the lessons, taking into cognizance any misconceptions that might arise during teaching and learning. For example, in their planning, we observed that the teachers had planned on the type of worked examples on graphs and the instructional methods and strategies to use. Our findings showed that the teachers could reflect on different teaching strategies to adopt while

teaching due to good planning. This was possible because the teachers were conversant with most of the misconceptions that learners bring to the classroom when learning graphs in Dynamics of Market.

We also found that learners tend to have misconceptions about the drawing and interpretation of graphs in DM. The main difficulties pointed out by both teachers were learners' misconceptions in the use of terminologies and similar concepts. For example, learners tend to understand 'changes in demand' to mean 'changes in quantity demanded'. It was found that learners generally have not developed adequate knowledge of those concepts. Both teachers demonstrated teachers' TSPCK as they engaged learners with deeper illustrations using different examples; more particularly, the teachers adopted an active learning strategy contrary to the conventional lecture approach in teaching economics. We found that the teachers could guide the learners when they invited them to the chalkboard to demonstrate the drawing of graphs. We found that the teachers had adequate knowledge of learners' learning difficulties and misconceptions in illustrations and drawing graphs.

We also found that learners tend to misconstrue the terminology that 'the demand curve slopes downwards from left to right' with shifting of the demand curve from left to right. The two sentences mean two different things. They also find it difficult to relate the negative slope of the demand curve to the inverse relationship between the price and quantity demanded.

Our findings showed that learners confused the functionality of the horizontal axis with that of the vertical axis, placing the 'Price (P)' on the 'X' axis of the graph and the 'Quantity (Q)' on the 'Y' axis of the graph. The teachers seem to have a pre-knowledge of these misconceptions as they could predict the misconceptions learners tended to have on DM graphs and emphasized the placement of the 'X' and 'Y' axes during their teaching.

In the drawing and interpretation of graphs in Dynamics of Market, we observed learners exhibit misconceptions about different aspects of graphs. For example, learners misunderstand the upward shift of the supply/demand curve in relation to the downward shift of the supply/demand curve. They construe the movement along the demand/supply curve as a shift of the demand/supply curve. The misunderstanding of the terminologies 'shift' and 'movement' was also found to pose a problem for learners to differentiate. The teacher (Mary) identified these misconceptions and explained that learners perceived shifts as up and down, rather than left and right. Another finding showed that learners tended to think that 'changes in demand/supply' mean the same as 'changes in quantity demanded/supplied'.

Amid all these misconceptions, both teachers demonstrated specific knowledge of the topic by clearing these misconceptions as they were able to identify these misconceptions and deal with them. Our findings showed that the two teachers had developed specific ways of ascertaining learners' misconceptions around the graphs in DM and could address these misconceptions using their TSPCK.

While we could identify similar skills possessed by both teachers, it is important to point out that John had an outstanding skill in using real-life examples to lessen learners' misconceptions. For example, he used the current economic situation in South Africa on the demand and supply of generators due to consistent load shedding. John used this scenario to explain learners' misconceptions about the theory and law of supply and demand. This was evident as learners could relate real-life examples to the economics way of reasoning. On the other hand, Mary was exceptionally good at asking learners to reflect on worked examples and to point out errors. This approach has helped learners better understand those areas where misconceptions are most likely to occur, thus finding ways to lessen them.

This finding suggests that teachers' knowledge of students' misunderstandings of certain concepts could be related to students' performance on the topic.

Discussion

The analyses of the results concerning economics teachers' Topic Specific Pedagogical Content Knowledge (TSPCK) by Mavhunga (2012) that framed our investigation led to the discussions under the following themes: Content knowledge (CK), specialized content knowledge (SCK). common content knowledge (CCK) and Knowledge of Learners' Misconceptions.

According to our findings, both teachers applied their common content knowledge (CCK) in facilitating learners' understanding of graphs in DM. This finding showed teachers' competence in their knowledge of common concepts in graphs. While our finding conforms with the findings of Ndlovu et al. (2017) that pre-service teachers were found competent with respect to their CCK, the finding contradicts the finding of Van Steenbrugge et al. (2014), who contend that most teachers are incompetent in their basic knowledge of common concepts in the topic they teach. Van Steenbrugge et al.'s (2014) findings further emphasize that the limitations found in their CCK may not predict success in teaching the topic.

Another interesting finding is that learners had problems differentiating between those economics concepts in graphs that look similar to the daily used concepts. However, the teachers were able to clarify the differences between these concepts to the learners. This finding suggests that both teachers could recognize the common concepts that look similar to learners' daily use and noted learners' incorrect use of those concepts. The possible reason teachers may assume these concepts are 'common' could be their familiarity with the concepts over the years, as they may have observed that

learners struggled with those concepts. Our finding resonates with that of Briand-Newman et al. (2012), where teachers identified the daily used concepts which seemed to be common knowledge to their learners and noted that the starting point for teaching a specific topic is to identify the CCK of the learners. The finding also concurs with that of Agnes et al. (2015), who found that interactions with environmental daily life experiences contribute to students' misconceptions. However, these findings are contrary to Bansilal et al. (2015), who explored teachers' CCK in some mathematical concepts and found that practicing teachers struggled with the common content they teach.

The result analyzed revealed that both teachers demonstrated SCK in reading the data and interpretation of graphs. Reading and interpreting the data should go concurrently, as both teachers did this by associating the data presented on the demand schedule with the graph. While this finding is consistent with that of Díaz-Levicoy et al. (2019), where teachers were successful in reading the data and interpreting the graphs, the finding is contrary to the findings of Bursal and Yetiş (2020) and Boote and Boote (2017), who found students' teachers had difficulties in reading and interpreting the graphs. This finding may imply that student teachers lack the specialized knowledge to read and interpret the graphs as expected. If teachers have deficiencies in reading and interpreting the graphs, it will negatively impact the students' understanding of the graphs.

Our findings on teachers' use of SCK to help learners in reading and handling graphs agree with Bolch and Jacobbe's (2019) finding that students had difficulty answering questions from graphs, but with the teachers' specialized knowledge, they could answer questions requiring reading of graphs. This contradicts the findings of Patahuddin and Lowrie (2019), who found that teachers were incompetent in reading graphs and reading beyond the data.

Another finding was on the step-by-step procedure followed by Mary which was accompanied by the conceptual explanation of each concept. The way she made the drawing and interpretation of the graph understandable to learners implied an organized teaching method. After the example shown with the step-by-step procedure, Mary gave the learners a similar problem and asked them to follow the same procedure. This finding agrees with that of Rosenshine (2012), where a new topic is taught to students in small steps, giving them the chance to practice step-by-step. However, Groth (2017) argues that learning procedures without understanding would require extensive practice to avoid forgetting the steps. One could argue that the step-by-step procedure would help to avoid the struggle of drawing an incorrect graph and avoid future repetition of similar errors they observe from past examinations. Although this argument was supported by Saleh and Battisha (2020), who believed that teachers employ step-by-step procedures because they want learners to complete tasks proficiently for examination purposes, Tajudin and Kadir (2014) disagreed with this procedure. They argued that the procedure showed a weak conceptual understanding of the content by the teachers, which may lead learners to memorization and rote learning.

Another finding was the teachers' ability to use their specific content knowledge to identify the correct graph from the incorrect graph in the textbook. This finding contradicts that of Ozmen et al. (2020), who found that teachers could not identify the incorrect graph types and errors in the graph. The teachers' successes in identifying the correct and incorrect graph could be due to their years of experience in teaching the topic.

One of our findings showed that both teachers have the TSPCK to analyze and interpret the graphs. This was evidenced when John was interpreting and analyzing the negative slope of the demand curve. The finding is in line with that of Patahuddin and Lowrie (2019), who found that the teachers do not possess adequate SCK and, therefore, were unable to interpret the graph. However, the finding is contrary to the findings of Ndlovu et al. (2017), where participants were competent solvers of school mathematics problems but could not analyze and interpret learners' errors for diagnostic purposes.

The teachers were found to have demonstrated their SCK using an analogy to explain some difficult concepts in the teaching of graphs in DM. This was evidenced by John's explanations of the ceteris paribus assumption and Mary's use of the 'Nike sign' to explain the concept of marginal cost and a smiling face to explain the concept of average cost. This finding might be surprising regarding how abstract the concept of graphs seems to learners. However, this finding has proved that it does not have to be so because the participant teachers acquired specialized skills in relating graphical concepts to other subject domains, thus finding similar concepts as analogies to describe those phenomena. This finding is similar to the findings of researchers (Burdina & Sauerb, 2015; Çalik et al., 2009; Jonane, 2015) who found the use of analogy helpful in teaching abstract topics. However, the findings are contrary to those of Treagust et al. (2003) and Gudyanga and Madambi (2014), who argue that learners have misconceptions despite the use of analogies because the teachers themselves have misconceptions, especially in presenting abstract concepts appropriately.

We also found that both teachers drew upon their conceptual knowledge as specialized knowledge when responding to learners' misunderstanding of concepts within DM lessons. For example, in analyzing Mary's illustrations using an analogy; one might be interested in determining the extent to which the use of 'Nike' drew upon her conceptual knowledge. The use of 'Nike' assesses Mary's conceptual knowledge because determining the appropriateness of an instructional decision requires that Mary draws upon a significant body of other related knowledge to illustrate the marginal cost (MC), similar to the 'Nike' symbol. The analogy used might have supported learners in conceptual understanding of the concept (MC) to visualize and relate it with other variables (Karaoglan Yilmaz et al., 2018) and help learners understand the meaning (Ada & Kurtuluş, 2010).

Again, John explained the concept of demand when a learner came up with a familiar and personal scenario, "As the prices of cars drop, the quantity demanded will not rise because his father just bought a new car" accesses conceptual knowledge. Because the learner's question raised a debate, it requires that he (John) makes sense of what the learners think for him to then think of how he could link learners' thinking to theory. Learners learned the required concepts at their own pace and strategy. Learners debating and discussing in the peer group and verbalizing their ideas also helped them develop explicit concepts towards encountered misconceptions in DM. The discussion over learners' areas of misconceptions provided opportunities for meaning-making and a mutual feedback system, which resulted in a better understanding of concepts for all.

Mary also drew upon her conceptual knowledge when she adopted a step-by-step approach to teaching, which they followed up with activities (activity-based learning). Our finding was that learners showed improvement in subsequent activities. This improvement in procedural fluency, followed by conceptual improvement, could be attributed to the step-by-step approach designed to contextualize the problems to fit into the learners' daily activities (Agustyaningrum et al., 2018; Diaz et al., 2020). One would argue that although teaching MD conceptually decreases learners' anxiety in drawing graphs, leading to an increase in their performance (Khoule et al., 2017), our findings showed that learners are stalled with the traditional method-procedural learning method.

One of the findings is that teachers demonstrated their TSPCK in addressing learners' questions when they struggled to link theory to practice. Learners do not seem to understand how the law of demand plays out in practice, especially how the graph reflects what is practiced in natural settings. The finding concurs with Chinn and Brewer (2001) and Glazer (2011), who found that learners often provide interpretations and explanations for the data that contradict the theories. Ghanaguru et al.'s (2013) findings align with our finding where theory linked to practice provided an assessment level for teachers' specific knowledge.

We also found that both teachers demonstrated the use of a higher-order thinking (HOT) level of questioning. We observed that both teachers were in the habit of asking questions requiring learners to analyze, evaluate or create a graph. These are HOT questions according to Bloom's taxonomy. However, we found that learners were unable to answer these questions adequately. Understanding graphs requires learners' critical thinking, and one effective way to help the students attain these thinking skills is teachers' questions and enabling student to participate in the class actively. Leaners' active participation was necessary to construct their MD knowledge, and the study showed that the same phenomenon was applied to deconstruct their misconceptions. Our findings correspond to those of Sekwena (2023), who found that active learning empowers learners to respond to Higher Order Thinking questions. However, it contradicts those of Musliha et al. (2021), who found that test questions created by the teacher lack the HOT type of questioning. The finding, however, agrees with the findings of Chinnappan and White (2015), who investigated the SCK of pre-service teachers in evaluating the plausibility of students' claims and errors and found that the teachers had developed a sense of student error. The HOT skills have become more extensive in our educational system because they tend to develop the quality of teaching and learning (Driana & Ernawati, 2019). According to Nguyễn and Nguyễn (2017), students who are frequently trained to solve more complex tasks that require HOT skills usually experience positive impacts on their learning improvement.

One of our findings was that the teachers were prepared and had planned before the lesson. We found that due to effective planning and having reflected on their teaching earlier, the teachers could tackle most misconceptions that might arise from learners during the lesson. The finding corresponds with that of Ní Shúilleabháin (2015), who supports planning as a means of checking teachers' effectiveness and competencies during teaching.

Based on teachers' knowledge of learners' misconceptions, our findings showed that the participating teachers could adopt active learning techniques to overcome most learners' misconceptions. This finding corresponds with that of Sekwena (2023), who argues for adoption of active learning as a more unconventional pedagogy in economics teaching. This helps to predict teachers' use of effective pedagogies. The finding resonates with Ramnarain and Moosea (2017), who used simulation learning as an effective strategy to overcome learners' misconceptions and Riga et al. (2017), who also used enquiry-based learning and contend that knowledge of pedagogies decreases students' misconceptions.

Our research also showed that the learners had misconceptions about most of the concepts related to the graphs in DM. Our findings showed that with the teachers' knowledge of learners' misconceptions, they could predict and identify these misconceptions and were also able to address these misconceptions. Chen et al. (2020) noted that without knowledge of learners' misconceptions, teachers, even with proficient subject matter knowledge, may miss the chance to address students' misconceptions and become absorbed in their own scientifically accurate points of view. These findings conform with Sadler et al. (2013), who found that teachers who could identify learners' misconceptions had much larger classroom, gains than the teachers who knew only the correct answer. Our findings agreed with the findings of Chen et al. (2020), who found that teachers' ability to predict students' misconceptions of an item results in better student performance.

The findings of this study suggest that economics teachers need sound topic-specific pedagogical content knowledge (TSPCK) to drive learners' understanding of the topic 'dynamics of market'. Therefore, economics teachers had a significant role in drawing from various knowledge domains (content knowledge and knowledge of the learners). The

study's findings support the TSPCK theory that teachers need specific knowledge to transform the content of a particular topic into teachable form using pedagogical reasoning. The findings also support the need for teachers to reason through a particular topic and focus on the transformation of the understanding of the content of that topic as one of the ways to improve learners' understanding of the dynamics of market.

Given the findings from our observed lessons, we can infer that the observed lessons provided some insight into the teaching of graphs in Dynamics of Market by experienced economics teachers using Topic Specific Pedagogical Content Knowledge. Based on these findings, a framework is proposed to complement Mavhunga's (2012) model of Topic Specific Pedagogical Content Knowledge in the teaching of graphs in Dynamics of Market. The proposed framework includes four dimensions; (1) Planning, (2) Execution of the worked examples, (3) Engaging Learners–Active learning) (4) Explanations and reflections.

It is hoped that the proposed framework will serve as a supportive mechanism to enhance learners' understanding of graphs in the dynamics of market. It is also hoped that this framework will enhance economics teachers' continual professional development. The implication of this is that the framework will not only be used by experienced teachers. Instead, it becomes relevant for pre-service and other teachers who struggle to teach graphs in dynamics of market. The framework will also help in assessing learning and learners' possible misconceptions and mistakes during teaching and learning. Table 1 shows the framework for the teaching of graphs in dynamics of market, which the researchers named Dynamics of Market Graphical Framework (DMG-Framework).

Table 1. Dynamics of Market Graphical Framework

Framework for the teaching of graphs in Dynamics of Market		
	Dimensions	**Elements**
1.	Planning	Plan on the type of worked examples to use (e.g., drawing, interpreting, transferring data). Plan on the instructional method to use. Plan on the use of Visual Signaling Cues. E.g. Arrows, colors (because sometimes they can be distractive)
2.	Execute work exampled graphs.	Step 1-Have learners understand basic terminologies of graphical concepts. Step 2-Access learners' prior knowledge and misconceptions on graphs. Step 3-Structure the worked examples. -Give different worked examples. -Show the step-by-step process of graph drawing -Avoid split attention (Give one information snippet at a time) Step 4-Use self-explanation prompts -Ask learners to explain the 'how' and 'why' of the concepts. Step 5-Draw incorrect worked examples and display a common mistake for learners to explain. Step 6-Incorporate instructional design features/instructional support. Step 7-Reduce cognitive load. -Allow learners to extract the common features in two given graphs and identify the problems in each worked example.
3.	Engage learners-Active Learning.	Step 1. Establish activity-based learning. -Ask learners to come to the board and draw the graph. Step 2. Allow for discussion of the drawn graph among learners. -Use Higher-Order Thinking questions to engage learners (analyze, evaluate, create). -Use Analogies to explain concepts -Link theories to practice
4.	Explanation and Reflection	Step 8- Explain worked-example graphs to learners. Step 9- Make room for schemata development. Step 10- Allow learners to reflect on the worked examples.

Conclusion

This study explored experienced economics teachers' Topic Specific Pedagogical Content Knowledge in teaching graphs in DM. The study established that the observed teachers' content knowledge of graphs in DM was adequate to enhance learners' understanding of graphs. In particular, the study established that the teaching of graphs in DM should be taught in a stepwise (step-by-step approach) manner to help learners learn. The study further established that alternative teaching strategies such as active learning and case study strategies should be used to augment the teaching of graphs in DM rather than the predominantly using chalk-and-talk approaches (Lecture method) of teaching graphs in economics.

In addition, teachers should use worked examples in the teaching of graphs and implement the Higher-Order Thinking method of questioning when teaching graphs. Notably, because of the complexity associated with the teaching of graphs, the intensive analysis and discussions observed by the participating teachers in the teaching of graphs in DM should be acknowledged. In essence, teachers' TSPCK assisted in the management of complexities observed in the teaching and learning of graphs in Dynamics of Market.

Teachers' knowledge of learners' misconceptions helps to limit the misconceptions and confusion learners come to the classroom with. The study also noted that the teachers used their TSPCK to predict and identify likely misconceptions that could hinder learning graphs in dynamics of market.

The TSPCK model helped understand the contribution of teachers' specific knowledge for a specific topic in teaching graphs in DM through observation in actual classrooms. This understanding led to new knowledge where a framework for teaching graphs in DM, named the Dynamics of Market Graphical- Framework (DMG-Framework) was proposed. This will positively impact teachers' professional development to address challenges they face in teaching graphs in Dynamics of market. The DMG-Framework will also enable teachers, especially the pre-service teachers, to collaborate with their peers on the best strategies for teaching graphs in dynamics of market.

Recommendations

The study recommends that other TSPCK components (knowledge of context and pedagogical knowledge) that were not explored in this study should be explored. It is also recommended that teachers' TSPCK should be explored in other difficult topics and specific topics in economics education. This could help develop required frameworks to enhance teaching such specific topics. Further research is also recommended to explore the effectiveness of the proposed Dynamics of Market Graph-Framework (DMG-Framework) in the teaching of Dynamics of Market.

Limitations

The study is a case study of two experienced economics teachers from two schools, which provides little basis for generalization of results. Also, more experienced economics teachers would improve the results. Although the fieldwork was limited to classroom observation, where five lessons were observed for each teacher, additional methods of data collection, such as interviews, would have strengthened the results.

Ethical Considerations

Informed consent was obtained from all participants to conduct the study.

Author's Contribution Statement

Ogbonnaya I.C: Conceptualization, design, analysis, writing, drafting the manuscript, Editing/reviewing, supervision. mentorship, and critical revision of the manuscript.

References

Ada, T., & Kurtuluş, A. (2010). Students' misconceptions and errors in transformation geometry. *International Journal of Mathematics Education in Science and Technology, 41*(7), 901-909. https://doi.org/10.1080/0020739X.2010.486451

Agnes, D., Kaniawati, I., & Danawan, D. A. (2015). Analisis deskriptif tes tiga tingkat materi optika geometri dan alat optik [Descriptive analysis three-tier test geometry optics and optical instruments]. In D. Irwanto, F. T. Akbar, & A. H. Aimon (Eds.), *Prosiding Simposium Nasional Inovasi dan Pembelajaran Sains* [Proceedings of the National Symposium on Science Innovation and Learning] (pp. 597-600). Institut Teknologi Bandung. https://bit.ly/46ELEKQ

Agustyaningrum, N., Abadi, A. M., & Mahmudi, A. (2018). An analysis of students' errors in solving abstract algebra tasks. *Journal of Physics: Conference Series, 1097*, Article 012118. https://doi.org/10.1088/1742-6596/1097/1/012118

Alacacı, C., Lewis, S., O'Brien, G. E., & Jiang, Z. (2011). Pre-service elementary teachers understanding of graphs. *Eurasia Journal of Mathematics, Science and Technology Education, 7*(1), 3-14. https://doi.org/10.12973/ejmste/75171

Arnal-Palacián, M., & Claros-Mellado, J. (2022). Specialized content knowledge of pre-service teachers on the infinite limit of a sequence. *Mathematics Teaching Research Journal, 14*(1), 169-189.

Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2010). *Introduction for research in education* (8th ed.). Cengage Learning.

Asikhia, O. (2010). Students and teachers' perception of the causes of poor academic performance in Ogun state secondary schools [Nigeria]: Implications for counselling for national development. *European Journal for Social Sciences, 13*, 229-242.

Aydin, S., Friedrichsen, P. M., Boz, Y., & Hanuscin, D. L. (2014). Examination of the topic-specific nature of pedagogical content knowledge in teaching electrochemical cells and nuclear reactions. *Chemical Education Research, 15*(4), 658-674. https://doi.org/10.1039/c4rp00105b

Ayers, C. A. (2015). *A qualitative study of the pedagogical content knowledge and personal orientations toward economics of award-winning secondary economics teachers*. [Master's dissertation, The University of North Carolina at Greensboro.] https://libres.uncg.edu/ir/uncg/listing.aspx?id=18399

Ball, D., Thames, M. H., & Phelps, G. (2008). Content knowledge for Teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407. https://doi.org/10.1177/0022487108324554

Bansilal, S., Brijlall, D., & Mkhwanazi, T. (2015). An exploration of the common content knowledge of high school mathematics teachers. *Perspectives in Education, 32*(1), 34-50. https://hdl.handle.net/10520/EJC151360

Bolch, C. A., & Jacobbe, T. (2019). Investigating levels of graphic comprehension using the LOCUS assessments. *Numeracy, 12*(1), Article 8. https://doi.org/10.5038/1936-4660.12.1.8

Boote, S. K., & Boote, D. N. (2017). Leaping from discrete to continuous independent variables: Sixth graders' science line graph interpretations. *The Elementary School Journal, 117*(3), 455-484. https://doi.org/10.1086/690204

Briand-Newman, H., Wong, M., & Evans, D. (2012). Teacher subject matter knowledge of number sense. In J. Dindyal, L. P. Cheng & S. F. Ng (Eds.), *Mathematics education: Expanding horizons. Proceeding of the 35th annual conference of the Mathematics Education Research Group of Australasia* (pp. 130-137). Mathematics Education Research Group of Australasia.

Burdina, M., & Sauerb, K. M. (2015). Teaching economic principles with analogies. *Review of Economics Education, 20,* 29-36. https://doi.org/10.1016/j.iree.2015.10.001

Bursal, M., & Polat, F. (2020). Middle school students' line graph skills and the affective states about common graph types used in science courses. *International Journal of Education in Mathematics, Science and Technology, 8*(4), 290-303. https://doi.org/10.46328/ijemst.v8i4.1026

Bursal, M., & Yetiş, S. (2020). Middle school students' graph skills and affective states about graphs. *International Journal of Research in Education and Science, 6*(4), 692-704. https://doi.org/10.46328/ijres.v6i4.1136

Çalik, M., Ayas, A., & Coll, R. K. (2009). Investigating the effectiveness of an analogy activity in improving students' conceptual change for solution chemistry concepts. *International Journal of Science and Mathematics Education, 7*, 651-676. https://doi.org/10.1007/s10763-008-9136-9

Chen, C., Sonnert, G., Sadler, P. M., & Sunbury, S. (2020). The impact of high school life science teachers' subject matter knowledge and knowledge of student misconceptions on students' learning. *CBE- Life Science Education, 19*(1), Article ar9. https://doi.org/10.1187/cbe.19-08-0164

Chinn, C. A., & Brewer, W. F. (2001). Models of data: A theory of how people evaluate data. *Cognition and Instruction, 19*(3), 323-393. https://doi.org/10.1207/S1532690XCI1903_3

Chinnappan, M., & White, B. (2015). Specialized content knowledge: evidence of pre-service teachers' appraisal of student errors in proportional reasoning. In M. Marshman, V. Geiger, & A. Bennison (Eds.), *Mathematics education in the margins. Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia* (pp. 157-164). Merga. https://bit.ly/3PDFzrw

Creswell, J. W. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Sage Publications.

Department of Basic Education. (2021). *National senior certificate diagnostic report, 2021. Part 1: Content subjects.* https://wcedeportal.co.za/eresource/196376

Department of Basic Education. (2022). *National senior certificate diagnostic report*, *2022*. *Part 1: Content subjects.* https://bit.ly/46fErBn

Diaz, V., Aravena, M., & Flores, G. (2020). Solving problem types contextualized to the quadratic function and error analysis: A case study. *Eurasia Journal of Mathematics, Science, and Technology Education, 16*(11), Article em1896. https://doi.org/10.29333/ejmste/8547

Díaz-Levicoy, D., Batanero, C., Arteaga, P., & Gea, M. M. (2019). Chilean children's reading levels of statistical graphs. *International Electronic Journal of Mathematics Education*, *14*(3), 689-700. https://doi.org/10.29333/iejme/5786

Ding, M. (2016). Developing pre-service teachers' specialized content knowledge: The case of associative property. *International Journal of STEM Education, 3,* Article 9. https://doi.org/10.1186/s40594-016-0041-4

Driana, E., & Ernawati, E. (2019). Teachers' understanding and practices in assessing higher order thinking skills at primary schools. *Acitya: Journal of Teaching and Education, 1*(2), 110-118. https://doi.org/10.30650/ajte.v1i2.233

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Gan, Y., Scardamalia, M., Hong, H.-Y., & Zhang, J. (2010). Early development of graphical literacy through knowledge building. *Canadian Journal of Learning and Technology, 36*(1), 1-28. https://doi.org/10.21432/T2C01S

Ghanaguru, S., Nair, P., & Yong, C. (2013). Teacher trainers' beliefs in microteaching and lesson planning in a teacher training institution. *The English Teacher, 42*(2), 104-116. https://cutt.ly/qNJFNNz

Glazer, N. (2011). Challenges with interpretation the graph: A review of the literature. *Studies in Science Education*, *47*(2), 183-210. https://doi.org/10.1080/03057267.2011.605307

González, M. T., Espinel, M. C., & Ainley, J. (2011). Teachers' graphical competence. In C. Batanero, G. Burrill, & C. Reading (Eds.), *Teaching statistics in school mathematics–Challenges for teaching and teacher education* (pp. 187-198). Springer. https://doi.org/10.1007/978-94-007-1131-0_20

Groth, R. (2017). Classroom data analysis with the five strands of mathematical proficiency. *The Clearing House: A Journal of Educational Strategies*, *Issues and Ideas, 90*(3), 103-109. https://doi.org/10.1080/00098655.2017.1301155

Gudyanga, E., & Madambi, T. (2014). Pedagogics of chemical bonding in chemistry; perspectives and potential for progress: The case of Zimbabwe secondary education. *International Journal of Secondary Education, 2*(1), 11-19. https://doi.org/10.11648/j.ijsedu.20140201.13

Güven, B., Öztürk, T., & Özmen, Z. M. (2015). Examination of middle school eighth-grade students' experiences in the statistical process. *Education and Science, 40*(177), 343-363. https://doi.org/10.15390/EB.2015.3313

Hafiyusholeh, M., Budayasa, K., & Siswono, T. Y. E. (2018). Statistical literacy: High school students in reading, interpreting and presenting data. *Journal of Physics: Conference Series, 947*, Article 012036. https://doi.org/10.1088/1742-6596/947/1/012036

Heng, C. K., & Karpudewan, M. (2017). Facilitating primary school students' understanding of water cycle through guided inquiry-based learning. In M. Karpudewan, A. N. M. Zain, & A. I. Chandrasegaran (Eds.) *Overcoming students' misconceptions in science* (pp. 29-49). Springer. https://doi.org/10.1007/978-981-10-3437-4_3

Jonane, L. (2015). Analogies in science education. *Pedagogika, 119*(3), 116-125. https://doi.org/10.15823/p.2015.027

Karaoglan Yilmaz, F. G., Gökkurt Özdemir, B., & Yasar, Z. (2018). Using digital stories to reduce misconceptions and mistakes about fractions: An action study. *International Journal of Mathematics Education in Science and Technology, 49*(6), 867-898. https://doi.org/10.1080/0020739X.2017.1418919

Keller, M. M., Neumann, K., & Fischer, H. E. (2017). The impact of physics teachers' pedagogical content knowledge and motivation on students' achievement and interest. *Journal of Research in Science Teaching, 54*(5), 586-614. https://doi.org/10.1002/tea.21378

Khoo, Y. Y., & Fitzgerald, R. (2017). Peer Learning with concept cartoons enhance critical thinking and performance in secondary school economics. *Journal of Economics and Economic Education, 18*(1), 1-13. https://bit.ly/3JmbBpi

Khoule, A., Bonsu, N. O., & El Houari, H. (2017). Impact of conceptual and procedural knowledge on students mathematics anxiety. *International Journal of Educational Studies in Mathematics, 4*(1), 8-18. https://bit.ly/43ZmUwY

Loughran, J. (2019). Pedagogical reasoning: the foundation of the professional *knowledge* of teaching, teachers and teaching. *Teachers and Teaching Theory and Practice, 25*(5), 523-535. https://doi.org/10.1080/13540602.2019.1633294

Loughran, J., Berry, A., & Mulhall, P. (2012). *Understanding and developing science teachers' pedagogical content knowledge* (2nd ed.) Sense Publishers.

Makar, K., & Fielding-Wells, J. (2011). Teaching teachers to teach statistical investigations. In C. Batanero, G. Burrill, & C. Reading (Eds.), *Teaching statistics in school mathematics–challenges for teaching and teacher education* (pp. 347-358). Springer. https://doi.org/10.1007/978-94-007-1131-0_33

Malyshkin, V. G. (2016). *Market dynamics. On supply and demand concepts*. arXiv preprint. https://arxiv.org/abs/1602.04423

Mankiw, N. G. (2015). *Macroeconomics* (7th ed.). Worth Publishers.

Manzi, W. I., Mosia, M., Moreeng, B., & Masvosve, T. (2021). Grade 12 learners' perceptions of opportunities to learn imperfect market structures: Frances Baard district. *International Journal of Learning, Teaching and Educational Research, 20*(9), 255-271. https://doi.org/10.26803/ijlter.20.9.15

Mavhunga, M. E. (2012). *Explicit inclusion of topic-specific knowledge for teaching and the development of PCK in pre-service science teachers*. [Doctoral dissertation, University of the Witwatersrand, Johannesburg]. https://bit.ly/46kHBny

Mukeredzi, T. G. (2017). Mentoring in a cohort model of practicum: mentors and pre-service teachers' experiences in a rural South African school. SAGE *Open 7*(2), 1-15. https://doi.org/10.1177/2158244017709863

Mukeredzi, T. G., Mthiyane, N., & Bertram, C. (2015). Becoming professionally qualified: the school-based mentoring experiences of part-time PGCE students. *South African Journal of Education, 35*(2), Article 1057. https://www.doi.org/10.15700/saje.v35n2a1057

Musliha, S., Sudana, D., & Wirza, Y. (2021). The analysis of higher-order thinking skills (hots) in the test questions constructed by English teachers. In *Fifth International Conference on Language, Literature, Culture, and Education (ICOLLITE 2021)* (pp. 610-617). Atlantis Press. https://doi.org/10.2991/assehr.k.211119.095

Ndlovu, Z., Amin, N., & Samuel, M. A. (2017). Examining pre-service teachers' subject matter knowledge of school mathematics concepts. *Journal of Education*, *70,* 46-72. Retrieved December 01, 2023, from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S2520-98682017000300003&lng=en&tlng=en.

Ng, S. F., & Chan, O. K. K. (2014). A preliminary study on the development of pedagogical content knowledge among economics and primary social studies student teachers in Singapore. *HSSE Online 3*(1) 25-36. https://bit.ly/46DQDLG

Nguyễn, T. M. T., & Nguyễn, T. T. L. (2017). Influence of explicit higher-order thinking skills instruction on students' learning of linguistics. *Thinking Skills and* Creativity, *26*, 113-127. https://doi.org/10.1016/j.tsc.2017.10.004

Ní Shúilleabháin, A. (2015). Developing mathematics teachers' pedagogical content knowledge through iterative cycles of lesson study. In K. Krainer & N. Vondrová (Eds.), *Proceedings of the Ninth Conference of the European Society for Research in Mathematics Education* (CERME9, 4-8 February 2015) (pp. 2734-2740). Charles University in Prague, Faculty of Education and ERME.

Ogbonnaya, I. C. (2023). Analysis of Grade 10 opportunity-to-learn dynamics of market from two economics textbooks. *Economic Education Analysis Journal, 12*(2), 83-97. https://doi.org/10.15294/eeaj.v12i2.69848

Ojose, B. (2015). Students' misconceptions in mathematics: analysis of remedies and what research says. *Ohio Journal of School Mathematics*, *72*, 30-34. http://hdl.handle.net/1811/78927

Özel, Z., Yılmaz, A., Işıksal-Bostan, M., & Özkan, B. (2022). Investigation of the specialized content knowledge of the pre-service primary school teachers about multiplication. *International Journal for Mathematics Teaching and Learning, 23*(2), 115-143. https://doi.org/10.4256/ijmtl.v23i2.464

Ozmen, Z. M., Guven, B., & Kurak, Y. (2020). Determining the graphical literacy levels of the 8th-grade students. *Eurasian Journal of Educational Research, 20*(86), 269-292. https://bit.ly/3TaSjsU

Patahuddin, S. M., & Lowrie, T. (2019). Examining teachers' knowledge of line graph task: A case of travel task. *International Journal of Science and Mathematics Education, 17*, 781-800. https://doi.org/10.1007/s10763-018-9893-z

Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C., Capraro, M. M., & Capraro, R. M. (2022). Secondary school teachers' perceptions of STEM pedagogical content knowledge. *Journal on Mathematics Education, 13*(1), 119-134. https://doi.org/10.22342/jme.v13i1.pp119-134

Ramnarain, U., & Moosea, S. (2017). The use of simulations in correcting electricity misconceptions of grade 10 South African physical sciences learners. International. *Journal of Innovation in Science and Mathematics Education, 25*(5), 1-20. https://bit.ly/3Q6TY0E

Riga, F., Winterbottom, M., Harris, E., & Newby, L. (2017). *Inquiry-based science education*. In K. S. Taber & B. Akpan (Eds.), *Science education* (pp. 247-261). Brill. https://doi.org/10.1007/978-94-6300-749-8_19

Roller, M. R., & Lavrakas, P. J. (2015). *Applied qualitative research design: A total quality framework approach.* Guilford Publications.

Rollnick, M., Davidowitz, B., & Potgieter, M. (2017). Is topic-specific PCK unique to teachers? In K. Hahl, K. Juuti, J. Lampiselkä, A. Uitto, & J. Lavonen (Eds.). *Cognitive and affective aspects in science education research: Selected papers from the ESERA 2015 Conference* (pp. 69-85). Springer. https://doi.org/10.1007/978-3-319-58685-4_6

Rollnick, M., & Mavhunga, E. (2016). Can the principles of topic-specific PCK be applied across science topics? Teaching PCK in a pre-service programme. In N. Papadouris, A. Hadjigeorgiou & C. P. Constantinou (Eds), *Insights from research in science teaching and learning: Book of selected papers from the ESERA 2013, Conference* (pp. 59-72). Springer. https://doi.org/10.1007/978-3-319-20074-3_5

Rosenshine, B. (2012). Principles of instruction: Research-based strategies that all teachers should know. *American Educator*, *36*(1), 12-21. https://bit.ly/3RodMNQ

Sadler, P. M., Sonnert, G., Coyle, H. P., Cook-Smith, N., & Miller, J. L. (2013). The influence of teachers' knowledge on student learning in middle school physical science classrooms. *American Educational Research Journal, 50*(5), 1020-1049. https://doi.org/10.3102/0002831213477680

Salazar Noguera, J. (2018). The role of classroom observation in pre-service English teachers' understanding of the teaching profession. *Porta Linguarum: Revista Internacional de Didáctica de las Lenguas Extranjeras*, *30,* 193-206. https://doi.org/10.30827/digibug.54068

Saleh, M., & Battisha, M. (2020). A proposed paradigm for the requirements for designing and using digital games-based learning by educable intellectual disabled children. *Technium Social Science Journal, 2*(1), 37-66. https://doi.org/10.47577/tssj.v2i1.54

Sekwena, G. L. (2023). Active learning pedagogy for enriching economics students' higher-order thinking skills. *International Journal of Learning, Teaching and Educational Research*, *22*(3), 241-255. https://doi.org/10.26803/ijlter.22.3.15

Shongwe, B. (2022). A Causal-comparative study of South African pre-service primary mathematics teachers' spatial visualization ability: Does common content knowledge matter? *International Journal of Mathematical Education in Science and Technology*, *53*(9), 2338-2363. https://doi.org/10.1080/0020739x.2020.1869333

Shulman, L. (1987). Knowledge and teaching: foundations of the new reform. *Harvard Educational Review, 57*(1), 1-23. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Tajudin, N. M., & Kadir, N. Z. A. (2014). Technological pedagogical content knowledge and teaching practice of mathematics trainee teachers. *AIP Conference Proceedings*, *1605*(1), 734-739. https://doi.org/10.1063/1.4887681

Thorsen, K. E. (2016). Practice teachers' role in teacher education-individual practices across educational curricula. *Acta Didactica Norge, 10*(2), 179-192. https://doi.org/10.5617/adno.2417

Treagust, D., Chittleborough, G., & Mamiala, T. (2003). The role of sub-microscopic and symbolic representations in chemical explanations. *International Journal of Science Education, 25*(11), 1353-1368. https://doi.org/10.1080/0950069032000070306

Uyanik, S., Elbir, D., & Ozmen, Z. M. (2023). Determining the graphical literacy levels of the middle school mathematics teachers. *Pedagogical Research, 8*(2), Article em0158. https://doi.org/10.29333/pr/13003

Van Steenbrugge, H., Lesage, E., Valcke, M., & Desoete, A. (2014). Pre-service elementary school teachers' knowledge of fractions: A mirror of students' knowledge? *Journal of Curriculum Studies, 46*(1), 138-161. https://doi.org/10.1080/00220272.2013.839003

Yong, C. L., & Kee, C. Z. (2017). Utilizing concept cartoons to diagnose and remediate. misconceptions related to photosynthesis among primary school students. In M. Karpudewan, M. D. Zain, & A. Chandrasegaran (Eds.), *Overcoming students' misconceptions in science: strategies and perspectives from Malaysia* (pp. 9-27). Springer. https://doi.org/10.1007/978-981-10-3437-4_2

Zembat, I., & Bayram, E. (2019, September 3-6). *An articulation of specialized content knowledge of mathematics teachers in the context of measurement concepts*. [Conference presentation]. European Educational Research Association. https://eprints.gla.ac.uk/216204/1/216204.pdf

Zhang, H. (2017). Accommodating different learning styles in the teaching of economics: With emphasis on Fleming and Mill's sensory-based learning style typology. *Applied Economics and Finance, 4*(1), 72-83. https://doi.org/10.11114/aef.v4i1.1921

Zuidhof, P.-W. (2014). Thinking like an economist: the neoliberal politics of the economics textbook. *Review of Social Economy, 72*(2), 157-185. https://doi.org/10.1080/00346764.2013.872952