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Assessing Grade 10 Learners' Misconceptions of the Supply Curve in Market Dynamics Graphs

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ABSTRACT

The aim of this study was to assess the Grade 10 learners' misconceptions of the supply curve in Market Dynamics graphs and finding ways to minimise them. This aspect of Market Dynamics tends to pose a challenge to many learners. Guided by the constructivist theoretical framework, this qualitative study followed a purposeful sampling method of 36 economics learners in the 10th grade. A test item of 15 questions was given to the learners using an observation method, but only five questions were used to generate the data, which was analysed thematically. The themes generated helped to group learners into three different categories (1 to 3) according to the level of misconceptions. One of our key findings was that most learners tend to overgeneralise economic concepts in a new setting. Another key finding was that learners demonstrated difficulties in using similar economic concepts and showed misconceptions about the terminologies that look similar in meaning. We also found that the traditional teaching method, especially in graphic presentations by the teacher, resulted in most misconceptions exhibited by the learners. This study contributes to the teaching and learning of graphs in economics in South Africa. More specifically, a framework was proposed to help minimise learners' misconceptions of the supply curve and perhaps other graphical concepts in Market Dynamics. The study further contributes to teachers' knowledge of the different areas where learners have misconceptions in understanding the supply curve graph as it prepares economics teachers to pay particular attention to those identified areas. The study concludes that learners indeed experience misconceptions in Market Dynamics supply curve graphs; however, those misconceptions can be minimised using a different approach to teaching. It is recommended that more instructional time should be allocated to the teaching of supply curve graphs and teachers could perhaps find alternative teaching strategies to help mitigate learners' misconceptions in those identified areas.

Keywords: Graphs, Learners, Market Dynamics, Misconceptions, Supply curve

INTRODUCTION

It is a concern that learners experience a lot of misconceptions that hinder the understanding of the supply curve in Market Dynamics. Thus, assessing learners' misconceptions of the supply curve and finding ways to improve learning is crucial for enhancing learners' success in the subject. The topic of Market Dynamics comprises a wide range of fundamental concepts such as price, equilibrium, and demand and supply curves that hold a crucial role in understanding all the Market Dynamics, thus making it challenging for learners. Market Dynamics (MD) is one of the most popular yet difficult topics in economics education and abounds in misconceptions for learners (Aguiló, Sard, & Tugores, 2016; Ayers, 2015; Ogbonnaya, 2022). *"Teachers needed to expose learners multiple times to the supply and demand concepts because their learners often considered the content dry, graphical and overly mathematical*" (Ayers, 2015). The current study focuses on common learners'

misconceptions in the supply curve aspect of Market Dynamics graphs that may indicate faulty or incomplete underlying conceptual knowledge.

Matuk, Zhang, Uk, & Linn (2019) contend that learners have challenges in nearly all aspects of graphs, such as reading, plotting and interpreting graphs and converting one type of graph to another type. Understanding the supply curve concept is critical because it is much used in analysing economic growth and the development of nations. In the school curriculum, understanding the supply curve encompasses understanding the movement along the supply curve, the shifts of the curves, the change in supply, the change in quantity supplied, etc. Although economists use the demand-supply curve to analyse the DM structure, we focus specifically on the supply curve aspect of the graph in this study.

In the South African context, learners have misconceptions about the concept of the supply curve. Although there has been substantial research (Burdina & Sauerb 2015; Khoo & Fitzgerald 2017; Ogbonnaya 2022; Manzi, Mosia & Moreeng 2021; Kurniawati, 2020) to mitigate learners' challenges in understanding graphs in DM. Literature is silence regarding the challenges faced by learners in understanding the supply curve aspect of Dynamics of Market. The present study argues that there is a gap in the literature that fails to account for the teaching of supply curve in DM. This study therefore took a different approach to observe the teaching of the supply curve in a class and a written test administered under a normal classroom setting. This was done to understand learners' challenges of the concept after the observed lessons on the supply curve graphs.

Learners' challenges in understanding the supply curve were evident from the National Senior Certificate Diagnostic Reports for the matriculation examination 2019-2021, which showed poor performance of learners in Microeconomics Paper 2. These questions required that learners demonstrate the skills of transferring data, drawing, and interpreting the supply curve graphs. It also requires learners' conceptual understanding to analyse the supply curves. Evidence from diagnostic report excerpts clearly showed that learners are challenged with the Market Dynamics graphs, especially the supply curve. The report states that *"the supply curve is not covered explicitly in the content, and learners showed misconceptions in addressing questions related to the supply curve"* (Department of Basic Education [DBE], 2021, p. 95). The report further indicated that "*Graphs in Microeconomics always appear to be a challenge as questions relating to graphs are either avoided or answered poorly"* (DBE, 2020, p. 83). Further report on poor learners' understanding of the supply curve are seen in (DBE, 2019. p. 95; DBE, 2020, p. 81, p. 93). Based on this evidence, the study seeks to assess the Grade 10 learners' misconceptions of the supply curve (SSC) in Market Dynamics. To achieve this purpose, the question investigated in this study was: *What areas of the supply curve do learners have misconceptions in understanding the Dynamics of Market graphs*?

LITERATURE REVIEW

Misconceptions are described as misunderstandings and interpretations that are technically inaccurate due to prior insight and wrong ideas (Cooper & Klymkowsky, 2013). Melhuish (2019) identified misconception as conceptual understanding "reflecting knowledge of concepts and linking relationships that are directly connected to (or logically necessitated by) the definition of a concept or meaning of a statement". In economics education, such misconceptions abound among learners on basic economic concepts, and unfortunately, little research

on learners' misconceptions of economic concepts can be found.

Goffe (2013) noted that there seem to be very few papers in economics education literature that measure college learners' conceptual understanding and misconceptions of economics concepts. Research on learners' misconceptions in economics is scanty; however, one outstanding work by Allgood et al. (2015) is still useful in today's studies on learners' misconceptions in economics education. Allgood et al. (2015) explored economics learners' misconceptions of basic economics terms and concepts and commented that "learners require the use of supply and demand in microeconomics." Although the analysis was only based on the principles level, it was found that learners have difficulties understanding the difference between the supply and demand concepts. Goffe (2013) pointed out that the study of misconceptions in economics is rarely systematic or formal compared to other disciplines, so attempts to deal with them are not easy. Goffe stressed that economic classes seem not to have made much impact on learning because of unaddressed misconceptions among learners.

In recent times, Ng (2016) conducted a study on learners' misconceptions of economics concepts and concluded that learners' misconceptions need to be addressed by teachers by incorporating strategies that will pre-empt or clarify concepts that tend to be confusing to learners. Parsons and Mamo (2017) also found that learners enter their economic studies with a significant set of pre-conceptions and biases which are correlated with their initial understanding of information. Burdina and Sauerb (2015) identified learners' misconceptions of the concept of the supply curve and described it as an error emanating from an 'incorrect mindset'. Burdina and Sauerb (2015) gave example of learners "shifting the supply curve right to illustrate a decrease" as a 'physical mindset' one derived from the learners' physical experiences which causes misconceptions with regard to the understanding of graphical representations.

While few studies have been conducted on learners' misconceptions in Market Dynamics graphs, there is limited evidence of learners' misconceptions of the supply curve aspect of Market Dynamics in the South African context. Due to the scarce literature on learners' misconceptions of the concept of the supply curve graph in the field of economics, we lend support from other fields, mostly in mathematics and sciences (Burgoon, Heddle, & Duran, 2011; Diyanahesa, Kusairi, & Latifah, 2017; Ernest & Albert, 2018) where learners' misconceptions of other concepts are well dealt with.

Im and Jitendra (2020) claimed that misconceptions are associated with inaccurate ideas that learners develop due to a lack of clarity in concept learning, which may have a root in their prior knowledge that they generalised inappropriately. Neidorf, Arora, Erberber, Tsokodayi, and Mai (2020) also argued that when learners have misconceptions about a concept, they tend to deliberate that either what they are doing is correct or they are not sure of what they are doing. Gultepe (2016) contended that misconceptions about graph interpretation could be influenced by prior theory and prior expectations from learners, thus, prior expectations may not be in line with the theory, which could result in biases and errors.

There are different sources of misconceptions. Turgut, Gürbüz and Turgut (2011) believed most misconceptions originated from learners' experiences of their daily lives. For example, the excessive dependence on daily language. Burdinaa and Sauerb (2015) described the tendency to identify with the everyday language usage of a word as a 'linguistic mindset'. Other sources of misconceptions could be

the inability of learners to distinguish specific attributes from a concept, incomplete thinking and low reasoning, lack of analytical skills, human error, or misconception caused by rote learning. Rote learning is a type of surface learning that occurs when learners cannot relate new knowledge to existing knowledge; thus, retrieval becomes difficult. Chan, Manley, and Ahn (2020) argue that retrieval associated with rote learning alters the learner's knowledge in response to the demands and goals of the present.

In his study, Mishra (2020) analysed and identified the difficulties and problems teachers encounter when learners undergo misconceptions over a concept and suggested that teachers should develop adequate skills to treat learners' misconceptions. Im and Jitendra (2020) studied learners' misconceptions about proportional reasoning and found that a specific teaching strategy could reduce learners' wrong ideas and faulty understanding of mathematical concepts. They also found a positive effect of schema-based instruction to enhance learners' learning. Vermeulen and Meyer's (2017) study on learners' misconception of the meaning of the equal sign found that learners struggle to understand this concept but supported the need to test learners' conceptual understanding using a test item. Consequently, Veith, Bitzenbauer and Girnat (2022) interpreted the test score of their learners as a measure of conceptual understanding of introductory categories and found that the test items adequately represents the knowledge domain; thus, they encouraged teachers to use tests to verify learners' understanding and misconceptions of specific concepts in their disciplines.

Soeharto and Csapó (2021) explored learners' misconceptions across physics, biology, and chemistry and found that the 32 developed items that are valid and reliable were the difficult items, indicating a high misconception level of the learners towards the concepts. Findings from Galvin, Simmie, and O'Grady (2015) on learners' misconception of the concepts of respiration and photosynthesis indicated that their misconception was caused by mistakes in biology class at the secondary school and college levels. Bahtaji (2020) argues that learners should be exposed to active construction and interpretation of graphs to improve their conceptual understanding.

Another important factor to consider in learners' misconceptions of concepts is their familiarity with the content. Learners should be familiar with the content as familiarity with the content could limit misconceptions and affect the ability to analyse a trend (Glazer, 2011). Glazer (2011) observed that viewers were less likely to describe a particular trend when unfamiliar with the data and did not expect anything and are more likely to describe a particular trend if they are familiar with it. Xuyan & Yuen (2016) contend that learners' familiarity with the content influences whether they could describe a certain trend. On the other hand, familiarity with the content might be problematic for novice learners, who need to refer to models and theories on the topic to make sense of the situation. Gultepe (2016) also found that prior expectations resulting from familiarity and unfamiliarity with the data and content of the graph affected graph interpretation.

Graph interpretations refer to a graph reader's skill and the ability to obtain meaning from graphs created by others or themselves (Aoyama, 2007; Glazer, 2011). Thus, interpreting graphs without the required skills comes with a lot of difficulties. Glazer (2011) identified the problems of connecting graphs with variables and defining the variables and stressed that the different ways data are presented affect the understanding and how easy it is to interpret the graph. Visual characteristics or display format affects

graph interpretation, especially when data is inappropriately displayed (Glazer, 2011).

In their study, Freedman and Shah (2002) described some graph characteristics that affect learners' clearness/complexity and viewers' ability to interpret graphs, such as the content, the type of graph, colour, etc. Colours simplify the graph interpretation process as it is easier to track changes and distinguish different patterns. For example, Almodaresi, Pandey, Ferdman, Johnson, and Patro's (2020) study represented the colour information efficiency presented in the de Bruijn graph. Their findings showed significant improvements in the general size and scalability of the representation of the colour information. Other studies by Ahmed (2012) and Chen, Dai, Li, Ma and Liu (2022) contend that using colours on graphs helps retrieve information easily. Another characteristic of graphs that affects the interpretation of graphs is that theories rule them. Learners most often face the challenge of providing interpretations and explanations for data that contradicts theories (Glazer, 2011).

To minimise learners' misconceptions in understanding difficult concepts, they must construct meaning and understanding from prior knowledge. Conceptual understanding is established upon the reorganisation of existing knowledge as advocated by the cognitive constructivist theory of learning (Piaget, 1951; Tobin, Tippins, & Gallard, 1994). Constructivism holds that learners come to gain or make their own knowledge through active construction and that their experiences determine their reality. Conceptual understanding involves schemas such as association, comparison, assimilation, and reorganisation of new knowledge with existing knowledge and transferring it to solve a new problem (Saricayir, Ay, Comek, Cansiz, & Uce, 2016).

MATERIALS AND METHOD

This study was conducted at a high school in Tshwane North District of South Africa, South Africa. Only one 10th-grade class of 36 economics learners (16 females and 20 males) participated in the lessons. The 10th grade was chosen because they are the foundation class in the Further Education and Training (FET) levels where the basic economics concepts required for the final matric exams are first taught. It is important to note that in the South African context, the FET phase is from the 10th to the 12th grade, and the matric exams are the final exit exams. The class was taught by the economics teacher, Paul (Pseudonym). Teacher Paul was purposefully chosen because he was recommended for his expertise in teaching economics due to his 18 years of teaching experience hence the choice of the school. A purposeful sample is most suited for this study as it is based on from whom the most could be learned and to gain insight into the phenomenon at hand (Etikan, Musa, & Alkassim, 2016).

As a part of a larger study, classroom observations and interviews were carried out on the topic of Market Dynamics for six weeks., It is also important to note that ethical clearance was sought from Tshwane University of Technology. Permission was also sought and granted by the Department of Education and the school principal in line with the requirement of conducting research (Creswell et al., 2016). Consent forms were obtained from the learners, and it was made clear to them that it was a voluntary participation and that one could withdraw at any time.

Therefore, we focused on the supply curve aspect of the Market Dynamics in the current study, by observing four consecutive lessons. Classroom observation was chosen because it gives an in-depth understanding of the situation (Creswell et al., 2016). The fourth lesson on the supply curve was a class test, and the

test item comprised fifteen questions on the supply curve; however, only five questions were used to generate the data. While we rely more on the test analysis, we also aligned the observations during the teaching periods with the answers provided by the learners in the test items. We believed this method would better show how we could detect learners' misconceptions about the supply curve graphs.

Guided by the constructivist theoretical framework, the study adopted a descriptive research design and thematic data analysis procedure. Thematic analysis has been chosen over other methods because we aimed to assess learners' misconceptions of the concept of the supply curve in Market Dynamics graphs. This study adopted the inquiry-based learning technique of a constructivist teacher, where different categories of questioning engaged learners. The teacher posed questions, and learners found answers to the problems. Learners were expected to construct meaning out of the posed questions and data instead of relying on the answers provided by the teacher. Learners' answers were then analysed thematically. After analysing learners' answers, the findings from their answers helped to classify the learners into three different themes and categories (Category 1 are learners with 'No Misconceptions'; Category 2 are learners with 'Partial Misconceptions' while Category 3 are learners with 'Full Misconceptions'. These categories are based on their performances compared to the criteria.

In the assessment criteria, all aspects of graphs were considered. The criteria included if the given statements were transferred correctly into the graphs, if the required graph was correctly drawn, if the axes were well specified and if the graph was correctly interpreted in relation to the required concepts. The total score was 50 marks for the five questions. The economics teacher verified the questions with his coordinator. The questions are reflected in the attached appendix.

RESULTS

Question 1 requires learners to define the concept of a supply curve as it relates to economics. Learners in Category 1 answered Q1 correctly using the necessary terminologies required to describe the concept. Only 11% of the learners fell into this category. A learner defined it as "*the graphical representation of the quantity of goods or services that suppliers are willing and able to supply at different prices.*"

Category 2 represented those learners who had partial misconceptions. We found that 36% of the learners fell into this category. We found that learners misunderstood the 'supply curve' concept to mean 'supply'. These two concepts mean two different things. Some learners defined the supply curve as "the relationship between price and quantity supplied". The supply curve is not just the relationship but a graphical representation of a relationship. Our findings are that learners in this category have not fully conceptualised the concept of the supply curve.

Category three learners could not define the supply curve at all as they just picked the word 'supply' without considering the word 'curve.' Thus, they assigned the literal meaning of supply as providing something to the public, e.g., "government providing water to the public." We found that 50% of the learners who addressed Question 1 were represented by Category 3. These learners confused the literal meaning of supply with the meaning of supply curve.

The key finding from Q1 was that most of the learners tend to overgeneralise economic concepts to a new setting which impede learning.

In Question 2, learners' conceptual understanding of the shift of the supply curve to the right was assessed. Learners

were also required to draw the supply curve, indicate the shift, and label the axes. Our findings showed that 11% of the learners in Category 1 performed well on this question. The learners accurately transferred the information given from the question to the graph. These learners drew the supply curve that reflected the shift to the right of the curves, and they also indicated the axes of the curves perfectly and represented the direction of the shifts with an arrow. These learners indicated the graph's horizontal axis as the quantity of Coke (C) and the vertical axis as the Price of Coke (P). After interpreting the test scores, we found that in the atmosphere of the test, learners could conceptualise the questions and relate them to real-life scenarios. However, it was not encouraging that only 11% of the learners were found in this category.

For learners in Category 2, Question 2 showed a slightly higher percentage of learners (30%) falling under this group. When the learners' test papers were analysed, our findings indicated that although most of the learners drew the correct curves and seemed to have the idea that the curve could shift either to the right or the left, they were confused about the direction of the shift. As a result, most learners indicated a leftward shift of the curve instead of a rightward shift. Furthermore, most of the learners incorrectly indicated the axes.

About 56% of the learners fall into Category 3, and these learners displayed complete misconception on Question 2. Learners in this category did not seem to have understood the 'shift' of the supply curves. These learners confused the 'shift' with 'movement along' the supply curve. This confusion was evident from their test answer papers. Worst still, some learners even drew the demand curve that was taught the previous week. This clearly shows that learners lacked knowledge of the concepts and were confused and unable to differentiate between the demand and supply curves. These learners also lacked relevant knowledge for attributing correct reasoning to Market Dynamics. Only two learners could draw the supply curve, but they wrongly indicated the shifts of the curves with the arrow pointing to the left. In addition, they also interchanged the axes of the graphs. The key finding was that learners demonstrated difficulties when using similar economic concepts and showed misconceptions about the terminology 'shift' to mean 'movement', which could be an effect of what learners gained from instructions.

Category 1 Category 2 Category 3

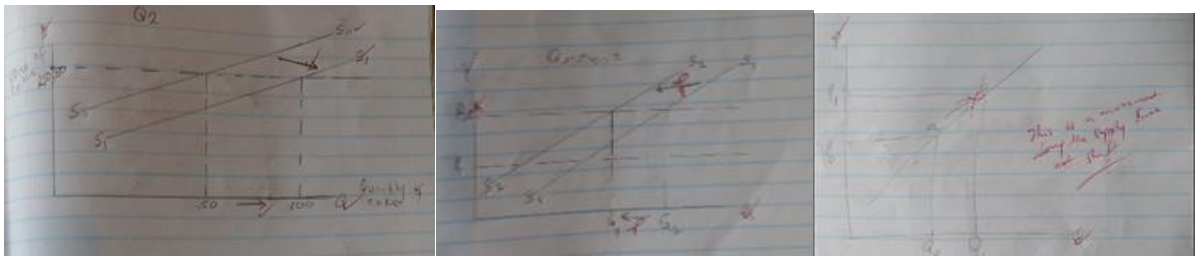


Figure 1. Example of Q2 answers from learners in Categories 1, 2 and 3

Question 3 was designed to assess learners' misconceptions of the shift of the supply curve to the left to make sense of the economic data and apply it to everyday situations. Our findings showed that 11% of the learners in Category 1 answered the question correctly using the correct graph, meaning that these learners understood the concepts of the left shift of the supply curve. The learners could also transfer the information from the question to the graph. These learners did indicate the left shift of the supply curve with an arrow, and the axes were well represented; prices of the chairs

were placed on the vertical axis, while the quantity of chairs were placed on the horizontal axis.

On the same Q3, 28% of the learners fell under Category 2. The majority of the learners were seen to have drawn the correct graphs but could not correctly determine the directions of the curves. Most learners interpreted the graph as a shift to the right of the supply curve instead of a shift to the left. Category 3 learners showed the highest percentage (60%) of learners who could not address Q3. These learners could not transfer the given information to the graph. This Category of learners showed no understanding of the question asked. While this question was set to understand their conceptual understanding of the right shift of the supply curve, it seems they confused this with the movement along the supply curve of the graph. Our finding shows that Category 3 learners are novice learners and have difficulty distinguishing important information from irrelevant information. From our class observation, we saw the need for the teacher to incorporate instructional design features that can highlight important features of the supply curve graphs and assist learners in accurately encoding the shifts and the movements.

Category 1 **Category 2**



Figure 2. Example of Q3 answers from learners in Categories 1 and 2

Question 4 assessed learners' conceptual knowledge of the active construction and interpretation of graphs. The question also exposes learners to the knowledge of transferring data from the supply schedule to the graph. Few learners, 13% in Category 1, captured the correctness of this question. These learners were aware that at a steady state supply is almost vertical. The learners labelled the axes correctly.

For learners in Category 2, 29% of the learners attempted Question 4. In addition, for Q4, the learners in Category 2 attempted to draw the graph but could not reason that the quantity supplied was constant; hence, their construction of the graph was wrong, likewise their interpretations. Our findings showed that most Category 3 learners could not address Q4. For Category 3, those that attempted to do so were completely off the question. These learners could not transfer information from the supply schedule to the graph and, therefore, could not construct the graph. The learners seemed lost on what had to be done, with most of the learners not attempting this question. Our findings through class observations showed that the learners were overloaded with the traditional method of drawing and transferring data without being provided with worked examples.

Category 1 Category 2

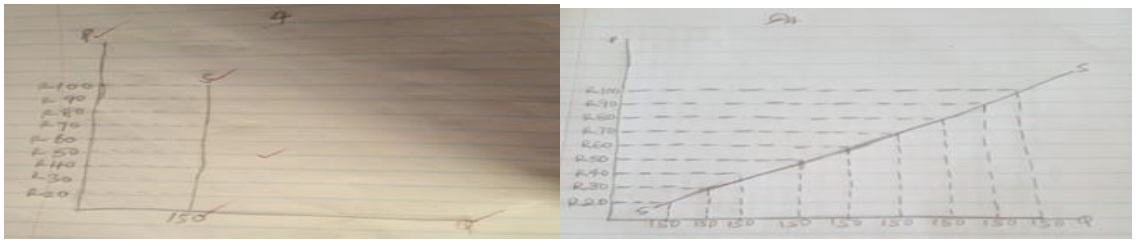


Figure 3. Example of Q4 answers from learners in categories 1 and 2

Question 5 examined learners' conceptual understanding of graphical representation or display formats. The question assessed learners' understanding of the use of colours in graphs. Learners were given a graph that showed both the movement along and the shifts of the curves and were asked to use two different colours to differentiate between the graphs and explain them. Our findings showed that very few learners (8%) in Category 1 could interpret the two graphs represented on the same graphs for Q5. These learners gave comprehensive and excellent explanations of the curves, indicating the shifts and movement along the curves with the arrows.

Category 1 Category 2

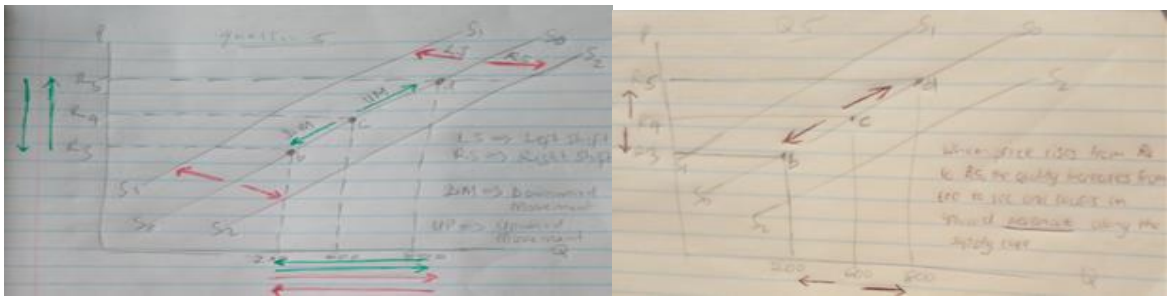


Figure 4. Example of Q5 answers from learners in categories 1 and 2

As for learners in Category 2, 28% of the learners attempted to interpret the graphs but failed to differentiate between the two graphs from the given graph in Q5. This group of learners understood the use of colours to differentiate graphs, but they failed to apply it to this question. Some of the learners thought that the question was wrong and re-drew it. They were somehow confused whether they were correct or wrong; thus, some learners interpreted only one aspect of the graph and left the other aspect unanswered. Fifty-eight per cent (58%) of learners that responded to Q5 fell under Category 3. Indeed, these learners demonstrated ignorance that two different graphs could be represented in one graph and that multiple colours could be used on a particular graph. The finding of this study showed that the learners could not conceptualise the use of different colours on the same graph. Learners believed that colours on graphs were only used to learn the bar chart, the histogram in mathematics or other disciplines. Our findings from question 5 were that while it is important to use visual signalling cues like colours to emphasise important points on the graphs, we noticed a 'split attention effect' where different information was included in different formats in the same graph.

DISCUSSION

This section discusses learners' misconceptions based on the feedback from the test items. Learners' responses to the

questions on the concept of the supply curve were presented based on the five questions on the test item.

In Q1, learners in Category 1 showed no misconception in defining the concept of supply curve in Market Dynamics graphs. Most learners in this category not only defined the concept of supply curve but also used the correct terminologies to explain the concept. This category of learners is classified as having 'no misconceptions', and we can conclude that they have a good conceptual understanding of the concept of the supply curve. This finding is in line with Melhuish's (2019) definition of conceptual understanding as "reflecting knowledge of concepts and linking relationships that are directly connected to (or logically necessitated by) the definition of a concept or meaning of a statement."

Our findings for the Category 2 learners showed that they have not fully conceptualised the concept of the supply curve. Our finding contradicts some of the definitions of conceptual understanding as the learners did not reflect knowledge of the concepts and could not link relationships that are directly connected to the definition of the concept. For Q1, learners in Category 3 showed a complete misconception of the concept of the supply curve. These learners' conception of the supply curve seemed to have been influenced by the daily use of the word 'supply', which supports the findings of Turgut et al. (2011) and Burdina and Sauerb (2015), who believed most misconceptions originated from learners' experiences of their daily lives. In this case, learners should be made aware of the correct subject terminology and language to show a proper understanding of the subject.

Our findings on Q2 for Category 1 learners showed that this group of learners demonstrated an adequate understanding of the concepts of the shift of the supply curve to the right. This finding resonates with the finding of Veith et al. (2022), who interpreted the test score of the learners who performed well as a measure of a complete conceptual understanding, arguing that the test score adequately represents the learner's knowledge domain. In our case, our test score shows that learners' conceptual understanding of the shift of the curve to the right represents the knowledge domain of the learners in this category. Another finding indicated that Category 2 learners exhibited a partial misconception of the shift of the supply curve for Q2. These learners seem confused about the direction of the shift, perhaps because the teacher may not have properly addressed the misconceptions these learners exhibit by incorporating other strategies that would have helped to pre-empt or clarify the concepts. This finding is in line with that of Ng (2016), who concluded that learners' misconceptions need to be addressed by teachers by incorporating the necessary strategies that will pre-empt or clarify concepts.

In Q2, the responses of Category 3 learners showed that they could not make any correct interpretations about the shifts of the curves, nor could they transfer the given statement from the question to the graph. They used the concept of shift and movement interchangeably. The reasons for this confusion could be a lack of familiarity with the content or being too familiar with the concepts of Market Dynamics graphs. Teachers should emphasise these concepts that look alike to enable learners to grasp the difference and overcome the associated misconceptions. These findings correlate with the findings of Glazer (2011) and Xuyan & Yuen (2016) who argued about familiarisation with the content and contended that familiarity with the content influences whether learners could describe a certain trend.

Our findings indicate that Category 1 learners addressed Q3 with understanding. The findings also showed that they have adequate conceptual understanding of the shifts of the curves to

the left and could make sense of it in everyday situations. This finding concurs with that of Çelik and Sağlam-Arslan (2012), who believed that learners should be taught to apply their learnings to everyday situations. It was also found that learners in Category 2 were really confused with the shifts of the supply curve, although they correctly indicated the axes of the curves. It appears that the same group of learners in this category also addressed Q2 of the test paper in the same pattern. This still concurs with Ng's (2016) findings.

Category 3 learners showed a lack of conceptual understanding of the shifts in the supply curve for Q3. This finding is in line with that of Burdina and Sauerb (2015), who identified learners' misconceptions of the concept of the supply curve and gave an example of shifting the supply curve right to illustrate a decrease as a 'physical mindset' derived by learners due to misconceptions with regards to the understanding of graphical representations.

Learners in Category 1 addressed Q4 in a manner that showed that they had developed schemas such as association, comparison, assimilation, and reorganisation of new knowledge with existing knowledge, as Saricayir et al. (2016) suggested in addressing such conceptual questions. The learners correctly labelled both axes. They could transfer information from a given data set to a graph, showing adequate conceptual understanding of the phenomenon. The finding resonates with Bahtaji's (2020) findings that learners' active construction and interpretation of graphs improve their' conceptual understanding. This finding shows that graphs should be drawn according to the given data. Being only familiar with how a graph should be presented could lead to errors if attention is not paid to the given data.

For Category 2 learners, addressing Q4 was somewhat of a challenge as their graphical construction and interpretation were not aligned with theory. The learners were confused about the nature of the graph as they expected to see the usual upward sloping of the supply curve. The learners challenged the direct relationship of the law of supply that says that the quantity supplied increases as the price of the good or service increases in the question as they could not relate theory to practice. Similar findings were reported by Gultepe (2016) on the relationship between theory and prior expectation. We conclude that learners should carefully apply theory to practice, considering the conditions on which the theories were based.

It is worrying that the highest percentage of learners, 61 %, fell into Category 3 for Q4. The learners seemed completely lost in the question. This finding questions the teacher and the teaching strategy that might have been adopted when teaching this concept. The teacher might have encountered difficulties clarifying learners' misconceptions about the concept. This conforms to Mishra's (2020) analysis, which identified the difficulties and problems teachers encounter while handling learners' misconceptions and suggested that teachers should develop adequate skills to treat learners' misconceptions. Ng's (2016) findings also align with the finding of this study that learners' misconceptions need to be addressed by teachers by incorporating strategies that will pre-empt or clarify concepts that tend to be confusing to learners. On the other hand, learners may have memorised the usual supply curve sloping upwards without considering other factors, the data, and other conditions governing the theory of supply. This assertion is in line with Chan et al. (2020), who argued that retrieval associated with rote learning alters the learner's knowledge in response to the demands and goals of the present. There was no conceptual reasoning from the learners concerning the question.

Category 1 learners answered Q5, applying knowledge of graphical

interpretation and clarity on the concept of supply curve when displayed with colours. It also suggests learners' adequate conceptual knowledge of the concepts of the shifts and movement associated with the supply curves. This finding is in line with the findings of Almodaresi et al. (2020), Ahmed (2012) and Chen et al. (2022), who found that the use of colours in graphs helps to retrieve information easily. The findings could also suggest learners' familiarity with the content and concepts, conforming to Glazer's (2011) argument that familiarity with the content could limit misconceptions and affect the ability to analyse a trend. Xuyan & Yuen (2016) contend that learners' familiarity with the content influences whether they could describe a certain trend. Again, the learners were not confused with the different colours used. This also shows that this category of learners has an adequate conceptual understanding of the supply curve, irrespective of how the graphs are positioned.

Our findings in addressing Q5 Category 2 learners showed that learners had an insufficient understanding of graphical interpretations, especially with the application of colours. This finding echoes Neidorf et al. (2020), who also claimed that learners tend to deliberate whether what they are doing is correct. The inability of the learners to apply colours to the graphs could also be due to their mistakes of not paying attention in their 8th grade when the use of colour in graphs was first introduced to learners. Galvin et al. (2015) have similar findings in their biology class, where learners' misconceptions of the concepts of respiration and photosynthesis emanate from their mistakes in biology class at the secondary school and college student levels. Our findings showed that Category 3 learners did not address Q5 as they could not conceptualise using different colours on the same graph. This failure is an example of a split attention effect, which, according to Ward and Sweller (1990), was disastrous to learning. In this way, the majority of the learners became confused. This finding is contrary to the finding by Ahmed (2012) and Chen et al. (2022), who argued that using colours on graphs helps retrieve information easily.

Our findings showed that the answers provided by the learners from the tests were a true reflection of how the teacher taught the learners, having observed the teaching of the supply curve graphs in the classroom before administering the test. The learners tended to exhibit many misconceptions about the supply curve Market Dynamics graphs. Our findings show that the teacher has used the usual traditional method of teaching graphs throughout the teaching period.

We therefore propose an alternative method of teaching using "Worked Examples" to minimise learners' misconceptions in understanding the supply curve graphs. We want learners to construct their own knowledge through worked examples on the supply curve graphs. We propose worked examples where learners follow step-by-step processes or schemas such as association, comparison, and reorganisation of new knowledge with existing knowledge to understand how the graphs were constructed and interpreted. Studying worked examples is encouraged as it reduces the extraneous load normally present in traditional problems, which Sweller (2012) referred to as cognitive load theory. We developed a framework called "Framework to minimise learners' misconceptions in the supply curve graphs," which we believe will help teachers minimise learners' misconceptions of the supply curve in Market Dynamics when adopted. The framework is self-explanatory and could be applied to the teaching of other concepts in different contexts other than the supply curve graphs. The framework is attached in Appendix 2.

CONCLUSION

This study assessed learners' misconceptions of the concept of the supply curve in the Market Dynamics graph. One of the findings were that most learners demonstrated many misconceptions about the difference between the shifts of the curves and movement along the curves. They had difficulty distinguishing between the concepts of shift and movement in the supply curve. Learners also showed misconceptions about using colour to differentiate between trends and graphs on the supply curve graphs.

However, our key findings concerned the reasons for the misconceptions. Most learners overgeneralise economic concepts in a new setting. Another key finding was that learners demonstrated difficulties using closely related economic concepts and showed misconceptions about the terminologies that look similar in meaning. We also found, especially in the presentation of graphs, that the traditional teaching methods resulted in the most misconceptions exhibited by the learners. These findings suggest that the supply curve concepts are not easy to grasp, and learners need to be handled explicitly during teaching and learning.

The study concludes that learners indeed experience misconceptions in Market Dynamics in the supply curve graphs; however, those misconceptions can be minimised using a different teaching approach. This study contributes to teaching and learning difficult concepts in economics in South Africa and globally by proposing a framework for teaching graphical concepts in economics. It contributes to teachers' knowledge of the different areas where misconceptions are most prevalent in understanding the supply curve; thus, the study prepares teachers to pay particular attention to those identified areas. The study recommends that more instructional time be allocated to teaching supply curve graphs, and further studies should be undertaken on other grade levels.

ETHICAL CONSIDERATIONS

This study is part of a larger study where ethics approval was obtained from Tshwane University of Technology with approval number FCRE/MSBE/STD/2018/03. The researcher made sure confidentiality and anonymity was ensured while risks to participants were minimized. Consent letter was given to all participants whereby they were told that they have the right to withdraw at any given time. The aims and objectives of the project was also explained.

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APPENDIX I.

Test item

Q1. Define the concept of supply curve.

(Supply curve is the graphical representation of the quantity of good or services that suppliers are willing and able to supply at different prices)

Q2. Assuming there is a decrease in the cost of production of coke which resulted to a large increase in the supply of coke, illustrate with a hypothetical diagram how the supply curve of the firm will look like indicating any shift of or movement along the supply curve.

(A decrease in the cost of production means an increase in supply which shifts the supply curve to the right)

Q 3. Suppose that the production of chairs is labor intensive and that there is a large increase in the cost of labour which leads to a decline in the quantity supplied at each price level. How will this affect the market supply of chair? Draw and represent this in a graph.

(This means there is a decline in the profit margin of producers leading to fewer chairs being supplied at every price level. The decrease in the supply of chair is shown by the shift of the supply curve up and to the left)

Q4. The data show the short run supply schedule of bananas at various prices. Construct a graph to represent the supply curve. Indicate the axes and interpret the graph.

Table 1. Short Run supply schedule

Price (R)	20	30	40	50	60	70	80	90	100
Quantity (Q)	150	150	150	150	150	150	150	150	150

Appendix 2 Framework to minimise learners' misconceptions in the supply curve graphs.

Framework to minimize learners' misconceptions in the supply curve graphs	
Worked Examples	
Phases	Elements
1. Planning	Decide on the type of worked example to use (e.g., drawing, interpreting, transferring data) Decide on the instructional method to use. Decide on the use of Visual Signaling Cues. Eg. Arrows, colors (because sometimes they can be distractive)
2. Execute the work exampled graphs	Step 1- Have learners understand basic terminologies in the supply curve concept. Step 2-Access learners' prior knowledge of the concept of supply curve. Step 3- Structure the worked examples. -Give different worked examples. -Show step-by-step process of graph constructions -Avoid split attention (Give one information 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. Explanation and Reflection	Step 8- Explain worked-exampled graphs to learners. Step 9- Make room for schemata development. Step 10- Allow learners to reflect on the worked examples.