THE EFFECT OF JIGSAW METHOD ON GRADE 12 LEARNERS' PERFORMANCE IN REACTION RATES IN MALEBOHO CENTRAL CIRCUIT

by

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Declaration

I declare that the study on the research topic**,** the effect of Jigsaw Method on Grade 12 learners' performance in reaction rates in Maleboho Central circuit, is my own work. All the sources that I have used have been indicated and acknowledged by means of complete references.

Moyahabo Jeridah Lehong

Full names

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Signature	**Date**

Dedication

I dedicate this to the subject advisors, science educators and learners around the country, who will be implementing effective educational methods in order to improve the education system.

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ABSTRACT

The purpose of the study was to investigate the effect of Jigsaw Method on Grade 12 learner's performance in reaction rates in Maleboho Central circuit as one of the improvement strategies. A quasi-experimental design with the Experimental Group (EG) and the Control Group (CG) was utilised to determine the effect of the Jigsaw Method on learners' performance as compared to the chalk-and-talk approach. The population of the study was made up of 315 Physical Science learners from ten schools that offer Physical Science in Maleboho Central Circuit. Two poorest performing schools from the same circuit were selected purposively from the population. One class at School A and another at School B were selected randomly as EG and CG, respectively. The sample consisted of 21 learners from school A (EG) and 23 learners from school B (CG). An achievement test with 21 open-ended questions was used as a pre-test as well as a post-test. Data from the tests were analysed using descriptive statistics. In the experimental group, the findings indicated that there was a significant difference between pre-test scores and post-test scores with p=.022. According to the results from Cohen's *d* (-0.94), the gain was large in EG as evidenced by the effect size (-0.95). The results of the t-test (t= 9.54, p=0.00) indicated that there was a statistical significance between the post-tests of EG and CG. Data analysed through ANCOVA (p=0.00) revealed that the Jigsaw Method was more effective than the traditional chalk-and-talk approach. Employing the Jigsaw Method in the Science classroom can help teachers to promote learners' participation and hence to improve their academic performance.

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1. CHAPTER 1: INTRODUCTION

1.1 Introduction

Traditionally, schools are dominated by the teacher-led, chalk-and-talk approach (Lin, Liu & Looi, 2008). Teachers face challenges of applying effective methods of instruction that could enhance academic achievement among students (Jayapraba, 2013). Research in science generally aims to investigate the effect of teaching strategies that could enhance students' achievement (Abdi, 2014). Carpenter (2006) found that a structured, controlled collaboration of the Jigsaw Method would probably be most comfortable for students as opposed to traditional methods. The Jigsaw Method is a cooperative learning technique that has been studied in various ways by many researchers and teachers in classes of different levels and subjects. Marcus (2009) indicates that the jigsaw lessons and classrooms were developed in the 1970s by Elliot Aronson in Austin, Texas, in response to poor performance and low self-esteem of African-American children in the wake of school desegregation.

The Jigsaw is a method for learning and participating in group learning activities (Maftei & Pespecu, 2012). In the jigsaw cooperative learning method, the students organise themselves into groups (Alfaro-Navarro, Fernández-Avilés, Mondéjar-Jiménez, Santamaría & Vargas-Vargas, 2011). Students actively participate in two different workgroups: in one as learners, and the other as teachers or experts (Bresnahan, Conderma & Henin, 2012). Each member of a group is assigned a different part of the material. Then all the students from different groups who have the same learning material gather together and form an "expert group" to discuss and communicate with each other until they all master the material (Mengduo & Xiaoling, 2010).

This method is a cooperative learning technique with a three-decade track record of increasingly positive educational outcomes (Mark, Dollard & Kate Mahoney, 2012). Maden (2011) observed that the jigsaw technique increases success, encourages self-confidence, develops cooperation and interaction, makes students more active and encourages them to research. It also creates a positive learning environment and implies more individual responsibility, encourages cooperation and peer teaching (Kardaleska, 2014). One of the primary advantages of the Jigsaw Method and many other cooperative learning strategies is that they tend to eliminate competition in the classroom and increase the cooperation among the students (Mark, Dollard & Kate Mahoney, 2012). It is no wonder the curriculum recommends a transition from teacher-centred to student-centred learning. Learners learn better when they are actively engaged (Bresnahan, Conderma & Henin, 2012). Active engagement occurs when learners process information through talking, moving, writing, manipulating, interacting, reading, discussing, and exploring values and attitudes rather than just watching and listening. All these benefits point to a single fundamental concept: student interaction (Deibel, 2005)

As an active learning technique, the significant benefit of the jigsaw approach is that it could be integrated into a number of classroom activities that are structured. This method is appropriate when the unit of study can be divided into smaller subunits, and when students are comfortable with learning from and with one another (Bresnahan, Conderma & Henin, 2012). “By making each student part of the solution, the jigsaw technique blurs the distinction between students who know and students who do not yet know” (Maden, 2011:915). Shoval and Shulruf, (2011:59) pointed out that: “Since it is not one single strategy that benefits everyone, it is important to know who benefits more or less from particular learning strategies”. The Jigsaw Method requires all students to make active responses and moves away from the experience of learning as a solitary activity that is detached from the social context (Maden, 2011). If each student's part is essential, then each student is essential; and that is precisely what makes this strategy so effective.

In integrating the Jigsaw Method in the classroom situations, institutions may have concerns about whether students would be inclined to attribute poor performance in the classroom to the relative insufficiency of their classmates’ teaching abilities (Williams, 2004). Such concerns could be remedied by setting limits on the amount of work to be taught by the students (Williams, 2004). For any problem, they are provided with the operating principles, the goals to be met by each group and the basic information structured in blocks. Generally, different students have different learning styles and too many are passive (Maden, 2011). The approach of traditional teaching and students’ assessment lead to student passivity (Maftei & Popescus, 2012).

After learning about science concepts through activities that address the various intelligence and learning styles, many students, still choose not to participate in classroom discussions (Jayapraba, 2013). Schools are dominated by the teacher-led, chalk-and-talk approach (Lin, Liu & Looi, 2008). Teachers ignore effective methods in the science classrooms. If not ignored, they are ineffectively used. The present study therefore investigated the effect of the Jigsaw Method on the performance of Grade 12 Physical Science learners.

1.2 Statement of the problem

In traditional classrooms, learners tend to work independently, and the teacher does most of the talking. The curriculum recommends the transition from teacher-centred to student-centred learning (Department of Basic Education: CAPS, 2011). Learning becomes effective when students are actively engaged (Zakaria & Iksan, 2007). Active learning occurs when students process information through talking, moving, writing, manipulating, interacting, reading, discussing, and exploring values and attitudes rather than just watching and listening (Bresnahan, Conderma & Henin, 2012).

Teachers continue to use traditional methods and ignore active learning methods. They use chalk and talk approach to satisfy the targeted content coverage in the pace setters (Lin, Liu & Looi, 2008). However, these methods do not achieve deep learning because learners are passive and they easily forget concepts and as a result perform poorly in examinations (Maftei & Popescus, 2012). Learners perform poorly when traditional methods are employed. For example, out of 184 383 learners who wrote Physical Sciences final examinations in 2013, only 42.7% (78 677) achieved at 40% and above (Department of Basic Education: NSC Examinations diagnostic report, 2013). Rammala (2009) indicated that poor performance refers to scores below 50%, which is a benchmark for university entrance.

On the other hand, Marcus (2009) indicated that the jigsaw lessons and classrooms were initially developed in the 1970s by Elliot Aronson in Austin, Texas, in response to poor performance and low self-esteem of African-American children. Including the Jigsaw Method in the classrooms may promote learners' motivation in learning, positive attitude and develop interpersonal skills and enrich students' achievement. The study, therefore, compared the effect of the jigsaw and traditional methods on Grade 12 learners' performance in reaction rates.

1.3 Definitions

For this study, a variety of concepts were used, and the following definitions apply to the selected concepts and terminologies**.**

Pacesetters: They are documents set by the Department of Education to guide teachers about what content to teach and at what time of the year.

The Jigsaw Method: It is a specialised group learning method which requires learners to actively construct knowledge themselves, discuss with other group members, share and hence retain more. It promotes student's interaction and collaboration, giving them equal opportunities to reflect and think critically to solve a problem.

1.4 Purpose of the study

The purpose of this study was to investigate the effect of the Jigsaw Method on the performance of Grade 12 Physical Sciences learners in Maleboho Central circuit as compared to the traditional method.

1.5 Research questions

The following research questions guided this study:

1. Is there a difference in the performance of learners taught using the Jigsaw Method and those taught using chalk-and-talk approach?

2. What is the effect of the Jigsaw Method on boys and girls performance?

1.6 Hypotheses

The following hypotheses were formulated:

H1: There is no significant difference in achievement between learners who are taught using the jigsaw learning method and learners who are taught using chalk-and- talk learning method.

H2: The Jigsaw Method improves academic performance of both boys and girls.

1.7 Significance of the study

The approach of traditional teaching and learners' assessment lead to student passivity (Maftei & Popescus, 2012). The study adds to the existing knowledge regarding facilitation in the science classrooms. Based on this background, the researcher decided to undertake a study on the use of the Jigsaw Method to improve conceptual understanding of topics, where learners acted as experts. The proposed study therefore provides teachers with alternative active learning method to the teaching of the concepts of reaction rates. The experience gained in this study could help in motivating teachers to apply the strategy to other topics in Physical Sciences. The results of the study can also serve as a reference material to policy makers to consider and include in the design of their programmes. Finally, the study contributes to further research in determining the effect of the Jigsaw Method on science teaching, at all levels of education.

1.8 Chapter outline

Chapter 1: Background to the study. This chapter provides the background information to the study. It describes the statement of the problem and provides definitions, the purpose of the study, research questions, hypotheses and significance of the study.

Chapter 2: Literature review: This chapter provides theoretical backgrounds to the study. It presents the effect of the Jigsaw Method based on the purpose of the study. Theoretical framework is also provided.

Chapter 3: Research Methodology: The research approach of the study, sampling and sampling strategies, research sites, data collection and data analysis strategies are explained in this chapter. Study delimitations and ethical considerations were taken into account and are also explained.

Chapter 4: Results: This chapter presents the findings of the study and analysis of data from the pre-test and post-test written by the CG and EG. Data were analysed using descriptive statistics such as arithmetic means and standard deviations. Inferential t-tests were utilised to establish significant difference (or lack of it) for using the intervention.

Chapter 5: Discussion and conclusion: This chapter contains a summary of findings from the previous chapter. Based on the findings and literature, the summary is based on the main research questions, study hypotheses, problem statement and purpose of the study presented in Chapter 1. Study limitations are also presented. Conclusions are drawn based on the literature, the findings and also, I made recommendations for further research.

2. CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Studies have revealed a number of problems regarding facilitation of sciences in South African classrooms. The teacher-led chalk-and-talk approach dominates schools. Learners demonstrate a lack of understanding of what is taught because the teacher often does most of the talking (Adams, 2013). However, these method does not achieve deep learning, because learners are passive and they quickly forget concepts and as a result perform poorly in examinations (Maftei & Popescus, 2012). It is possible that many science teachers have inadequate knowledge of proper teaching and learning approaches to use in teaching the content. Thus, many teachers are still transmitters of information in most schools.

Teachers should not be simply transmitters of knowledge but should facilitate the process of learning, to make learning easier (Jia, 2010). Facilitation involves a balance between explaining concepts and allowing learners to construct their ~~own~~ understanding. It is, therefore the responsibility of the facilitator to ensure that, all learners are exposed to the required science concepts. Therefore, teachers must consider how to prepare learning environments in which learners will be active (Abdi, 2014). One of the methods that provide such environment is the Jigsaw Method, which is considered effective in increasing positive educational outcomes (Mengduo & Xiaoling, 2010).

This chapter provides theoretical backgrounds to the study. It presents the effect of the Jigsaw Method based on the purpose of the study. The theoretical framework is also provided. The present research aimed to investigate the effect of the Jigsaw Method on the performance of Grade 12 Physical Science learners on reaction rates.

2.2 Theoretical framework

A number of theoretical perspectives had informed the research on how children learn, and under what conditions they learn. One of the most influential perspectives was developed by a Russian psychologist, Vygotsky in 1978. His theory of knowledge acquisition is often described as social constructivism. Constructivist learning theory is based on the idea that the constructed knowledge is on a base of prior knowledge (Jia, 2010). Moreover, it is proposed that, learners come to learning situation with already formulated knowledge, ideas and understanding. Again, children's knowledge, ideas, attitudes and values developed through interaction with others. He indicated that people do not learn in isolation from others. People naturally learn and work cooperatively throughout their lives.

Furthermore, in the constructivist classroom, learners work in groups**.** According to Resnick theory of effort-based learning, one of the most common claims about group settings is that they force learning with understanding and are likely to foster conceptual change. The teacher facilitates the process of learning where learners are encouraged to be responsible for the learning process. Curriculum, also recommends this transition from teacher-centred to learner-centred learning (Department of Basic Education: CAPS, 2011). Moreover, constructivists suggest that learning is effective when learners are involved in the learning process. However, researchers need to focus on cooperative methods that are more effective (KOÇ et. al., 2010). The teaching approach (jigsaw) chosen in this research builds from the theory of constructivism, since it allows more active involvement of learners in the teaching and learning process.

2.3 Performance in Science

Nyagaga'ia (2012) indicated that chemistry is one of the science subjects which are performed poorly by learners. Rates of reaction and its factors is a critical topic in chemistry. A report on National Senior Certificate indicated that the reaction rate was found to be a challenge to learners (with an average mark of 36%). Even the definition of reaction rate was a challenge (Department of Basic Education: NSC Examinations diagnostic report, 2014). Studies have shown that learners find difficulty in understanding issues such as relationships between reaction rate and factors affecting it (Kurt & Ayas**,** 2011). Furthermore, understanding of many concepts in reaction rates is difficult for most learners. It is even difficult for learners to apply them in real life.

It has been reported that out dated teaching practices and lack of essential content knowledge resulted in poor performance (Makgato & Mji, 2006). Traditional teaching methods still predominate and remain the principle of learning in most schools. Again, it was reported that inadequate chemistry teaching resulted from lack of teachers' training and inadequate prior knowledge on the learners (Ahmadpanah, Soheili, Jahangard, Bajoghli, Haghighi, EHolsboer-Trachsler, Conrad, Brand & Keikhavandi, 2014). Furthermore, some science teachers have inadequate knowledge to teach using appropriate approaches to effect the understanding of the content. Koç, Doymuş, Karaçöp and Şimşek, (2010) also reported that rate of chemical reactions was found to be difficult for learners, mostly because it generally involves more complex mathematics, as well as qualitative explanations for both rate equations and factors that affect the rate of reaction. These challenges make learning difficult. Teachers are therefore encouraged to use effective methods when teaching science.

Keller (2013) conducted a study to help learners to acquire the science content knowledge to improve student knowledge in the processes of inquiry-based learning (IBL), and increase student engagement in appreciation of science. He found that IBL took a long time, and it was not possible to cover enough subject matter in the time. Some learners found the change to be too challenging because they felt lost and didn't know what to do. This challenge cannot be resolved by just adopting new standards or curriculum.

Changing the way of teaching and what to teach is a great concern. Teachers need to ensure that teaching is effective. Efforts should be taken to direct the presentation of science lessons away from teacher centred to a more student-centred approach (Zakaria & Iksan, 2007). A variety of teaching methods are recommended for use in science ranging from teacher-centred to learner-centred approach. One of such methods is the Jigsaw Method. The Jigsaw Method reduces teachers' dominance, and learners' reluctance to participate in the in the classroom (Mengduo & Xiaoling, 2010). It increases the amount of student participation in the classroom.

Doymuş and Karaçop (2011) investigated the effect of the Jigsaw and Animation techniques on student's understanding of concepts and subjects in electrochemistry.

The researchers used 122 first-year undergraduates chemistry learners of Aturk university in Turkey. When the learning ability and understanding of concepts were tested, no significant difference was found between the jigsaw and animation group, but they had little improvement as compared to traditional method. Traditional based instruction emphasises the passive acquisition of knowledge, and poor memorisation of concepts being taught (Zakaria & Iksan, 2007). Instruction is, therefore not for conceptual understanding. Learners who are exposed to the Jigsaw Method have the good conceptual understanding and can perform successfully.

The results above are in parallel with the results of the study conducted by Koç, et. al., (2010), who investigated the effect of the Jigsaw Method on ‘reaction rates’ with undergraduate learners in Erzurum-Turkey. They found that the Jigsaw Method was more effective than other traditional methods. According to these researchers, the reason can be attributed to the difference in the application process of the techniques, and to the fact that learners were directed and encouraged to express their ideas in a warm atmosphere to convey and cooperate with their peers. The researchers suggested that student-centred teaching should be implemented in the presence of an expert.

2.4 The Jigsaw Method

The Jigsaw Method is a research-based cooperative learning invented and developed in the 1970_s by Elliot Aronson and his group in response to poor performance of African American children (Al-Salkhi, 2015). It is a specialised group learning method which requires learners to construct knowledge themselves actively, discuss with other group members, share and hence retain more (Marcus, 2009). Learners work together in a group towards a common goal (Messerchdmidt, 2003). Learners listen to and respect one another. It promotes learners’ interaction and collaboration, giving them equal opportunities to reflect and think critically to solve a problem. Learning is most effective when the learner is active, and the process of learning is interesting for him.

In order to have effective student-student interaction, learners should be provided with cooperative tasks (Mehta & Kulshrestha, 2014). Active learning occurs when learners process information through talking, moving, writing, manipulating, interacting, reading, discussing, and exploring values and attitudes rather than just watching and listening (Deibel, 2005). The Jigsaw Method is particularly confirmed as an efficient and successful cooperative learning technique **(**Ahmadpanah, et.al., 2014). Learners take responsibility for the learning process, and the teacher is a facilitator.

2.5 Advantages of Jigsaw Method

Despite of the advantages of cooperative learning, Elliot Aronson and other teachers in Austin, Texas developed a cooperative learning method called the jigsaw (Al-Salkhi, 2015). It promotes learners' interaction and collaboration, giving them equal opportunities to reflect and think critically to solve a problem. The Jigsaw Method was particularly confirmed as an efficient and successful cooperative learning technique **(**Ahmadpanah, et.al., 2014). The Jigsaw cooperative learning improves acquisition of knowledge relative to traditional teaching. It emphasises cooperative learning by providing learners with an opportunity to actively help each other, as it implies more individual responsibility by encouraging cooperation and peer teaching (Kardaleska, 2014). Learners are likely to succeed through helping each other. Understanding and skills in the learning area being taught are improved (Messerchdmidt, 2003).

The method can also improve the quality of teacher instruction as well. The Jigsaw Method allows the teacher to divide learners into groups and break down assignments into smaller pieces. Small groups allow teachers to engage in more individualised teaching to have effective the Jigsaw cooperative learning (Blatchford, Brown & Basset, 2011). Group size also plays an important role. Bresnahan, Conderma and Henin (2012) proposed that learners working in small groups can approach more complex tasks. Small groups enable learners to interact, share answers and receive feedback. Learners can share their knowledge, learn from one another, and practice social skills. Based on the studies above, the benefits of using small groups are learners' engagement and mastery of complex materials. This study used small numbers of learners in each group, to increase learner engagement. Learners are not so reliant on every word the teacher is saying. The teacher is a facilitator, and the learner responsible for the learning process. Numbers of studies had been conducted to find the effect of this method on learners' Performance.

2.6 The Jigsaw Method over other learning methods

The South African curriculum recommends a transition from teacher-centred to student-centred learning (Department of Basic Education: CAPS, 2011). Learning becomes effective when learners are actively engaged (Zakaria & Iksan, 2007). The Jigsaw technique allows active involvement in the teaching and learning process, thus creating an active learner-centred atmosphere. Several studies investigated the effect of the Jigsaw Method on learners' learning.

Azmin (2015) investigated the effect of the Jigsaw Method on student performance in psychology and views towards that method. The sample of the study included one class of Form Six College in Brunei with 16 learners, seven boys and nine girls. He found that the Jigsaw Method improved the performance of learners, which led to better learning outcomes. He further indicated that the procedure used by this method helped the learners to perform better. Furthermore, findings from the open-ended survey indicated that the Jigsaw Method was favourable to learners. The study used small numbers of learners. Small groups allow teachers to engage in more individualised teaching to have effective jigsaw cooperative learning (Blatchford, Brown & Basset 2011). Small groups of learners in learning are responsible for teaching material to their peers. The smaller the group size, the higher the individual accountability may be. All learners in a group are held accountable for doing their share of the work and for mastery of all the material to be learned.

Brand and Keikhavandi (2014) investigated children's social skills and acquisition of science knowledge in Iran. The participants included 120 fifth grade learners from 13 elementary boys' schools in Ilan city, Iran. A quasi-experimental pre/post-test assessment test was used. Also, the Jigsaw Method was deemed to improve the

social skills and the acquisition of knowledge in science, though it was tested on boys only.
Another study that used a sample of only girls was conducted in Amman, Jordan by Al-Salkhi (2015), to find out the effectiveness of the Jigsaw strategy on the Performance and learning motivation of grade 7 primary learners. The sample of the study consisted of 53 female learners: 26 learners in the Experimental Group, and 27 learners in the Control Group. The researcher used a semi-empirical procedure to investigate the effectiveness of the Jigsaw strategy, where the Performance test and the motivation learning scale of Islamic Education were used. The Jigsaw Method was found to be successful in improving learners’ academic performance.

The results of the above studies are consistent with the results of Najmonnissa, Amin, and Ismail (2017), who also investigated the effect of the Jigsaw Method on learners’ academic Performance in Karachi. A quasi-experimental design was employed. The participants of the study included 128 Grade, 7 female learners. The findings revealed the efficiency of the Jigsaw Method on learners’ learning. We can see that in some studies the samples included only girls and other studies the sample included only boys. The studies were homogeneous regarding gender. The Jigsaw Method improved learners’ performance irrespective of gender. According to Yorak (2016), group success is not based on gender, but on group success itself. Further research is required to investigate the effect of the Jigsaw Method with the heterogeneous group in terms of gender. Gender was not heterogeneous. In contrast, this study explored the strategy with heterogeneous groups. On the other hand, the samples of the three studies above included only primary learners.

Fini conducted a study that also included primary learners, Jamri and Zainalipour (2012) to investigate the effect of cooperative learning as compared to the Jigsaw Method on the academic Performance of 2nd -grade middle school learners in District 1 of Bandar Abbas city, Iran. A study that also included primary learners was conducted by Fini, Jamri and Zainalipour (2012) in order to investigate the effect of cooperative learning as compared to the Jigsaw Method on the academic Performance of 2nd -grade middle school learners in District 1 of Bandar Abbas city, Iran. The sample size included 153 learners, 89 of which were girls and 64 were boys. This study applied the Jigsaw technique on 76 learners and the traditional method of instruction on 77 other learners. The researcher considered semi-experimental research. It had an experimental group and a control group and used a pre-test and the post-test methodology. The findings of the study indicate that a cooperative learning method that focuses on the Jigsaw technique has significant effect on learners' Academic Performance. The sample of the study included primary learners. Further research can be carried out to study the effect of the jigsaw cooperative learning on the learners at higher grade as well.

Further study on primary learners was conducted by Amadpanah, Soheili, Jahagard, Bajoghli, Haghighi, Holsboer-Trachler, Conrad, Brand and Keikhavandi (2014) to investigate childrens' social skills and acquisition of knowledge in Iran using the Jigsaw Method. The participants included 120 fifth grade learners from 13 elementary boys' schools in Ilan city, Iran. A quasi experimental pre/post-test assessment test was used. It was found that the Jigsaw Method improved the social skills and acquisition of knowledge in science, though it was tested on boys only. According to the researchers, the Jigsaw Method allows more active engagement of learners in the teaching and learning process. Researchers proposed that further study is required to investigate the effect of the Jigsaw Method in the non-western countries, different grades and subjects.

Yorak (2016) investigated the effect of the Jigsaw Method on learners' 'Chemistry Laboratory Performance' in Turkey. The sample consisted of 63 learners who were studying at an elementary science education program. Learners were divided into two groups using the true experimental design. Further analyses were carried out to investigate the gender factor. The research revealed that the Jigsaw Method increases learners' academic Performance. The findings revealed that, group success is not based on gender, but on group success itself. It depends on what learners are doing in the groups. The Jigsaw Method improved learners' understanding of concepts.

The results are consistent with the results of the study conducted by Jimoh, Idris, and Olatunji (2016), who examined the effect of the jigsaw cooperative learning strategy and gender on academic Performance of learners. The study adopted a 2X2 factorial design comprising two groups (control and experimental). The population of the study included 405 final year cost accounting learners drawn from two colleges of education in Ogun State. The study also revealed that gender did not contribute significantly to varying learners’ Performance scores. The Jigsaw Method improved learners’ performance even if gender was homogeneous.

Similar results on the Jigsaw Method were discovered by Marhama and Mulyadi (2013). Their study focused on investigating the effect of the jigsaw cooperative learning instruction on second-year undergraduates’ Performance of Teaching Learning Strategy. Undergraduates’ opinions about the jigsaw cooperative learning instruction were also investigated. The results showed that learners in the experimental group had more significant improvement on Performance measures than the learners in the control group who were taught using the discussion method.

The significant findings of the two studies support the effectiveness of the jigsaw learning. The researchers used one class and divided it into experimental, in which the Jigsaw Method was employed, and control group, in which group discussion was employed. The present researcher intended to employ the strategies in two different groups. The above studies proved the effectiveness of the Jigsaw Method, but with learners at lower grades and university level. It did not include learners at senior level. There is lack of evidence of the use of the Jigsaw Method in the senior phase.

The results of the studies above are in conjunction with the results of the study conducted by Arif, Rachmawaty and Wijaya (2013), which reported that the learners reading comprehension in descriptive text improved in three cycles by using the jigsaw technique. The above researched class VIII A which consisted of 32 learners. Research used to examine teaching practice is classroom action research. Classroom action research is a kind of research that is used to examine teachers’ practices, to solve problems and to do innovation in their teaching. The researcher and the teacher planned the process together. The researcher there acted as a collaborator, while the teacher was teaching. They gave feedback to each other about what had been done. After that they moved to the next cycle, in improving the teaching and learning process. The study used three cycles on the same group. It was found that, the learners’ reading comprehension of descriptive text improved in three cycles by using the Jigsaw technique**.** The lesson was repeated until the teacher got the strategy well.

The results showed that the learners' reading comprehension on descriptive text improved in three cycles by using the Jigsaw II technique**.** The cause of improvement was because learners received the same information many times. Therefore, the present study focused on the use of the Jigsaw Method on two groups, which are experimental and control groups. The researcher was the teacher. The teaching strategy was implemented once in each group. This means each group received information once.

On the other hand, Vargas-Vargas (2011) investigated the effect of the jigsaw cooperative learning on attitudes towards statistics in New European Higher Education. He wanted to find out whether jigsaw cooperative learning could increase motivation and learners' satisfaction. Data were collected from the Study Process Questionnaires. The results for attitudes towards statistics indicated that the jigsaw cooperative learning provided some improvements which were not statistically conclusive. More studies about the Jigsaw Method need to be conducted. Learning focused on attitudes towards the new method. The present study collected data from the pre and post-test to find out how the strategy could improve learners' learning and performance. This can enable the researcher to make real judgements on the process of learning, as learners were tested on questions from the topic taught.

Maden (2011) conducted a study which aimed to compare the effects of the Jigsaw I technique from the cooperative learning methods with traditional teaching method on academic performance and retrieval of Turkish teacher candidates in the matter of written expression. The sample of the study consisted of 70 learners studying at the Department of Turkish teaching College. "The Model of pre-test/post-test with control group", was employed. Besides, experimental groups' pre-test and post-test, stability test and the Jigsaw technique were found to be more effective than the traditional method.

Kilic (2013) investigated the effect of group research, the jigsaw techniques and traditional teaching methods on democratic common attitudes and academic performances of first-year university learners studying “Introduction to Educational Science”. The participants in this research were the first-year learners from the Department of primary teacher training in a large state university in the Eastern Anatolia Region of Turkey. A mixed design was used in the research. It has been observed that the learners, who have taken education via the group research technique, have been more successful than the learners who have taken education via the jigsaw technique and the traditional teaching method concerning post-test academic performance scores. The cause may be the fact that it was investigated on the university learners. There are lots of diversities at that level. Baker and Clark (2010) investigated cooperative learning in multicultural groups. They found that differences can influence characteristics such as decision making, quality and group member satisfaction. The present study focused on Grade 12 Physical Science learners from the same geographical area.

In addition to the findings above, Crone and Portillo (2013) conducted a study to find out whether the jigsaw classroom would have an effect on learners’ attitudes about their academic abilities and practices at university level. The sample of the study included learners at an urban, minority-serving the University. Seventy learners (11 men, 59 women) enrolled in one of the three sections of cognitive psychology participated in at least one aspect of data collection. Different professors taught those sections. One section received a full jigsaw exposure, one received a reduced jigsaw exposure, and one received no jigsaw exposure. Participants in the full jigsaw schedule reported having more confidence in their ability to communicate orally about psychology, to teach class materials to others, and an increased belief in themselves as scholars as compared to the control group. Based on the results of the above study, the lack of effects may be due to learners not feeling fully prepared for the jigsaw activity. Learners need to be prepared on what is expected of them, based on the teaching strategy to be implemented.

Learners used in the above studies were from urban universities. There are lots of diversities as learners were from various geographical backgrounds. Differences can influence characteristics such as decision making, quality and group member satisfaction (Baker and Clark, 2010). The study which focus on secondary learners from rural schools, need to be conducted. Most studies discussed above are supporting the use of the jigsaw learning strategy as compared to other methods such as lecture, traditional, animation method, original group method and enquiry based learning (Al-Salkhi, 2015; Amadpanah et al., 2014; Arif, Rachmawaty & Wijaya, 2013; Arif, Rachmawaty & Wijaya, 2013; Fini, Jamri & Zainalipour, 2012; Marhama & Mulyadi, 2013; Bukurlola & Idowu, 2012; Vargas-Vargas, 2011; Doymus & Karakop, 2011; Maden, 2011; Azmin, 2015; Crone & Portillo, 2013; Yorak, 2016.)

Only a few studies found that the use of jigsaw is as effective as other learning methods (Killic, 2013; Crone & Portillo, 2012; Doymus & Karakop, 2011). The traditional method did not improve learners' understanding of concepts in most studies as compared to jigsaw and other methods. Crone and Portillo (2012) used very few boys in their study. Girls were dominating boys. Some studies were homogeneous concerning–gender. Amadpanahn et.al., 2014), used only boys in Grade five from 13 elementary schools. Al-Salkhi (2015) used only girls in his study. The researcher in the present study used heterogeneous groups in terms of gender. Some researchers used very large classes (Fini, Jamri & Zainalipour, 2012).

Moreover, studies about the Jigsaw Method took place in foreign countries like Iran, Turkey, Europe, Indonesia and Nigeria. There is lack of research about the effectiveness of this method in South Africa and even in Maleboho Central Circuit. There is a need to investigate this method using learners in the mentioned circuit above. Furthermore, most of the participants in the studies discussed above are university learners (Killic, 2013; Crone & Portillo, 2012; Marhala & Mulyadi, 2013; Maharma & Mulyadi; 2013; Azmin, 2015; Vargas-Vargas, 2011; Maden, 2011; Doymas & Karakop, 2011). Few used junior primary and junior secondary learners (Fini, Jamri & Zai 2012 & Amadpanah et al., 2014) used lower grade learners. Arif, Rachmawaty and Wijaya (2013) and Bukurlola and Idowu (2012) used class VIII in junior secondary schools. There is lack of evidence of the use of the Jigsaw Method on the high school senior phase, especially in Physical Science. This study, therefore, researched the effect of the Jigsaw Method on the performance of Grade 12 physical science learners on reaction rates.

2.7 Conclusion

Traditionally based instructions in learning emphasise the passive acquisition of knowledge and poor memorisation of concepts being taught. Efforts should be taken to direct the presentation of science lessons away from traditional to a more student-centred approach. In addition, Koç, et. al. (2010) suggested that student-centred teaching should be implemented in the presence of an expert. The Jigsaw Method was considered effective in increasing positive educational outcomes (Mengduo & Xiaoling, 2010).

The Jigsaw Method is mostly investigated in foreign countries and it worked well. In some studies, the sample included only girls, and in other studies, the sample included only boys. Again, primary and tertiary learners were sampled for the effect of the Jigsaw Method in most studies discussed above. Further studies are also required to investigate the effect of the Jigsaw Method in the non-western countries, higher grades, different subjects and heterogeneous groups. Research of the Jigsaw Method on learners' understanding of reaction rate concepts is limited (Abdi, 2014). The present research aimed to investigate the effect of the Jigsaw Method on the performance of Grade 12 Physical Science learners on reaction rates.

3. CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The present study investigated the effect of the Jigsaw Method on the performance of Grade 12 Physical Science learners in Maleboho Central circuit as compared to the traditional method (the chalk-and–talk approach). The research approach of the study, sampling and sampling strategies, research sites, data collection and data analysis strategies are explained in this chapter. Study delimitations and ethical considerations were taken into account and are also explained.

3.2 Design

The study adopted a quantitative approach, in order to achieve the research objectives. Quantitative research typically explores specific and clearly defined questions that examine the relationships between two events (Cohen, Manion, & Morrison, 2007). It was used to examine the cause and effect of relationships between variables. The study adopted this method as it compared the influence of intervention between two groups.

A quasi-experimental design was used, with Experimental Group (EG) and Control Group (CG) was utilised to determine the effect of the Jigsaw Method on learners' performance (Cooper, 2012). Quasi-experimental design involves selecting groups, upon which a variable is tested, without any random pre-selection processes (Cohen, Manion, & Morrison, 2007). The experimental group was taught using the jigsaw learning method, which included activities such as group discussions, problem-solving, hands-on activities and writing tests. The control group was taught using the traditional method using activities such as demonstrations, discussions and writing tests.

3.3 Research Sites

The present study took place at two different secondary schools designated A and B in Maleboho Central Circuit. School A was the Experimental group (EG) and School B was the Control Group (CG). A non-equivalent pre-test and post-test design was used. The researcher was responsible for the EG and CG during implementation and marking of the tests, and also taught CG using the traditional method (chalk-and-talk approach). The researcher collaborated with one Physical science teacher from school B who administered tests in the CG.

3.4 Sample and Sampling Strategy

The population of the study included 315 Grade 12 Physical Sciences learners from 10 schools in Maleboho Central Circuit that offer Physical Sciences. Forty-four learners, (21 from school A and 23 from school B) from two schools that offer Physical Science in the above circuit were purposively selected based on their performance which was the poorest among all the schools in the mentioned circuit. The selection of schools had been done through purposive sampling, but classes were randomly assigned as Experimental Group (EG) and Control Group (CG) groups. The experimental group was taught using the Jigsaw Method (new method and not familar) and the control group was taught using the traditional method (familiar). Geographical background of the learners was comparable and their age ranged from 17 to 18. The researcher taught the two classes during normal instruction time.

3.5 Data Collection

Data were collected from pre-test and post-tests written by the EG (21 learners) and the CG (23 learners). The same pre-test was given to both the CG and EG before employing the jigsaw cooperative learning. After the pre-test, the EG was taught using the Jigsaw Method, and CG was taught using the chalk-and-talk approach. Classroom instruction for the treatment groups was four hours per week. Learners were observed in formal classroom settings during the two weeks period.

A post-test was administered to the EG and CG, to check for any differences in performance of the two groups after the implementation of the different treatments. Cohen et al (2007) indicated that the period between the pre-test and post-test should not made too long, since the situational factors may change, and also not too short that the participants will remember the first test.

For validity, the designed lesson plan, pre and post-tests were checked by a senior lecturer from the university and four science teachers from neighbouring schools in the same circuit. For the tests, five raters used a five-point Likert scale supplied by the researcher to rate each test item. The researcher then calculated the content validity index. It is the extent to which an assessment accurately measures what it is intended to measure. The values range between 0 and 1. Assessments with coefficient 0.6 and above were considered acceptable or highly valid. The calculated CVI was found to be 0.95. This was calculated using the formula $CVI = N_x/N$. N_x refers to number of items receiving positive ratings of content relevance from all raters. N refers to total number of items on measure. Test items were relevant for the study.

For reliability, the researcher piloted a pre-test on 10 Grade 12 Physical Science learners from school C of the same circuit as school A and B, who did not be take part in the investigation. Lee Cronbach developed Alpha in 1951, in order to measure the internal consistency of a test. Internal consistency is connected to the inter-relatedness of the items within the test (Tavakol & Dennick, 2007)**.** He expressed it as a number between 0 and 1. The calculated Cronbach Alpha was 0.80, showing a high degree of internal consistency of the test items according to the output in Table 3.1 below.

Table 3.1: Cronbach Alpha output.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.801	.80	21

3.6 Intervention

Control group's participants were traditionally taught by the teacher, who explained concepts to learners. Afterwards, learners prepared themselves for the post-test at school. In experimental group, the teacher assigned learners to home groups and prepared them based on the new method. The chapter was split into five topics.

Each student was given a specific topic to study and provided with materials to read. Learners were provided with the background of the topic and were asked to discuss their topic within their groups. Learners studying the same topic aligned with each other to form expert group. In expert groups, learners exchanged ideas and discussed issues together. The teacher assigned expert sheets to expert groups, assessed validity of their responses and asked questions based on the original material. Learners answered expert questions and completed the expert sheets. Learners returned to home groups to share information of what they have learned, with their peers in the home group. The teacher reviewed and clarified any concepts which the learners did not understand. The teacher assessed each student using the post-test. He then revised any topic found to be difficult based on the post- test assessment.

ALLOCATION OF THEMES

Learners were given cards. Letters represented home groups and numbers, expert groups. A learner having card A1 was in home group A and expert group1

Table 3.2: ***Allocation of themes.***

	HOME GROUP				**THEMES**
EXPERT GROUP	A1	B1	C1	D1	Temperature
	A2	B2	C2	D2	Concentration
	A3	B3	C3	D3	Surface area
	A4	B4	C4	D4	Pressure
	A5	B5	C5	D5	Catalyst

3.7 Data Analysis

Data were analysed using descriptive (means and Standard deviations) and inferential statistics (t-tests, Cohen d and Analysis of Covariance (ANCOVA). Descriptive were used to determine change of one variable over the other. Inferential statistics were utilised to establish significant differences after the intervention. T-test was used to discriminate between the performances of the groups before and after the intervention of the Jigsaw Method and the traditional chalk-and-chalk approach. Cohen's d was used to measure the effect size between the two groups after intervention and ANCOVA was used to determine if the intervention had any effect on the performance of the two groups.

3.8 Delimitations of the study

The present study was applicable to Grade 12 Physical Sciences learners in Maleboho Circuit. The study was conducted in two secondary schools performing poorly in Physical Sciences from the above-mentioned circuit, since they had similar cultural and educational backgrounds. The study took place in the classroom only. Learners were taught by the same teacher during normal instruction time. Only a quantitative approach was employed in this study.

3.9 Ethical considerations

The researcher was granted permission from the University of Limpopo (UL) Research Ethics Committee, Department of Education, circuit office, school principals, learners and parents. Recruitment of learners and teachers who participated in the study was done procedurally according to section S71 of SA Health Act, 2012. Learners were given equitable alternatives to participate in the research. The following ethical issues were observed when conducting this research: Informed consent, confidentiality, anonymity, respect and discontinuance, according to section S71 of SA Health Act, 2012.

3.9.1 Informed consent

Informed consent seeks to incorporate the rights of autonomous individuals through self-determination. Autonomy is the ability for self-determination in action according to personal plan. Individuals can make informed decisions in order to participate in the research voluntarily, only if they have information on the possible risks and benefits of the research before the research begin (Fouka & Mantzorou, 2011).

The purpose of research, expected duration and procedures were also made clear to the participants. An instruction of the participants' right to decline to participate and to withdraw from the research was clarified to the participants. To comply with the above requirements, all the participants were asked to sign consent forms after observing all the above issues, and before the beginning of the research.

3.9.2 Discontinuance

It is the freedom of the participant to withdraw without giving any reason without being penalised. The researcher made plain the participants' rights to withdraw from the research at any time, irrespective of whether or not payment or other inducements were offered (Fouka & Mantzorou, 2011). The researcher ensured that the participants knew their rights to withdraw. The participants had the rights to withdraw retrospectively, and to require that their own data, including recordings, be destroyed. This principle was observed by including a statement of explicit, informing the participants that they were free to withdraw from the research without offering any inducement or payment.

3.9.3 Confidentiality

Confidentiality relates to the protection of data gathered. It is the management of private information by the researcher in order to protect the subject's identity (MacLlean & Poole, 2010). Participants in Science research have the rights to expect that the information they provide will be treated confidentially and if published, will not be identifiable as theirs. The researcher informed the participants about the methods which would be used to protect anonymity and confidentiality.

3.9.4 Anonymity

Making data anonymous means that the contributors' names are not disclosed in order to protect participant's identity. The researcher took as many precautions as she could to protect anonymity and gave an advice of any special action participants should take, to avoid risk. Anonymity is protected when participant's identity cannot be with personal response (Fouka & Mantzorou, 2011).

3.9.5 Respect

This principle requires the researcher to avoid discrimination against colleagues or learners on basis of sex, race, gender, ethnicity or other factors that are not related to their scientific competence and integrity (David & Resnic, 2011). In this study, all people taking part were treated equally irrespective of their gender, social, economic and religious differences.

3.10 Conclusion

This chapter clarified the research methodology which included design, research sites, sampling and data analysis. Aspects of ethical considerations were discussed and strict rules governing the aspect of the study were observed throughout the whole process of the study. Study delimitations were also clarified. Data analysis is explained in the next chapter and further discussed.

4. CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents an analysis of data and findings from the pre-test and post-test written by the CG and EG. To determine the difference between the variables of the two groups, descriptive statistics of the test scores were calculated. An independent t-test was further applied to see whether a significant difference existed among the mean values. The level of significance was observed at 0.05 alpha level.

The EG and the CG did not differ significantly in their pre-tests (t-value = 1.468, and p-value = .071). Again, learners in the control group did not improve significantly in their post-tests. The findings revealed that the experimental group improved significantly in their post-tests. Also, a statistically significant difference was found between the experimental and the control groups' post-tests (t= 9.536 and p=0.001).

4.2 Presentation:

The table below shows the pre-test scores for each learner in the experimental and control groups.

Table 4.1:Pre- test scores for experimental and control groups.

Learner number	Experimental: Marks for each learner	Control: Marks for each learner
1.	8	20
2.	22	28
3.	28	16
4.	24	16
5.	14	18
6.	26	16
7.	18	12
8.	20	18
9.	16	6
10.	22	12
11.	12	26
12.	26	24
13.	14	10
14.	14	22
15.	10	22
16.	26	16
17.	12	22

18.	26	14
19.	30	24
20.	8	22
21.	12	20
22.		22
23.		12

Learners in the experimental and the control groups were given the pre-test to test their abilities, before employing intervention strategy. Their results were recorded and presented in Table 4.1 above.

Learners in the experimental and control groups were further given the post-test after the implementation of the intervention strategy. Table 4.2 below shows the post-test scores for each learner in the experimental and control groups.

Table 4.2:Post-test scores for experimental and control group.

Learner number	**Experimental: Marks for each learner (%)**	**Control: Marks for each learner (%)**
1.	92	56
2.	82	40
3.	86	50
4.	56	44
5.	66	48
6.	98	56
7.	74	56
8.	84	36
9.	84	44
10.	60	48
11.	64	52
12.	78	48
13.	82	46
14.	84	54
15.	96	46
16.	68	50
17.	82	56
18.	48	48
19.	78	40
20.	82	48
21.	70	56
22.		46
23.		50

TABLES FOR OVERALL RESULTS

In order to determine the difference between the variables of the two groups, descriptive statistics of the test scores shown in Tables 4.1 and 4.2 were calculated and a t-test was applied to see whether a significant difference existed among the mean values. Tables 4.3 to 4.14 present the overall results of the pre and post-tests.

The table 4.3 below shows outcomes of the t-test results between the experimental and the control groups before the intervention was employed.

Table 4.3***: T-test results of the experimental and control groups' pre-test (significant at p < .05).***

Groups	N	Df	Mean	St.dev	t	p
Experimental	21	42	18.48	7.04	.16	.07
Control	23		18.17	5.52		

Table 4.3 reports the outcomes of the independent t-test for the overall mean scores for the experimental group (M = 18.48, SD = 7.04) and the control group (M = 18.17, SD = 5.52). The means of the pre-test scores for the experimental and control groups are 18.48 and 18.17 respectively. The mean of the experimental group is slightly higher than the mean of the control group, but this small difference is not statistically significant. Analysis shows that t-value = .16, and p-value = .07. The results indicated that p value is greater than 0.05 alpha value. There was no statistically significant difference between the pre-test scores of the experimental and control groups. The lack of any significance indicates that learners in the EG and CG were at the same level of understanding at the beginning before the intervention strategy was employed.

A t-test analysis was further applied to compare the results of pre and post-tests for the control group. The results are presented in the table below:

Table 4.4: T-test results of the control group's pre- and post-test (significant at p < .05).

Tests	N	Df	Mean	St.dev	t	p
Pre-test	23	21	18.17	5.52	-18.55	.84
Post-test	23	22	48.61	5.60		

Table 4.4 presents the results of the independent t-test for the overall mean scores of the pre-test against post-test for the control group. The means and standard deviations for the pre-test (M = 18.17, SD = 5.52) and post-test (M = 48.61, SD = 5.60) are presented in the above table. The mean of the post-test was found to be higher than that of the pre-test, but when the mean values were compared using the independent t-test, no statistically significant difference was found. The independent t-test showed that t= -18.55 and p = .84. There is no statistically significant difference between these means, as the p-value is less than 0.05 Alpha value.

An independent t-test was further used to analyse the results of pre-test versus post-test for the experimental group. The results are presented in the table below.

Table 4.5: T-test results of the experimental group's pre- and post-test (significant at p < .05).

Tests	N	Df	Mean	St.dev	t	p
Pre-test	21	20	18.48	7.04	-18.15	.02
Post-test	21	20	76.86	12.95		

Table 4.5 above presents the results for pre-test versus post-test scores for the experimental group. The mean scores and standard deviations were reported as (M

= 18.48, SD = 7.04) for the pre-test and (M = 76.86, SD = 12.95) for the post-test. The mean gain is 58.38. This revealed a large improvement in the experimental group. When an independent t-test was applied to compare the difference between these mean values, a statistically significant difference was found. The t-test results (t =-18.15 and p =.02) in the above table confirmed that there is a significant difference between the means of the pre-test and the post-test in the experimental group, as indicated by $p<0.05$. Learners performed significantly better after being exposed to Jigsaw Method in their lessons. This indicates that the Jigsaw Method applied in the experimental group was effective method in enhancing learners' performance.

The post-test scores for the experimental and control groups shown in table 4.2 were further analysed using the SPSS software (Statistical Package for Social Sciences). The t-test results are shown in table 4.6 below.

Table 4.6: Post-test results of the experimental and control groups (significant at p < .05).

Groups	N	Df	Mean	St.dev	t	p
Experimental	21	20	76.86	12.95	9.54	.00
Control	23	22	48.61	5.59		

Table 4.6 above shows the statistical indicative differences in the means of the post-test scores of the experimental group and the control group. The means of the post-test scores for the experimental and control group are 76.86 and 48.61, with a variance of 12.95 and 5.59. The mean of experimental group is higher than the mean of the control group in the post-tests. When t-test was used to analyse this comparison, it was found that t = 9.54 and p = 0.00. The p-value indicates a significant level of p-value less than 0.05 alpha value. This shows that there is a statistically significant difference in the post-test performance scores between the experimental group and the control group after the intervention. Based on the data provided by the above table, it can be concluded that the intervention used in the

experimental group enhanced learners' understanding of 'reaction rates' and performed better than the one used in the control group. The null hypothesis (There is no a significant difference in performance between learners who are taught using the jigsaw learning method and learners who are taught using traditional learning method.) was not confirmed.

Further analysis was made to find the effect of gender on learners' performance. Table 4.7 presents analysis of pre-test for boys versus girls in the experimental group.

Table 4.7: T-test results of the pre-test for boys and girls in the experimental group (significant at p< .05).

Gender	N	Df	Mean	St.dev	t	p
Boys	12	11	19.67	6.19	8.90	.21
Girls	9	8	16.89			

(t=.890, p=.207)

Table 4.7 reports the mean scores of the pre-test between boys and girls in the experimental group. The means of boys and girls are 19.67 and 16.89, with variances of 6.19 and 8.13. T-test was further applied to see, whether there is a significant difference between the means of the test scores. The results of the t-test indicate a significant level of $p > 0.05$ ($t = 8.90$, p=. 21). These values suggest that there was no significant difference between the means of the pre- test between the boys and girls in the experimental group before the intervention. They both had little knowledge on the understanding of the 'reaction rate' concepts.

Pre-test results for boys versus girls in the control group were, also analysed using the independent t-test. The results are shown in the table below.

Table 4.8: T-test results of the pre-test for boys and girls in the control group (significant at p < .05).

Gender	N	Df	Mean	St.dev	t	p
Boys	13	12	17.84	5.32	-.86	.50
Girls	10	9	19.60	4.09		

Table 4.8 presents the results of the independent t-test for the overall means of the pre-test between boys and girls in the control group. The mean of girls (M =19.60, SD = 4.09) is slightly higher than the mean of boys (M = 17.84, SD = 5.32). When the t-test was performed to find whether a significant effect existed among the mean scores, it was found that p > 0.05 (p = .50, t = -.86). This t-value means that there was no significant difference between the means of the pre- test between the boys and girls in the control group before the intervention. They were at the same level of understanding before receiving the treatment.

Post-tests scores for boys versus girls in control and experimental groups were compared. Table 4.9 reports the outcomes of the t-test results for boys and girls in the experimental group.

Table 4.9*: T-test results of the pre-test for boys and girls in the experimental group (significant at p < .05).*

Gender	N	Df	Mean	St.dev	t	p
Boys	12	11	77	13.14	.76	.06
Girls	9	8	76.66	13.49		

The means and variances for the pre-test results for boys against girls in the experimental group are reported in table 4.9. The mean of girls (M = 76.66, SD = 13.49) is slightly lower than that of boys (M = 77.00, SD = 13.14). The differences between these mean values were analysed using independent t-test. It was found that, t = .76 and of p = .06, which is greater than p = 0.05. No significant difference was found between the means of the post-test between boys and girls in the experimental group after the intervention. Boys and girls were at the same level of understanding of reaction rates concepts.

Table 4.10 reports the outcomes of the t-test results for boys and girls in the control group.

Table 4.10: T-test results of the post-test between boys and girls in the control group (significant at $p < .05$).

Gender	N	Df	Mean	St.dev	t	p
Boys	13	12	48.69	6.34	-.03	.37
Girls	10	9	48.78	4.99		

Post-test results for boys against girls in the control group are presented in table 4.10. The means of boys and girls are 48.69 and 48.78 with t = -.03, p =.37. They indicated a significant level of $p > 0.05$ with p value of .369. This confirms that there is no statistical significance difference between the means of the post-test between boys and girls in the control group after the intervention. Gender had no influence on the results.

To find whether boys in the experimental group have improved or not, their pre-test and post-test's scores were analysed. Table 4.11 presents the outcomes for t-test results.

Table 4.11: T-test results of the pre- and post-tests for boys in the experimental group (significant at p < .05).

Tests	N	Mean	St.dev	t	df	p
Pre-test	12	19.67	6.20	-19.67	22	.01
Post-test	12	77.00	13.14			

Table 4.11 above presents the results for pre-test versus post-test for boys in the experimental group. Descriptive statistics of the scores obtained were calculated and t-test was applied to see whether there is a statistical difference between mean values. The means are reported as (M = 19.67, SD = 6.20) for the pre-test and (M = 77.00, SD = 13.14) for post-test. When independent t-test was performed to find, whether a statistical difference existed between the mean values, it was found that, t = -19.67 and p=.01 These results revealed a significant level of $p < 0.05$. A statistically significant difference was found between pre-test and post-test for boys in the experimental group. There was an improvement after intervention with a mean difference of 57.33. The Jigsaw Method improved the performance of boys in the experimental group.

Pre and post-test results are compared in the table below to check whether there is an improvement with boys in the control group or not.

Table 4.12: T-test results between the pre-test and post-test of boys in the control group (significant at p < .05).

Grade level	N	Df	Mean	St.dev	t	p
Pre-test	13	12	17.84	5.32	-13.38	.69
Post-test	13	12	48.07	6.17		

Table 4.12 above shows the overall results for pre-test versus post-test for boys in control group. The means and variances for these tests are (M = 17,84, SD = 5.32) for the pre-test and (M = 48.07, SD = 6.17) for the post-test. The mean of the post-test is higher than the mean of the pre-test. An independent t-test was performed to see, whether a significant effect existed among the mean scores. It was found that there is no statistically significant difference (t =-13.38, p =.69; p > 0.05.) between the means of the pre-test and post-test for boys in the control group.

Table 4.13 below shows the overall mean scores between the pre-test and post-test for girls in the experimental group.

***Table 4.13**: T-test results between the pre-test and post-test of girls in the control group (significant at p < .05).*

Tests	N	Df	Mean	St.dev	t	p
Pre-test	9	8	12.44	3.43	-13.84	.02
Post-test	9	8	76.66	13.49		

An independent t-test was performed to compare the difference between the mean values. A significant difference existed between the means of the pre-test (M = 12.44, SD = 3.43) and post-test (M = 76.66, SD = 13.49) conditions, t -13.84, p = .02. After the Jigsaw Method was employed, girls in the experimental group performed better.

Table 4.14 below indicates the results for pre-test versus post-test for girls in the control group.

Table 4.14: T-test results between the pre-test and post-test of girls in the control group (significant at p < .05).

Tests	N	Df	Mean	St.dev	t	p
Pre-test	10	9	19.60	4.09	-14.56	.73
Post-test	10	9	49.30	4.99		

The results are t =-14.56, p =.73. The mean values and standard deviations are also reported. The mean of girls (M = 49.30, SD = 4.89) in the post-test is higher than in the pre-test (M = 19.60, SD 4.09). The results from the table show significant levels of p> 0.05. (t =-14.56, p=.73). There is no statistically significant difference between the mean values of the pre-test and post-test for girls in the control group.

Each item in the pre-test and post-test for the experimental and the control groups were analysed. The means and standard deviations for each test item in the experimental and control groups were compared and t-test was applied to see if there was a significant difference between each item. Cohen-d was also applied to each test item to check the effect size between the compared mean differences. Tables 4.14 to 4.22 present the results for questions per item per individual.

The values of mean scores, t-test values and effect size values for each item in the pre-test for the control against the experimental group are presented in table 4.15 below.

Table 4.15: T-test results of the experimental and control groups' pre-test *(significant at p < .05).*

Item no	**Group**	**mean**	**St.dev**	**t-test**	P-value	Effect size (d)
1.1	EXPERIMENT	0.38	0.68	.53	.29	0.08
	CONTROL	0.26	0.80			
1.2	CONTROL	1.23	0.99	-3.79	0.00	0.31

	EXPERIMENT	0.61	0.94			
1.3	CONTROL	0.61	0.94	2.16	.31	0.31
	EXPERIMENT	1.24	0.99			
1.4	CONTROL	0.87	1.01	-.36	.492	0.05
	EXPERIMENT	0.76	0.99			
1.5	CONTROL	0.61	0.61	8.43	.13	0.14
	EXPERIMENT	0.86	1.01			
1.6	CONTROL	0.78	0.99	-.73	.16	0.12
	EXPERIMENT	0.57	0.93			
1.7	CONTROL	0.19	0.60	-2.44	0.02	0.26
	EXPERIMENT	0.61	0.94			
1.8	CONTROL	0.44	.84	-.63	.21	0.09
	EXPERIMENT	0.29	.72			
1.9	CONTROL	0.67	0.97	-2.18	0.03	0.06
	EXPERIMENT	0.78	0.97			
1.10	CONTROL	0.78	1.17	-.36	.33	0.01
	EXPERIMENT	0.67	0.97			
2.1	CONTROL	0.67	0.97	-2.98	0.00	0.06
	EXPERIMENT	0.78	0.99			
2.2.1	CONTROL	0.78	0.99	-.39	.44	0.06
	EXPERIMENT	0.67	0.96			
2.2.2	CONTROL	1.30	0.97	-.54	.32	0.08
	EXPERIMENT	1.14	1.01			
2.2.3	CONTROL	0.52	0.89	-.96	.05	0.15
	EXPERIMENT	0.28	0.71			
2.2.4	CONTROL	0.78	0.99	-.73	.16	0.11
	EXPERIMENT	0.57	0.93			
3.1	CONTROL	1.39	0.89	-1.58	.53	0.25
	EXPERIMENT	0.91	0.94			
3.2.1	CONTROL	0.47	0.73	-.51	.07	0.07
	EXPERIMENT	0.38	0.50			
3.2.2	CONTROL	0.43	0.51	-2.52	0.01	0.01
	EXPERIMENT	0.44	0.66			
3.3	CONTROL	0.33	0.58	-6.56	.00	0.15
	EXPERIMENT	0.17	0.49			
3.4	CONTROL	0.90	0.29.	-3.68	.00	0.67
	EXPERIMENT	0.17	0.49			
3.5	CONTROL	0.38	0.81	.77	.11	0.11
		0.22	0.59			

Table 4.15 presents the mean scores of each item in the pre-test, for the reaction rate knowledge between the experimental and control groups. This table shows the mean scores and standard deviations for each item in the pre-test between the experimental and the control group. T-test was also applied to see whether there was a significant difference between these mean values. Based on analysis in the above table, there is no significant difference in items: 1.1, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1, 3.2.1 and 3.5. It can be clearly seen that many items did not show a significant difference. The performance of the two groups revealed that learners in the experimental and control had very little knowledge concerning of conceptual understanding of 'reaction rates'. They were, therefore suitable for the study.

In addition to the t-test, Cohen-d was applied to measure the effect size of the compared mean differences. The mean differences between the CG and CG revealed small effect sizes for questions 1.2 (d = 0.31), 1.3 (d = 0.31), 1.7 (d = 0.26), 3.1 (d = 0.25), and medium effect size for question 3.4 (d = 0.67). No effect was found on questions 1.1, 1.4, 1.5, 1.6, 1.8, 1.9, 1.10, 2.1, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.2.1, 3.2.2, 3.3, and 3.5. These sixteen questions had values less than 0.2. This confirms that learners in both groups had very little understanding of 'reaction rates' concepts. None of the test items indicated a large effect. A t-test analysis and the effect size values were also used to compare the results of the pre- and post-tests for each item in experimental group. The results are shown in table 4.6 below.

Table 4.16: T-test results of the experimental group's pre- and post-test *(significant at p < .05).*

Item no	test type	mean	St.dev	t- test	P- value	Effect size (d)
1.1	PRE	0.48	0.87	-5.02	0.13	0.61
	POST	1.71	0.72			
1.2	PRE	1.14	1.01	0.91	1.00	0.34
	POST	0.86	1.01			
1.3	PRE	1.24	0.99	-0.64	0.22	0.09
	POST	1.43	0.93			
1.4	PRE	0.76	0.99	-4.13	0.00	0.34
	POST	1.81	1.81			
1.5	PRE	0.86	1.01	-3.16	0.00	0.29
	POST	1.71	1.71			

1.6	PRE	0.47	0.87	-5.02	0.12	0.61
	POST	1.71	0.72			
1.7	PRE	0.95	0.43	-5.97	0.00	0.22
	POST	1.43	1.43			
1.8	PRE	0.19	0.60	-3.70	0.00	0.14
	POST	1.14	1.01			
1.9	PRE	0.47	0.87	-1.62	0.01	0.25
	POST	0.95	1.02			
1.10	PRE	0.67	0.97	-0.93	0.13	0.14
	POST	0.95	1.02			
2.1	PRE	0.09	0.44	-6.49	0.00	0.49
	POST	0.87	0.87			
2.2.1	PRE	0.67	0.97	-1.08	0.000	0.17
	POST	0.91	0.30			
2.2.2	PRE	1.14	1.01	0.20	0.000	0.03
	POST	1.09	0.43			
2.2.3	PRE	0.28	0.71	-5.31	0.00	0.64
	POST	1.86	1.15			
2.2.4	PRE	0.57	0.93	-10.05	0.17	0.84
	POST	4.62	1.59			
3.1	PRE	0.91	0.94	-14.07	0.01	0.91
	POST	4.48	0.68			
3.2.1	PRE	0.38	0.49	-5.54	0.00	0.65
	POST	2.48	1.66			
3.2.2	PRE	0.57	0.51	-12.91	0.00	0.89
	POST	2.00	0.00			
3.3	PRE	0.43	0.51	-10.11	0.00	0.84
	POST	1.91	0.44			
3.4	PRE	0.33	0.58	-13.23	0.00	0.89
	POST	2.00	0.00			
3.5	PRE	0.95	0.92	-4.284	0.00	0.56
	POST	1.91	0.43			

Table 4.16 reports the results of pre-test against post-test for the experimental group. The means and standard deviations for each test item are reported. The means of post-test indicate large improvement. To see whether a significant effect existed among these mean scores, an independent t-test was performed. It was found, that $p > 0.05$ for items 1.1, 1.2, 1.3, 1.6, 1.10 and 2.2.4. Moreover, it was revealed that $p<0.05$ for the following fifteen out of twenty-one items: 1.4, 1.5, 1.7, 1.8, 1.9, 2.1, 2.2.1, 2.2.2, 2.2.3, 3.1, 3.2.1, 3.2.2, 3.3, 3.4 and 3.5. This is 71.4% of the test items indicating that there is a statistically significant difference in the pre- against post-test for the experimental group. Experimental group learners' understanding of reaction rates improved much better than

in the control group.

When Cohen-d was applied to accompany the reporting of the t-test, the effect size was small for items 1.2(d = 0.34), 1.4 (d = 0.34), 1.5 (d = 0.29), 1.7 (d = 0.22), 1.9 (d = 0.25), 2.1 (d = 0.49), medium for questions 1.6 (d = 0.61), (1.1=0.61), 2.2.3(d=0.64), 3.2.1(d = 0.65), 3.5 (d = 0.56) and large for questions 2.2.4 (d = 0.84), 3.1 (d =0.91), 3.2.2 (d = 0.89), 3.3 (d = 0.84) and 3.4 (d = 0.89). There was no effect for items1.3, 1.8, 1.10, 2.2.1 and 2.2.2, with difference of less than 0.2.

A t-test analysis and the effect size values were also used to compare the results of the pre- and post-tests for each item in control group. The results of this comparison are shown in Table 4.17 below.

Table 4.17: T-test results of the control group's pre- and post-test *(significant at p < .05).*

Item no	**Test type**	**mean**	**St.dev**	**T-Test**	P-value	Effect size (d)
1.1	PRE	0.17	0.57	-6.53	0.01	0.69
	POST	1.57	0.84			
1.2	PRE	0.09	0.41	-3.42	0.00	0.95
	POST	0.87	0.01			
1.3	PRE	0.61	0.94	-2.46	0.54	0.34
	POST	1.30	0.97			
1.4	PRE	0.87	1.01	-2.53	0.01	0.35
	POST	1.56	0.84			
1.5	PRE	0.61	0.94	-3.21	0.53	0.43
	POST	1.47	0.89			
1.6	PRE	0.78	0.99	-2.87	0.02	0.39
	POST	1.57	0.84			
1.7	PRE	0.69	0.97	-2.12	0.00	0.29
	POST	1.30	0.97			
1.8	PRE	0.61	0.94	-1.809	0.102	0.26
	POST	1.13	1.01			
1.9	PRE	1.13	1.02	0.580	0.606	0.08
	POST	0.96	1.02			
1.10	PRE	0.78	1.16	0.000	0.57	0.00
	POST	0.78	0.99			
2.1	PRE	1.30	1.66	-0.33	0.00	0.13
	POST	1.43	0.89			
2.2.1	PRE	0.78	0.99	-0.2	0.00	0.03

	POST	0.82	0.39			
2.2.2	PRE	1.30	0.97	0.95	0.00	0.13
	POST	1.09	0.5			
2.2.3	PRE	0.52	0.89	-3.46	0.03	0.46
	POST	1.61	1.19			
2.2.4	PRE	0.78	0.99	-7.65	0.12	0.75
	POST	3.65	1.49			
3.1	PRE	1.39	0.89	-7.98	0.54	0.76
	POST	3.78	1.12			
3.2.1	PRE	0.14	0.73	-4.66	0.00	0.63
	POST	2.17	1.59			
3.2.2	PRE	0.23	0.51	-9.95	0.74	0.56
	POST	1.82	0.58			
3.3	PRE	0.43	0.66	-3.99	0.01	0.51
	POST	1.39	0.94			
3.4	PRE	0.17	0.49	-7.73	0.05	0.75
	POST	1.65	0.78			
3.5	PRE	0.09	0.29	10.61	0.02	0.84
	POST	1.74	0.69			

Table 4.17 reports the means and standard deviations for each item for the pre-test and post-test of the control group. The mean differences were further analysed using a t-test. It was found that, fourteen items did not improve significantly ($p > 0.05$): 1.2, 1.3, 1.5, 1.6, 1.8, 1.9, 1.10, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1, 3.2.2 and 3.5. A statistically significant difference was found in only seven items: 1.1; 1.4, 1.7; 2.1; 3.2.1; 3.3 and 3.4. This forms 33.33% of the test items having a p-value less than 0.05. This indicates that there is no significant difference in many test items in a group, where traditional method was used. The effect sizes of the above mean differences for the pre against post-test were small for items 1.3 ($d = 0.34$), 1.4 ($d = 0.35$), 1.5 ($d = 0.43$) 1.6 ($d = 0.39$), 1.7 ($d = 0.29$), 1.8 ($d = 0.39$), 2.2.3 ($d = 0.46$), medium for items 1.1 ($d = 0.69$), 2.2.4 ($d = 0.75$), 3.1 ($d = 0.76$), 3.2.1 ($d = 0.63$), 3.2.2($d = 0.56$), 3.4 ($d = 0.75$) and large for items 1.2 ($d = 0.95$) and 3.5 ($d = 3.84$). There was no effect for items 1.9, 1.10, 2.1, 2.2.1 and 2.2.2. The improvement is not satisfactory, as it can be seen that the effect is large in only two test items.

Tables 4.18 to 4.20 compare performance scores of boys and girls. A t-test analysis, the effect size and the mean scores for each test-item in the pre-test were used to compare the results of boys and girls in the experimental group. The comparison is shown in table 4.18.

Table 4.18: T-test results of boys' and girls' performance in the experimental group's pre-test *(significant at p < .05).*

Item no	**gender**	**mean**	**St.dev**	T-test	P	Effect size (d)
1.1	BOYS	0.67	0.98	-1.56	0.25	0.26
	GIRLS	0.22	0.67			
1.2	BOYS	1.00	1.04	-0.75	0.46	0.16
	GIRLS	1.33	1.00			
1.3	BOYS	1.33	0.98	-0.51	0.61	0.10
	GIRLS	1.11	1.05			
1.4	BOYS	0.50	0.90	-1.39	0.16	0.29
	GIRLS	1.11	1.05			
1.5	BOYS	0.67	0.98	-0.99	0.32	0.30
	GIRLS	1.11	0.05			
1.6	BOYS	0.67	0.98	-1.16	0.25	0.26
	GIRLS	0.22	0.67			
1.7	BOYS	0.00	0.00	-1.26	0.21	0.23
	GIRLS	0.22	0.67			
1.8	BOYS	0.33	0.77	-1.26	0.21	0.29
	GIRLS	0.00	0.00			
1.9	BOYS	0.33	0.77	-0.87	0.39	0.19
	GIRLS	0.67	1.00			
1.10	BOYS	0.00	0.00	-1.16	0.25	0.92
	GIRLS	2.22	0.67			
2.1	BOYS	0.50	0.90	-0.91	0.36	0.19
	GIRLS	0.88	1.05			
2.2.1	BOYS	1.16	1.02	0.12	0.90	0.06
	GIRLS	1.11	1.05			
2.2.2	BOYS	0.33	0.77	-0.35	0.72	0.08
	GIRLS	0.22	0.66			
2.2.3	BOYS	0.66	0.98	0.54	0.59	0.12
	GIRLS	0.44	0.88			

2.2.4	BOYS	0.75	0.96	-0.89	0.37	0.19
	GIRLS	1.11	0.92			
3.1	BOYS	0.33	0.49	-0.50	0.61	0.11
	GIRLS	0.44	0.51			
3.2.1	BOYS	0.41	0.44	-1.61	0.10	0.26
	GIRLS	0.77	0.83			
3.2.2	BOYS	0.33	0.49	-0.99	0.32	0.21
	GIRLS	0.55	0.52			
3.3	BOYS	0.16	0.38	-1.44	0.15	0.31
	GIRLS	0.55	0.77			
3.4	BOYS	0.33	0.77	-0.86	0.38	0.18
	GIRLS	0.66	1.00			
3.5	BOYS	1.08	0.99	-0.68	0.49	0.20
	GIRLS	0.7	0.83			

Table 4.18 reports the means and variances for each item for the pre-test results for boys and girls in the experimental group. T-test was applied to see, whether there was a significant effect between these mean values. Based on the data in table 4.18, $p > 0.05$ for all test items. This means that the test was fair since boys and girls were at the same level from the beginning. The effect sizes for the mean differences indicated in the above table revealed small effect for questions 1.1 ($d = 0.26$), 1.4 ($d = 0.29$),1.5 ($d = 0.30$),1.6 ($d = 0.26$),1.7 ($d = 0.23$),1.8 ($d = 0.29$), 3.2.1 ($d = 0.26$), 3.2.2 ($d = 0.21$), 3.3 ($d = 0.21$), 3.5 (0.20) and is large for1.10 ($d = 0.92$). There is no effect size for questions 1.2, 1.3, 1.9, 2.1, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1 and 3.4. Learners in the pre-test were similar regarding knowledge in ‘reaction rates’ concepts, irrespective of gender. The mean scores for each test-item, a t-test analysis and the effect size were, also used to compare the pre-test results of boys and girls in the control group. The comparison is shown in Table 4.19.

Table 4.19: T-test results of boys' and girls' performance for the control group's pre-test *(significant at p < .05).*

Item no	gender	mean	St.dev	T-test	P	Effect size (d)
1.1	BOYS	0.30	0.75	-1.27	0.20	0.27
	GIRLS	0.00	0.00			
1.2	BOYS	0.00	0.00	-1.14	0.25	0.91
	GIRLS	2.00	0.63			
1.3	BOYS	0.61	0.96	-0.03	0.96	0.01
	GIRLS	0.60	0.97			
1.4	BOYS	1.07	1.03	-1.11	0.26	0.23
	GIRLS	0.60	0.96			
1.5	BOYS	0.76	1.61	-0.93	0.35	0.14
	GIRLS	0.40	0.84			
1.6	BOYS	0.76	1.01	-0.67	0.94	0.02
	GIRLS	0.80	1.03			
1.7	BOYS	0.76	1.01	-0.41	0.68	0.08
	GIRLS	0.60	0.96			
1.8	BOYS	0.46	0.87	-0.85	0.39	0.18
	GIRLS	0.80	1.03			
1.9	BOYS	0.07	1.03	-0.28	0.77	0.48
	GIRLS	1.20	1.03			
1.10	BOYS	0.30	0.75	-2.23	0.02	0.45
	GIRLS	1.40	1.34			
2.1	BOYS	1.84	1.90	-1.59	0.11	0.38
	GIRLS	0.60	0.96			
2.2.1	BOYS	0.92	1.03	-0.77	0.44	0.16
	GIRLS	0.60	0.96			
2.2.2	BOYS	1.32	0.96	-0.45	0.65	0.06
	GIRLS	1.20	1.03			
2.2.3	BOYS	0.46	0.87	-0.36	0.71	0.08
	GIRLS	0.60	0.96			

2.2.4	BOYS	0.61	0.96	-0.91	0.30	0.19
	GIRLS	1.00	1.05			
3.1	BOYS	1.30	0.94	-0.48	0.63	0.11
	GIRLS	1.50	0.84			
3.2.1	BOYS	0.46	0.77	-0.96	0.89	0.03
	GIRLS	0.50	0.70			
3.2.2	BOYS	0.30	0.63	-0.84	0.39	0.19
	GIRLS	0.10	0.31			
3.3	BOYS	0.38	0.65	-0.44	0.65	0.09
	GIRLS	0.50	0.70			
3.4	BOYS	0.23	0.59	-0.42	0.67	0.14
	GIRLS	0.10	0.31			
3.5	BOYS	0.15	0.37	-1.27	0.20	0.28
	GIRLS	0.00	0.00			

The means and standard deviations for each item in the control group's pre-test for boys against girls are illustrated in table 4.19. Based on the mean values of the pre-test for boys against girls in the control group, there is a statistically significant difference in item 1.10 only. The independent t-test showed that, $p < 0.05$ for only one item which forms 4.7% of the test items. The results indicate that boys and girls were at the same level of understanding, before receiving the treatment. The mean differences reveal a small effect for items 1.1 ($d = 0.27$), 1.4 ($d = 0.23$), 1.9 ($d = 0.48$), 1.10 ($d = 0.45$), 2.1 ($d = 0.38$), 3.5 ($d = 0.23$) and large for item 1.2 ($d = 0.91$). There was no effect for items 1.3, 1.5, 1.6, 1.7, 1.8, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1, 3.2.1, 3.2.2, 3.3 and 3.4. The Table below presents the results per item for the control group's post-test (boys against girls).

Table 4.20: T-test results of boys' and girls' performance in the control group's post-test *(significant at p < .05).*

Item no	**gender**	**mean**	**St.dev**	T-test	P	Effect size (d)
1.1	BOYS	1.53	0.87	-0.36	0.714	0.07
	GIRLS	1.40	0.96			
1.2	BOYS	0.30	0.75	-2.60	0.01	0.54
	GIRLS	1.40	0.96			

1.3	BOYS	1.07	1.03	-1.27	0.20	0.29
	GIRLS	1.66	0.84			
1.4	BOYS	1.84	0.55	-1.82	0.06	0.36
	GIRLS	1.20	1.03			
1.5	BOYS	1.69	0.75	-1.30	0.19	0.26
	GIRLS	1.20	1.03			
1.6	BOYS	1.84	0.55	-1.36	0.17	0.27
	GIRLS	1.40	0.96			
1.7	BOYS	1.07	1.03	-1.27	0.20	0.27
	GIRLS	1.60	0.84			
1.8	BOYS	1.23	1.01	-1.00	0.31	0.21
	GIRLS	0.80	1.03			
1.9	BOYS	0.30	0.75	-3.03	0.00	0.63
	GIRLS	1.60	0.84			
1.10	BOYS	0.30	0.75	-1.74	0.08	0.36
	GIRLS	1.00	1.05			
2.1	BOYS	1.30	0.94	-0.84	0.39	0.16
	GIRLS	1.60	0.84			
2.2.1	BOYS	0.92	0.27	-0.55	0.39	0.16
	GIRLS	0.80	0.42			
2.2.2	BOYS	1.50	1.00	-0.95	0.32	0.32
	GIRLS	1.00	0.31			
2.2.3	BOYS	1.76	1.09	-0.55	0.39	0.14
	GIRLS	1.40	1.42			
2.2.4	BOYS	1.00	0.31	-4.69	0.00	0.39
	GIRLS	2.00	1.63			
3.1	BOYS	4.40	0.77	-2.60	0.00	0.51
	GIRLS	3.20	1.22			
3.2.1	BOYS	2.61	1.70	-0.92	0.35	0.18
	GIRLS	2.00	1.63			
3.2.2	BOYS	1.84	0.55	-0.19	0.84	0.03
	GIRLS	1.80	0.63			

3.3	BOYS	1.69	0.75	-1.30	0.19	0.26
	GIRLS	1.20	1.03			
3.4	BOYS	2.00	0.00	-2.45	0.01	0.28
	GIRLS	1.20	1.03			
3.5	BOYS	1.84	0.55	-0.19	0.84	0.03
	GIRLS	1.80	0.63			

The means and variances for each item in the post-test are reported in this table. When t-test was applied to confirm the effect of the differences between the mean values, it was found that, $p < 0.05$ for items 1.2, 1.9, 2.2.4, 3.1 and 3.4 (23.8**%)**. There is a statistical significant difference in very few test items. There is no statistical significant difference in many test items like: 1.1, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.10, 2.1, 2.2.1, 2.2.2, 2.2.3, 3.2.1, 3.2.2, 3.3 and 3.5. There is a little difference, which is not statistically significant. The results of Cohen's *d* reveal small effects for questions 1.2 (d = 0.54) , 1.3 (d=0.29), 1.4 (d = 0.36), 1.5 (d = 0.26), 1.6 (d = 0.27), 1.7(d = 0.27), 1.8(d = 0.21), 1.10 (d = 0.36), 2.2.2 (d = 0.32), 2.2.4 (d = 0.39), 3.3 (d = 0.26), 3.4 (d = 0.28), medium for 1.9 (d = 0.63) and 3.1 (d = 0.51) . No effect for questions 1.1, 2.1, 2.2.1, 2.2.3, 3.2.1, 3.2.2 and 3.5. The means and standard deviations for each item in the experimental group's post-test-results for boys and girls are compared in table 4.21 below.

Table 4.21: Post-test results of boys and girls in the experimental group (significant at p < .05).

Item no	**gender**	**mean**	**St.dev**	t-test	P	Effect size(d)
1.1	BOYS	1.66	0.77	-0.35	0.72	0.08
	GIRLS	1.77	0.60			
1.2	BOYS	1.00	1.04	-0.74	0.45	0.16
	GIRLS	0.66	1.00			
1.3	BOYS	1.50	0.90	-0.40	0.68	0.105
	GIRLS	1.30	1.00			
1.4	BOYS	1.83	0.57	-0.20	0.83	0.05
	GIRLS	1.77	0.66			
1.5	BOYS	1.66	0.77	-0.35	0.72	0.08

	GIRLS	1.77	0.66			
1.6	BOYS	1.66	0.77	-0.35	0.72	0.08
	GIRLS	1.77	0.66			
1.7	BOYS	1.33	0.98	-0.54	0.58	0.12
	GIRLS	1.55	0.88			
1.8	BOYS	1.16	1.02	-0.12	0.90	0.02
	GIRLS	1.11	1.05			
1.9	BOYS	1.00	1.04	-0.24	0.80	0.06
	GIRLS	0.88	1.05			
1.10	BOYS	1.00	1.04	-0.24	0.80	0.06
	GIRLS	0.88	1.05			
2.1	BOYS	1.66	0.77	-1.26	0.20	0.24
	GIRLS	1.22	0.97			
2.2.1	BOYS	0.91	0.28	-0.20	0.8	0.048
	GIRLS	0.88	0.33			
2.2.2	BOYS	1.16	0.38	-0.83	0.40	0.18
	GIRLS	1.00	0.50			
2.2.3	BOYS	1.75	1.05	-0.56	0.57	0.10
	GIRLS	2.00	1.32			
2.2.4	BOYS	4.58	1.08	-0.68	0.49	0.04
	GIRLS	4.44	2.12			
3.1	BOYS	4.41	0.66	-0.60	0.59	0.10
	GIRLS	4.55	0.72			
3.2.1	BOYS	2.33	1.66	-0.49	0.62	0.09
	GIRLS	2.66	1.73			
3.2.2	BOYS	1.83	0.57	-0.86	0.39	0.21
	GIRLS	2.00	0.00			
3.3	BOYS	1.00	0.05	0.00	1.00	0.9
	GIRLS	2.00	0.00			
3.4	BOYS	1.83	0.57	0.86	0.39	0.17
	GIRLS	2.00	0.40			
3.5	BOYS	1.83	0.57	-0.87	0.39	0.17
	GIRLS	2.00	0.40			

The results were further analysed by t-test to find the effect of mean differences in each item. It was found that p > 0.05 for all test items. After the intervention, there was no statistical significant difference between boys and girls in the experimental group. Boys and girls in the experimental group improved equally after the intervention was employed. In addition to the t-test, effect size for the mean differences was calculated. The mean difference between the boys and girls in the experimental post-test reveals a small effect for items 2.1 (d = 0.24) and 3.2.1 (d = 0.21). No effect size was found between items 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1, 3.2.2, 3.4 and 3.5. Boys and girls were similar regarding understanding of concepts. Post-test (per test item) results for the experimental and control groups are reported in Table 4.22.

Table 4.22: Post- test results for the control and experimental groups *(significant at p < .05).*

Item no	**Group**	**mean**	**St.dev**	T-test	P value	Effect size (d)
1.1	EXPERIMENT	1.73	0.88	2.30	.00	0.29
	CONTROL	1.14	1.01			
1.2	EXPERIMENT	0.86	1.01	-.41	.94	0.01
	CONTROL	0.87	1.01			
1.3	EXPERIMENT	1.47	0.89	1.49	.02	0.22
	CONTROL	1.04	1.02			
1.4	EXPERIMENT	1.73	0.68	1.62	.00	0.23
	CONTROL	1.33	0.96			
1.5	EXPERIMENT	1.65	0.77	2.22	.00	0.32
	CONTROL	1.04	1.02			
1.6	EXPERIMENT	1.65	0.77	1.88	0.00	0.42
	CONTROL	1.14	1.01			
1.7	EXPERIMENT	1.47	0.89	2.16	.04	0.31
	CONTROL	0.85	1.01			
1.8	EXPERIMENT	0.10	1.62	.98	.01	0.00

	CONTROL	0.11	1.02			
1.9	EXPERIMENT	0.95	1.02	-.014	.98	0.01
	CONTROL	0.96	1.02			
1.10	EXPERIMENT	0.95	1.02	.56	.36	0.08
	CONTROL	0.78	0.99			
2.1	EXPERIMENT	1.47	0.87	.16	.76	0.02
	CONTROL	1.43	0.89			
2.2.1	EXPERIMENT	0.91	2.88	-1.15	.00	0.04
	CONTROL	1.09	0.700			
2.2.2	EXPERIMENT	1.08	0.51	-.27	.00	0.12
	CONTROL	1.14	0.83			
2.2.3	EXPERIMENT	0.30	0.75	-3.03	0.00	0.63
	CONTROL	1.60	0.84			
2.2.4	EXPERIMENT	4.60	1.59	-2.38	.02	0.31
	CONTROL	3.60	1.49			
3.1	EXPERIMENT	4.47	0.67	-2.18	.03	0.35
	CONTROL	3.78	1.12			
3.2.1	EXPERIMENT	2.47	1.66	.62	.48	0.21
	CONTROL	2.17	1.58			
3.2.2	EXPERIMENT	4.47	0.67	2.44	0.68	0.35
	CONTROL	3.78	1.12			
3.3	EXPERIMENT	1.90	0.43	-2.18	0.03	0.48
	CONTROL	1.04	1.02			
3.4	EXPERIMENT	1.91	0.41	1.14	.02	0.17
	CONTROL	1.71	0.71			
3.5	EXPERIMENT	1.91	0.41	2.98	.00	0.41
	CONTROL	1.23	0.99			

The means, standard deviations and t-tests (for each item) are reported on this table. An independent t-test was performed to find the effect of these mean values. No significant ($p > 0.05$) different was found between the means of items 1.2, 1.9, 1.10, 2.1, 3.2.1 and 3.2.2. On the other hand, the mean differences of these test-items revealed that there is a significant difference ($p < 0.05$) between items 1.1, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1, 3.3, 3.4 and 3.5, which is 71.4% of the total test items. The effect size is small for questions 1.1 (d = 0.297), 1.3 (d = 0.22), 1.4 (d = 0.23), 1.5 (d = 0.32), 1.6 (d=0.424), 1.7 (d = 0.31), 2.2.4 (d = 0.31), 3.1 (d = 0.35), 3.2.1 (d = 0.21),3.2.2 (d = 0.35), 3.3 (d = 0.48), 3.5 (d = 0.41) and medium effect for item 2.2.3 (d = 0.63). No effect size was found on questions 1.2, 1.8, 1.9, 1.10, 2.1, 2.2.1, 2.2.2 and 3.4.

Table 4.23 presented the results for Cohen's *d* measuring the magnitude of the treatment effect.

Table 4.23***: Cohen's d for measuring the effect size between the means of the pre- and post-tests.***

1	**PRE-TEST**	**EXPERIMENTAL**	**CONTROL**	**Cohen's *d***	Effect size
	MEAN	18.48	18.17	-0.01	-0.03
	SD	6.83	5.52		
2	**POST-TEST**	**EXPERIMENTAL**	**CONTROL**	**Cohen's *d***	
	MEAN	76.86	48.61	2.83	0.82
	SD	12.96	5.60		
3	**CONTROL**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	18.52	48.61	-5.77	-0.94
	SD	4.80	5.60		
4	**EXPERIMENTAL**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	18.47	76.86	-5.60	-0.95
	SD	7.04	12.95		
5	**PRE-CONTROL**	**BOYS**	**GIRLS**	**Cohen's *d***	
	MEAN	17.84	19.60	-0.37	-0.38
	SD	5.32	4.09		

6	**POST-C0NTROL**	**BOYS**	**GIRLS**	**Cohen's *d***	
	MEAN	48.69	48.78	0.00	0.001
	SD	6.34	4.99		
7	**PRE- EXPERIMENT**	**BOYS**	**GIRLS**	**Cohen's *d***	
	MEAN	19.66	16.88	0.38	0.19
	SD	6.19	8.13		
8	**POST-EXP**	**BOYS**	**GIRLS**	**Cohen's *d***	
	MEAN	77.00	76.66	0.02	0.01
	SD	13.14	13.49		
9.	**BOYS-EXPERIMENT**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	19.67	77.00	-8.14	
	SD	6.30	7.71		-0.97
10	**GIRLS- EXPERIMENT**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	14.67	74.44	-5.58	
	SD	5.43	14.13		-0.94
11	**BOYS-CONTROL**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	17.85	48.08	-5.24	
	SD	5.32	6.17		-0.93
12	**GIRLS-CONTROL**	**PRE-TEST**	**POST-TEST**	**Cohen's *d***	
	MEAN	19.60	49.30	-6.51	
	SD	4.09	4.99		-0.96

Cohen *d* is an appropriate effect size for the comparison between two means. This effect size can be used to accompany the reporting of t-test by measuring the magnitude of the treatment effect, with values ranging between 1 and -1 (Cohen, Manion, & Morrison, 2007). Values can either be positive or negative depending on the mean you put first. The sign does not indicate tell anything about the effect. Cohen defined effect size as small ($0.2 \geq r < 0.5$), medium ($0.5 \geq r < 0.8$) and large ($r > 0.8$).

Results for Cohen's d are presented in table 4.23 above. The calculated Cohen's d for the pre-test control versus experimental is -0.03. It shows no effect, as the calculated value is less than 0.2. The calculated Cohen's d for the pre/post control and experimental is -0.94 and -0.95 respectively. The effect is large as it is closer to one but is in favour of the experimental group. When the results of boys versus girls in the pre-test control group were compared, the calculated Cohen's *d* was -0.38, indicating a small effect. Boys and girls in the experimental group indicated that there is no effect between the mean differences with the effect size of 0.19, which is less than 0.2.

When the results of boys versus girls in the post-test control group were compared, the calculated Cohen's *d* was 0.00, indicating that there is no effect between their mean differences. The effect size for boys and girls in the post-test experimental group was found to be 0.01. No effect size was found between these mean differences Pre-test against post-test for boys in the experimental group is (-0.97) a large effect. Pre- against post-test for girls in experimental group was (-0.95) which is large effect. Pre/post -test for boys in the control group (-0.95) large effect. Pre- against post-test for girls in control group with $p = -0.94$ which is a large effect. Looking at post-test, the effect size for experimental/ control groups is 0.82. A large effect was revealed between the mean differences between the experimental and the control group's post-test. ANCOVA was further conducted to determine if the treatment had an effect on the performance of the two groups. The dependent variable included learners' post-test scores, and the covariate were the learners' scores on the pre-tests. Table 4.24provide the necessary information to determine if group difference is significant.

Table 4.24***: ANCOVA: Summary of post-test with pre-test as a covariate (significant at p < .05).***

Source	SS	Df	F	P
Pre-test	152.17	1	1.60	0.21
Post-test	8811.08	1	92.73	0.00
Error	3895.86			

R squared =.70 (adjusted R squared = .68)

The preliminary analysis evaluating the homogeneity of regression indicated that the relationship between the covariate and the independent variable did not differ significantly ($F = 0.21$, $p > .05$). We also see that $F = 92.73$, $p <.05$, indicating that the experimental group is significantly different from the control group in the post-tests. This difference is mainly due to the teaching method employed (jigsaw versus traditional method) and is in favour of the experimental group which studied using the Jigsaw Method. Therefore, the Jigsaw Method has got an effect on learners' understanding of reaction rates concepts.

4.3 Summary of results and conclusion

Analysis of data obtained from the pre/post-test obtained from the experimental and control groups have been presented in this chapter. The findings are summarised as follows:

- Learners in the experimental and control group demonstrated a similar level of understanding according to the pre-test results.
- The experimental and the control groups experienced a certain form of conceptual change after the intervention
- Learners in the experimental group and control group improved in the post-test. The improvement in the control group is not statistically different.
- The experimental group, where the Jigsaw Method was used outperformed the control group, in which traditional method was applied.

It can be concluded that the Jigsaw Method applied in the experimental group improved understanding of reaction rates concepts better than the traditional method in the control group.

5. CHAPTER 5: DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter discusses the summary of findings from the previous chapter. Study limitations and implications were also presented in this chapter. Conclusions were drawn based on the findings, and also, recommendations for further research were made. These conclusions are based on the main research questions, study hypotheses, problem statement and purpose of the study presented in Chapter 1.

5.2 Discussion

The present study aimed to investigate the effect of the Jigsaw Method on the performance of Grade 12 physical science learners on reaction rates. The results show that the learners from EG taught using the Jigsaw Method outperformed the CG which used tradition chalk-and-talk approach and also the performance of boys and girls in EG did not differ from each other after the intervention (Table 4.9). These results show that the jigsaw improved learners' performance because it allowed learners to be participants during the study. This participation is in agreement with the constructivist theory where learners learn from each other (Jia, 2010) and that their knowledge is the Zone of Proximal Distance (ZPD) to the expert (Vygotsky, 1978). Messerchdmidt, (2003) and Najmonnissa, Ammin & Ishmael (2017) contend that understanding and skills in the learning area being taught are improved through the use of the Jigsaw Method. It further implies that learners were more responsible by encouraging cooperation and peer learning (Kardaleska, 2014). Thus, learners should be provided with cooperative tasks so that they have effective learner-learner interaction (Mehta & Kulshrestha, 2014). One of the most common claims about group settings is that they force learning with understanding and are likely to foster conceptual change.

At the beginning, all learners' knowledge was similar about reaction rates concepts (Table 4.3) because they were from the similar environment. It suggests learners' prior-knowledge was taken into consideration through the use of pre-test. Constructivist learning theory is based on the idea that knowledge is constructed on a base of prior knowledge (Jia, 2010). Learners construct their deep understanding because they have to evaluate, integrate and elaborate upon their existing knowledge. Learners' understanding levels of the same topic varied significantly after intervention (Table 4.5). This implies that the Jigsaw Method helped learners to demonstrate the understanding of the reaction rates concepts, because learners who were using the Jigsaw Methods, were directed and encouraged to express their ideas in warm atmosphere better than learners in the control group. Constructivist learning theory is also based on the belief that learning occurs during learners' active involvement in a process of meaning and knowledge construction. Lesson was learner-centred, and learners were allowed to express their views and construct their understanding. Koç et. al. (2010) suggested that, learner-centred teaching should be implemented in the presence of an expert. This observation is in agreement with Mengduo and Xiaoling (2010), who suggested that engaging learners in the expert group keep weaker learners at a pace with the rest of the class. The weak learners gained from seeing how academically strong learners approach the problem.

Learners in the control group did not improve significantly in the post-test (Table 4.4). The difference between the pre- and post-tests were not statistically significant. The reason is that the control group was taught the reaction rates concepts in a traditional way and lessons were teacher-centred. Learners received knowledge passively when lessons are teacher-centred. When learners are passive, they quickly forget the concepts (Maftei & Popescus, 2012). The instruction is therefore not for conceptual understanding of facts, but rather memorising of facts. Teachers need to change their ways of teaching and shift the presentation of science lessons away from teacher centred to a more learner-centred approach to make learning effective (Zakaria & Iksan, 2007). The facilitator must ensure that all learners are exposed to the required science concepts by engaging them in the lesson.

Hypothesis 1 states that there is no significant difference in performance between learners who are taught using the jigsaw learning method and learners who are taught using traditional learning method*.* This null hypothesis was rejected, as the findings of the study revealed that the EG where the Jigsaw Method was employed performed successfully after intervention and outperformed the CG where the traditional method was used. The findings of the study are in parallel with Marhama and Mulyadi (2013) who also found that, learners in the experimental group, where the Jigsaw Method was used, performed better than the learners in the control group, who were taught using traditional method. Learners in the experimental comprehended the reaction rates concepts better than learners in the control group because they were actively engaged. The Jigsaw Method was considered effective in increasing positive educational outcomes (Mengduo & Xiaoling, 2010).

In addition to the findings above, the results of ANCOVA also suggested that the Jigsaw Method is an effective method in improving the academic performance of learners (Table 4.24). Small groups allow teachers to engage in more individualised teaching to have effective the jigsaw cooperative learning (Blatchford, Brown & Basset, 2011). Thus, it can be inferred that the Jigsaw Method improved Grade 12 learners' performance in reaction rate concepts.

Again, the performance of learners using the Jigsaw Method did not differ significantly, regardless of whether they were girls or boys. The level of understanding looked similar between boys and girls after the intervention. The results suggest that gender does not influence on the learner's performance. The Jigsaw Method increases learners' reluctance to participate in the classroom and create an active learner-centred atmosphere. These results are in parallel with the other studies (Al-Salkhi, 2015; Amadpanah et al., 2014; Arif, Rachmawaty & Wijaya, 2013; Arif, Rachmawaty & Wijaya, 2013; Fini, Jamri & Zainalipour, 2012; Marhama & Mulyadi, 2013; Bukurlola & Idowu, 2012; Vargas-Vargas, 2011; Doymus & Karakop, 2011; Maden, 2011; Azmin, 2015; Crone & Portillo, 2013; Abdulkadir & Yorak, 2016), which revealed that group success was not based on gender, but on group itself. Furthermore, performance did not depend on gender but depended on how knowledge was received.

Hypothesis 2 also believes that the Jigsaw Method improves the academic performance of both boys and girls. This study hypothesis was accepted. The Jigsaw Method improved on both boys and girls (Table 4.11). Also, there is no effect between the experimental boys and girls in their post-tests (Table 4.23). Understanding levels of boys and girls did not differ in reaction rates concepts.

When the results of the pre-test for each item were compared, the difference appeared to be significant in a few items, meaning they had little knowledge of 'reaction rates' concepts. After the intervention, it could be seen that the experimental group improved significantly in fifteen questions and control group in only seven questions. Again, it was found that, in experimental group, the effect size was large in five items (1.3, 1.8, 1.10, 2.2.1, 2.2.2). Learners in the control group failed to attempt these questions. These questions involved interpretation of graphs and the shifting of the equilibrium positions in a given change. Most learners in the control group failed to describe how a given change (factor) can affect equilibrium position and the yield of production. Finally, learners in the control group were also introduced to the Jigsaw Method to close these gaps. In the end, all learners who participated in the study had a similar understanding of 'reaction rates' concepts.

5.4 Limitations

The study was limited to one topic in science and two schools. Therefore, it cannot be generalised to all other topics and schools. Only two schools and a few learners from one circuit took part in the study. In the future, studies need to be carried out using larger samples and more topics at various class levels. Again, the involvement of different circuits and more teachers and curriculum advisors will be necessary. The experimental period exceeded the average expected time. Slow learners took long time to get familiar with the material they had to present. Since the Jigsaw Method was a new method in the classroom, the teacher also took a long time to prepare learners, to make them get familiar with the new method. Study duration needs to be extended to have enough time for preparations and to meet the needs of slow learners.

5.5 Study implications

The results of this study indicate clearly that the Jigsaw Method improved academic performances in Physical Science learners relative to the traditional method. Nevertheless, this method does not work automatically. It, therefore, requires adequate implementation and further development. The findings pinpoint the implications that are significant for teachers and curriculum developers. The Jigsaw Method encourages learners to become engaged in learning. They learn the material and share the information with peers. Learners are responsible for their learning. Each member in a group must perform well for the whole group to succeed. Furthermore, learner engagement maximises interaction, cooperation and atmosphere of respect for other learners.

Therefore, learners need to be thoroughly prepared. Teachers move around to see and read what was written while learners are working. This may help the teachers in guiding learners on how to prepare for peer teaching. Learners should also be provided with cooperative tasks in order to have effective student-student interaction (Mehta & Kulshrestha, 2014). Moreover, teachers must avoid assigning vague tasks. In addition to these tasks and academic test, learners need to be provided with an instrument to measure their views towards the Jigsaw Method. The Jigsaw Opinion Scale (JOS) is the relevant instrument to determine the views of learners in the experimental group on the Jigsaw Method applied to them (Yapici, 2016). He indicated that the scale should be applied to the group studying with the Jigsaw Method, before writing the post-test. The scale includes multiple choice questions and an open-ended question for a further view. The learners indicate their responses on five-point Likert Scale. There is a need to measure student views on the new method applied to the experimental group in future research. Curriculum advisors and textbook writers must, therefore include activities which are based on the Jigsaw Method in science curriculum and textbooks.

5.6 Suggestions for further research.

The researcher, therefore, suggests that these results of the Jigsaw Method be disseminated to all Science teachers and curriculum advisors in Maleboho Central Circuit to encourage them to consider the Jigsaw Method as an effective instructional approach that should not be neglected. Physical Science teachers need to get familiar with this teaching method and use it effectively in the classroom. In classes where the Jigsaw Method was used for teaching, learners gradually took responsibility for each other's learning. The Jigsaw Method in the teacher's educational programmes is offered by faculties of education, need to be revised. Curriculum advisors and textbook writers must, therefore include activities which are based on the Jigsaw Method in science curriculum and textbooks. It is also suggested that intensive in-service course be implemented to all science teachers about this teaching approach.

5.7 Conclusion

The present study explored the effect of the Jigsaw Method on Grade 12 Physical Sciences learners' performance in reaction rates to find out whether it can improve learners' learning and performance. It was confirmed that learners who were instructed using the Jigsaw Method achieved better than those instructed using the traditional method. There was a statistically significant mean difference from the results of the post-test of the two groups (CG and EG) after the intervention. Learners' learning improved when the Jigsaw Method was employed. Results of ANCOVA in the post-tests revealed that the Jigsaw Method had got an effect on the academic performance of learners. Based on the findings, the alternative hypothesis (Jigsaw Method elevates the academic performance of learners.) was supported. Although the Jigsaw Method cannot be the panacea for all the challenges faced by the teachers in teaching and learning science, it serves as an alternative to the traditional method. More comprehensive research with an extended period should be conducted to determine the effect of Jigsaw Method on science teaching, at all levels of education.

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APPENDICES

Appendix A: Jigsaw lesson plan for experimental group.
CORE KNOWLEDGE AREA

THEME: REACTION RATES

TIME FRAME: 5 HOURS

EVIDENCE OF ACHIEVEMENTS: Learners must be able to:

1. Explain what is meant by reaction rate
2. List factors which affect reaction rate
3. Explain in terms of collision theory how various factors affect chemical reactions
4. Use graph showing the distribution of molecular energies to explain why only some molecules have enough energy to react
5. Explain what is meant by closed system, reversible reactions and dynamic equilibrium
6. List factors which influence the position of equilibrium

TEACHER ACTIVITY	LEARNER ACTIVITY
1. Introduce lesson by means of scenario and questions to stimulate students' interest in the lesson.	Listen and respond to questions.
2. Assign learners to home groups containing four learners and assign topic to each team member.	
3. The members of each home group are divided into expert groups.	Join in home groups.
4. Assign expert sheets to expert groups.	Join in expert groups.

5. Assess validity of their responses and ask questions based on the original material. 6. Reviews and clarifies any concepts which it appears the learners did not understand. 7. Assess each student using post-test. 8. Re-teach any topic found to be difficult based on the post- test assessment.					Answers expert questions and complete the expert sheets. Return to home groups to teach peer and share information with each other. Write post-test
	HOME GROUPS				**THEMES**
EXPERT GROUP	A1	B1	C1	D1	Temperature
	A2	B2	C2	D2	Concentration
	A3	B3	C3	D3	Surface area
	A4	B4	C4	D4	pressure
	A5	B5	C5	D5	Catalyst

ALLOCATION OF THEMES

Learners were given cards. Letters represented home groups and numbers, expert groups. A learner having card A1will be in home group A and expert group1.

Activity1

Changing temperature Learners look for the reactions in the materials given and classify them as exothermic and endothermic reactions. Explore energy changes (enthalpy change) that accompany chemical reactions. Explore the connections between energy changes and chemical reactions.

In terms of collision theory:

For a reaction to take place, the reactant particles must collide. Not all collisions are effective. Collisions with a too little energy do not produce chemical reactions.

To understand energy implications of chemical reactions note the following:

*Energy is required to break the bonds

*Energy is released when new bonds form

You will be expected in terms of collision theory why changing temperature of the reaction changes its reaction rate

Activity2

CHANGING CONCENTRATION

Collision Theory

For a reaction to take place, the reactant particles must collide. Not all collissions are effective. Collisions with a too little energy do not produce chemical reactions.

To understand energy implications of chemical reactions note the following:

*Energy is required to break the bonds

*Energy is released when new bonds form

You will be expected in terms of collision theory why changing concentration of the reaction changes its reaction rate

Learners look for the cases in the materials given where solution of different concentrations are given. They were expected to arrange them from lowest to highest concentration. Explore what effect will each of them have on reaction rate. Motivate your answers.

Summary and important facts

Activity 4

CHANGING SUFACE AREA

Notes:

In terms of collision theory:

For a reaction to take place, the reactant particles must collide. Not all collisions are effective. Collisions with a too little energy do not produce chemical reactions.

To understand energy implications of chemical reactions note the following:

*Energy is required to break the bonds

*Energy is released when new bonds form

Learners study the given materials. They searched for the situations where substance of different masses and/or states is given. They then explored how each mass and/ or state affects its reaction rate. They were expected in terms of collision theory why changing the surface area of the reaction changes its reaction rate

Learner’s summary

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Activity 4

CHANGING PRESSURE

Learners look for the reactions in the materials given. They were expected to balance equations for each reaction. They were then expected to explore the connection between volume and number of moles in each reaction. How changing volume and number of moles can affect reaction rate. You will be expected in terms of collision theory why changing pressure of the reaction changes its reaction rate.

In terms of collision theory:

For a reaction to take place, the reactant particles must collide. Not all collisions are effective. Collisions with a too little energy do not produce chemical reactions.

To understand energy implications of chemical reactions note the following:

*Energy is required to break the bonds

*Energy is released when new bonds form

Summary

Activity 5

ADDITION OF CATALYST

Learners look for the reactions in the materials given. They were expected to search for equations where catalyst is added. They were then had to explore how addition of catalyst affects the forward and the reverse reactions for equations. They were then being expected in terms of collision theory how adding catalyst of the reaction changes its reaction rate. Use also diagrams and graphs.

In terms of collision theory:

For a reaction to take place, the reactant particles must collide. Not all collisions are effective. Collisions with a too little energy do not produce chemical reactions.

To understand energy implications of chemical reactions note the following:

*Energy is required to break the bonds

*Energy is released when new bonds form

Summary

Appendix B: Traditional lesson plan (for control group)

CORE KNOWLEDGE AREA: CHEMICAL CHANGE

THEME: REACTION RATES

TIME FRAME: 5 HOURS

EVIDENCE OF ACHIEVEMENTS: Learners must be able to:

1. Explain what is meant by reaction rate
2. List factors which affect reaction rate
3. Explain in terms of collision theory how various factors affect chemical reactions
4. Use graph showing the distribution of molecular energies to explain why only some molecules have enough energy to react
5. Explain what is meant by closed system, reversible reactions and dynamic equilibrium
6. List factors which influence the position of equilibrium

TEACHER ACTIVITY	LEARNERS' ACTIVITY
1.Use scenario and questions in order to stimulate learners' interest in the lesson	Respond to questions
2. Explain concepts by using words, pictures and drawing graphs.	Listen and learn to draw and interpret graphs.
3. Ask questions based on the content explained	Respond to questions arising from the explanation of concepts.
4. provide learners with worksheet	Complete worksheet
5. Assess learners' questions based on respond from worksheet	

6. Clarifies any concept which seems to be not clear to learners 8. Give post test	 Write post-test

Activity1

Notes

The rate of reaction is affected by the factors, namely:

1. Surface area of solids.
2. Temperature
3. Concentrations of solids and gases
4. Pressure
5. Catalyst

Surface area

The reaction rate increases if the surface area of the solid reactants increases. This is because, the greater the surface area is, the greater the numbers of particles are exposed. This leads to more effective collisions.
Example: Dissolving calcium carbonate chunks and the powdered calcium carbonate.

An educator wrote the following balanced equation for the reaction on the chalkboard and the end products were named by learners.

$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Since the gas released is carbon dioxide (CO_2), results for the volume of the gas released in a certain time period were used to measure the rate of reaction.

Learners were asked to plot graphs from the results of the experiment provided to them, on the same set of axis. Label the curve A ($CaCO_3$ powder) or B ($CaCO_3$ chips)

From the curves of the graphs, an educator clarified the following features, and asks learner questions.

- The difference in the steepness of the two graphs.-------------------------------------
  ----

- Why the mass of $CaCO_3$ and the amount and concentration of HCl(*aq*)is the same in both experiments? What does it tells us about the total volume of the gas?--
  ----

- After few minutes, both reactions slow down. Explain.--------------------------------
  ----

Activity 2

The effect of concentration on reaction rate

An educator clarified it by decreasing or increasing concentration of acid in its reaction with sodium thiosulphate.

Experiment	1	2	3	4	5
Volume (cm^3) ($Na_2S_2O_3$)					
Volume of(H_2O) (cm^3)					
Voume (cm^3) (HCl)					

Learners compared the recorded time for the cross to disappear with the concentration.

Learners were requested to draw and complete the table where concentrations of different experiments were compared. They did this by writing the concentrations in increasing order, and then paired them with time taken for each concentration to cover the cross under the beaker.

A.

CONCENTRATION (mol/dm^3)	**TIME (min)**

B. Identify the dependent--- and the dependent variable---

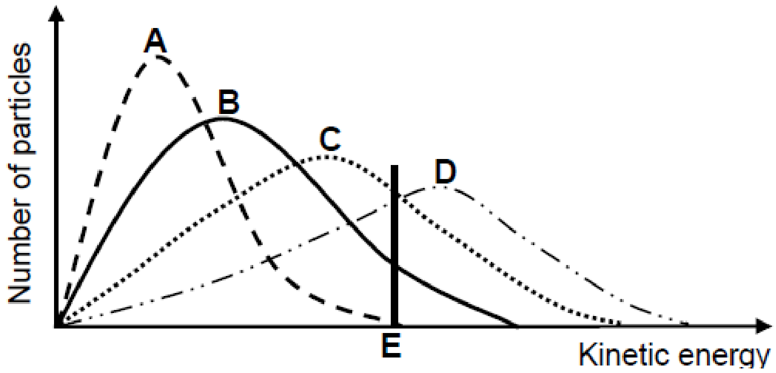
C. Conclusion:--

Activity 3

The effect of temperature on reaction rate

Temperature is related to the average kinetic energy of the reactant molecule. The higher the temperature, the higher the average kinetic energy of the molecules. This will increase the frequency of collisions which will increase number of effective collisions. The rate of reaction increases.

The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures. The minimum kinetic energy needed for effective collisions to take place is represented by **E**.



The teacher helped learners to study the following graph. She then asked the following questions with the help of the teacher.

1. Which graph contains the lowest number of particles with enough energy to react? --
   ----
2. Name the graph with the highest temperature---

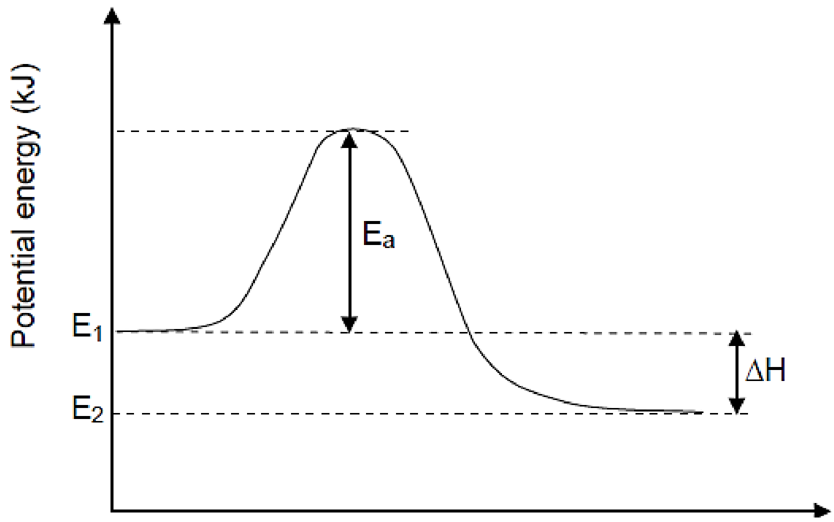
   ----
3. Which graph indicate the highest rate?---

Activity 4

Addition of catalyst.

Energy is absorbed when bond breaks, and is released when new bonds form. Catalyst works by providing a different pathway for the reaction. The catalyst is incorporated into the activated complex.

A certain chemical reaction is represented by the potential energy diagram below.



1. In the above diagram, name the energy which will be affected by addition of catalyst.--

2. Say whether it will increase, decrease or stay the same when catalyst is added.

----

3. Will enthalpy change be positive or negative for the above diagram?

----

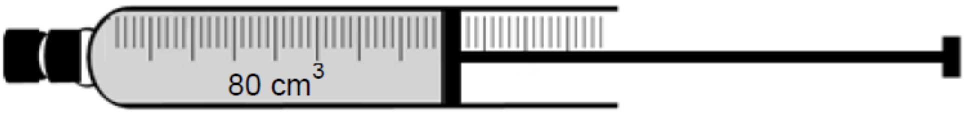
4. Say whether the reaction indicated by for the above diagram is exothermic or endothermic.

Activity 5

The effect of pressure on reaction rate

The teacher demonstrated with gas syringe on how to increase and decrease pressure.

The diagram below shows the reaction mixture in the gas syringe after equilibrium is established.



The pressure is now increased by decreasing the volume of the gas syringe at constant temperature as illustrated in the diagram below.

Learners observed. The teacher requested them to explore how the change in pressure could affect volume and concentration of the gas particles.

Appendix C: Pre-test

GRADE 12
AUGUST 2015
TOTAL: 50

QUESTION 1

1.1

Activation energy can best be described as the minimum energy required to …

A cause effective collisions.

B make reactant molecules collide.

C increase the kinetic energy of reactant molecules.

D change the orientation of reactant molecules. (2)

1.2

In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the …

A enthalpy of the reaction.

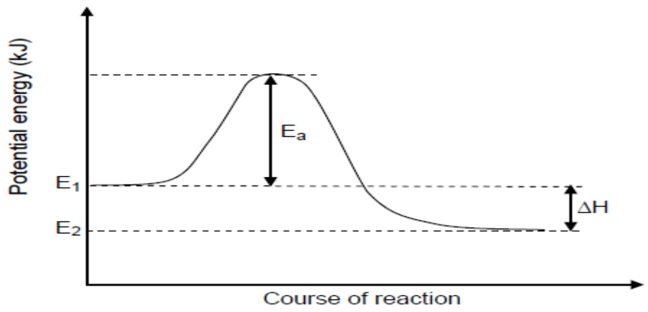
B rate of the reaction.

C enthalpy change of the reaction.

D total potential energy of the particles. (2)

1.3

A certain chemical reaction is represented by the potential energy diagram below.



Which ONE of the following quantities will change when a catalyst is added?

A E_2

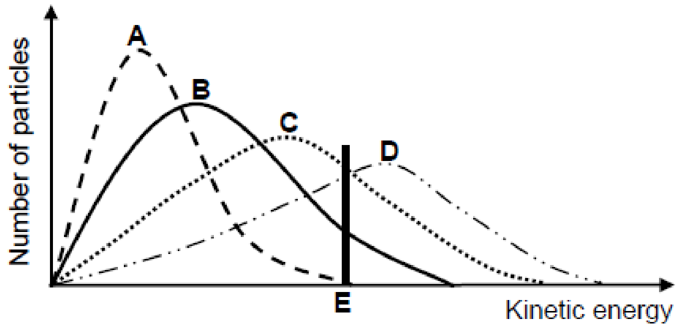
B E_1

C E_a

D ΔH (2)

1.4

The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures. The minimum kinetic energy needed for effective collisions to take place is represented by **E**.



Which ONE of these curves represents the reaction with the highest rate?

A A
B B
C C
D D (2)

1.5

Which ONE of the following CORRECTLY describes the effect of an INCREASE IN TEMPERATURE on a reaction at equilibrium?

	Reaction favoured	Reaction rate
A	Exothermic	Increases
B	Exothermic	Decreases
C	Endothermic	Increases
D	Endothermic	Decreases

(2)

1.6

Each of the reactions represented below is at equilibrium in a closed container. In which ONE of these reactions will an INCREASE IN PRESSURE (by decreasing the volume) favour the formation of products?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

B $PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g)$

C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

D $NO_2(g) + CO(g) \rightleftharpoons NO(g) + CO_2(g)$ (2)

1.7

The following hypothetical reaction reaches equilibrium in a closed container at a certain temperature:

$$X_2(g) + Y_2(g) \rightleftharpoons 2XY(g) \qquad \Delta H < 0$$

Which ONE of the following changes will increase the AMOUNT of XY(g)?

A Decrease in temperature

B Increase in temperature

C Increase in pressure

D Decrease in pressure (2)

1.8

Consider the chemical reaction represented by the equation below.

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

Which ONE of the following changes will increase the rate of production of $CO_2(g)$?

A Increase in pressure

B Increase in mass of $CaCO_3$

C Increase in volume of $HC\ell(aq)$

D Increase in concentration of $HC\ell(aq)$ (2)

1.9

The following reaction reaches equilibrium in a closed container at a certain temperature:

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

The pressure is now decreased by increasing the volume of the container at constant temperature.

Which ONE of the following is correct as the reaction approaches a new equilibrium?

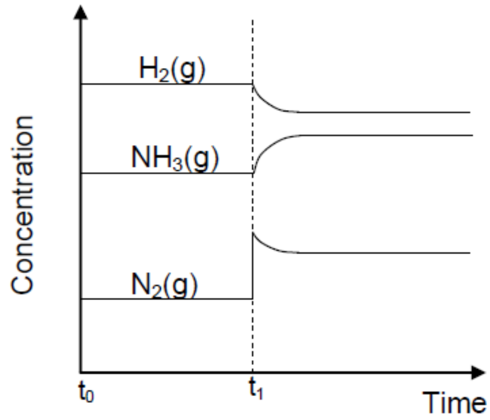
	NUMBER OF MOLES OF $O_3(g)$	NUMBER OF MOLES OF $O_2(g)$	CONCENTRATION OF $O_2(g)$
A	Increases	Decreases	Decreases
B	Decreases	Increases	Increases
C	Decreases	Increases	Decreases
D	Increases	Decreases	Increases

(2)

1.10

The graph below shows a change made to a chemical equilibrium in a closed container at time t_1. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$



Which ONE of the following is the change made at time t_1?

A Addition of a catalyst

B Increase in temperature

C Increase in the concentration of $N_2(g)$

D Increase in pressure by decreasing the volume (2)

(20)

QUESTION 2

2.1 Name two factors determining whether a collision is effective or not. (4)

Consider the following chemical reaction: 100 g zinc granules are added to 500 ml hydrochloric acid. Describe how each of the following will affect reaction rate.(Write only **increase, decrease or remain the same.)**

2.2.1 Zinc powder with the same mass is used instead of granules. (2)

2.2.2 The reaction mixture is heated. (2)

2.2.3 750 ml Hcl is used instead of 500 ml. (2)

2.2.4 Copper shavings are added to the reaction mixture. (2)

(12)

QUESTION 3

.1 Define the term *reaction rate* in words. (2)

earners use the reaction between IMPURE POWDERED calcium carbonate and xcess hydrochloric acid to investigate reaction rate. The balanced equation for the action is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

hey perform four experiments under different conditions of concentration, mass and mperature as shown in the table below. They use identical apparatus in the four xperiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	**2**	**3**	**4**
Concentration of acid ($mol\cdot dm^{-3}$)	1	0,5	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid (°C)	30	30	40	40

.2 The results of experiments **1** and **3** are compared in the investigation.

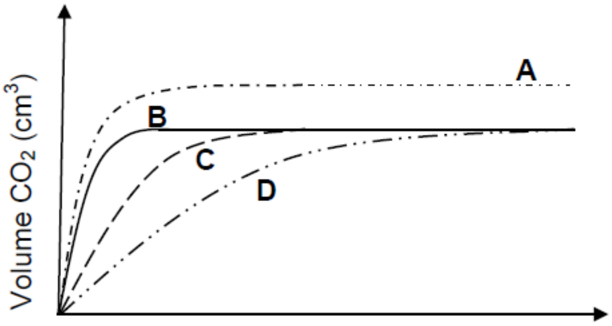
Write down the:

5.2.1 Independent variable (1)

5.2.2 Dependent variable (1)

.3 Use the collision theory to explain why the reaction rate in experiment **4** will be higher than that in experiment **3**. (3)

he learners obtain graphs **A**, **B**, **C** and **D** below from their results.



.4 Which ONE of the graphs (**A**, **B**, **C** or **D**) represents experiment **1**? Fully explain the answer by comparing experiment **1** with experiments **2**, **3** and **4**. (6)

.5 When the reaction in experiment **4** reaches completion, the volume of gas formed is 4,5 dm^3. Assume that the molar gas volume at 40 °C is equal to 25,7 dm^3.

Calculate the mass of the impurities present in the calcium carbonate. (5)

[18]

Appendix D: Post-test

GRADE 12
AUGUST 2015
TOTAL: 50

QUESTION 1

1.1

Activation energy can best be described as the minimum energy required to …

A cause effective collisions.

B make reactant molecules collide.

C increase the kinetic energy of reactant molecules.

D change the orientation of reactant molecules. (2)

1.2

In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the …

A enthalpy of the reaction.

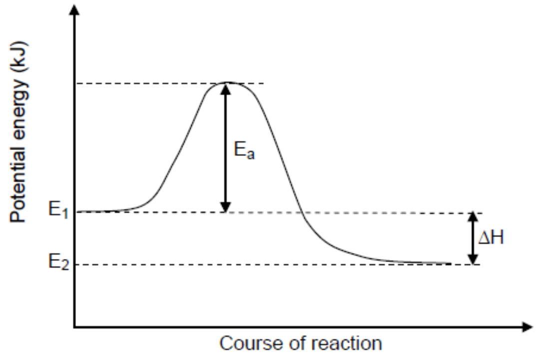
B rate of the reaction.

C enthalpy change of the reaction.

D total potential energy of the particles. (2)

1.3

A certain chemical reaction is represented by the potential energy diagram below.



Which ONE of the following quantities will change when a catalyst is added?

A E_2

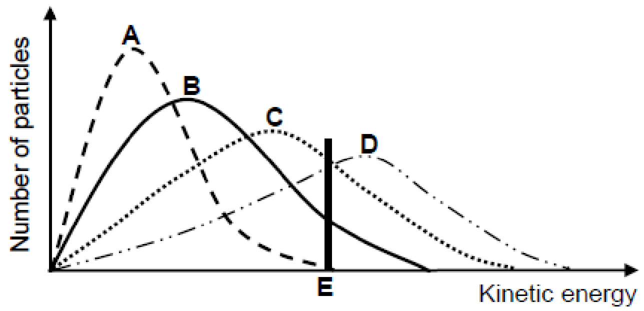
B E_1

C E_a

D ΔH (2)

1.4

The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures. The minimum kinetic energy needed for effective collisions to take place is represented by **E**.



Which ONE of these curves represents the reaction with the highest rate?

A A
B B
C C
D D (2)

1.5

Which ONE of the following CORRECTLY describes the effect of an INCREASE IN TEMPERATURE on a reaction at equilibrium?

	Reaction favoured	Reaction rate
A	Exothermic	Increases
B	Exothermic	Decreases
C	Endothermic	Increases
D	Endothermic	Decreases

(2)

1.6

Each of the reactions represented below is at equilibrium in a closed container. In which ONE of these reactions will an INCREASE IN PRESSURE (by decreasing the volume) favour the formation of products?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

B $PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g)$

C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

D $NO_2(g) + CO(g) \rightleftharpoons NO(g) + CO_2(g)$ (2)

1.7

The following hypothetical reaction reaches equilibrium in a closed container at a certain temperature:

$$X_2(g) + Y_2(g) \rightleftharpoons 2XY(g) \qquad \Delta H < 0$$

Which ONE of the following changes will increase the AMOUNT of XY(g)?

A Decrease in temperature

B Increase in temperature

C Increase in pressure

D Decrease in pressure (2)

1.8

Consider the chemical reaction represented by the equation below.

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

Which ONE of the following changes will increase the rate of production of $CO_2(g)$?

A Increase in pressure

B Increase in mass of $CaCO_3$

C Increase in volume of $HC\ell(aq)$

D Increase in concentration of $HC\ell(aq)$ (2)

1.9

The following reaction reaches equilibrium in a closed container at a certain temperature:

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

The pressure is now decreased by increasing the volume of the container at constant temperature.

Which ONE of the following is correct as the reaction approaches a new equilibrium?

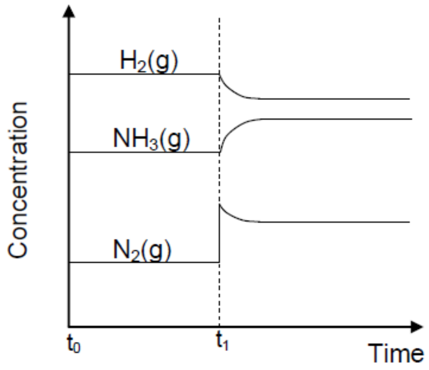
	NUMBER OF MOLES OF $O_3(g)$	NUMBER OF MOLES OF $O_2(g)$	CONCENTRATION OF $O_2(g)$
A	Increases	Decreases	Decreases
B	Decreases	Increases	Increases
C	Decreases	Increases	Decreases
D	Increases	Decreases	Increases

(2)

1.10

The graph below shows a change made to a chemical equilibrium in a closed container at time t_1. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$



Which ONE of the following is the change made at time t_1?

A Addition of a catalyst

B Increase in temperature

C Increase in the concentration of $N_2(g)$

D Increase in pressure by decreasing the volume (2)

QUESTION 2

2.1 Name two factors determining whether a collision is effective or not. (4)

Consider the following chemical reaction: 100 g zinc granules are added to 500 ml hydrochloric acid. Describe how each of the following will affect reaction rate. (Write only **increase, decrease or remain the same.)**

2.2.1 Zinc powder with the same mass is used instead of granules. (2)

2.2.2 The reaction mixture is heated. (2)

2.2.3 750 ml Hcl is used instead of 500 ml. (2)

2.2.4 Copper shavings are added to the reaction mixture. (2)

(12)

.1 Define the term *reaction rate* in words. (2)

earners use the reaction between IMPURE POWDERED calcium carbonate and xcess hydrochloric acid to investigate reaction rate. The balanced equation for the eaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

hey perform four experiments under different conditions of concentration, mass and emperature as shown in the table below. They use identical apparatus in the four xperiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	**2**	**3**	**4**
Concentration of acid ($mol \cdot dm^{-3}$)	1	0,5	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid (°C)	30	30	40	40

.2 The results of experiments **1** and **3** are compared in the investigation.

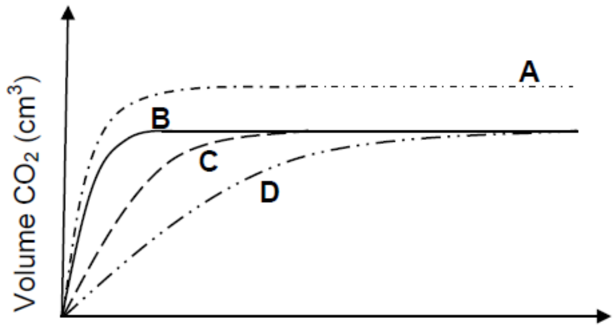
Write down the:

5.2.1 Independent variable (1)

5.2.2 Dependent variable (1)

.3 Use the collision theory to explain why the reaction rate in experiment **4** will be higher than that in experiment **3**. (3)

he learners obtain graphs **A**, **B**, **C** and **D** below from their results.



.4 Which ONE of the graphs (**A**, **B**, **C** or **D**) represents experiment **1**? Fully explain the answer by comparing experiment **1** with experiments **2**, **3** and **4**. (6)

.5 When the reaction in experiment **4** reaches completion, the volume of gas formed is 4,5 dm^3. Assume that the molar gas volume at 40 °C is equal to 25,7 dm^3.

Calculate the mass of the impurities present in the calcium carbonate. (5)
[18]

Appendix E: Content validity index (CVI)

Question number	Rater 1	Rater 2	Rater 3	Rater 4	Rater5	CVI
1.1	**X**	**X**	**X**	**X**	**X**	**1.00**
1.2	**X**	**X**	**X**	**X**	**X**	**1.00**
1.3	**X**	**X**	**X**	**X**	**X**	**1.00**
1.4	**X**	**X**	**X**	**X**	**X**	**1.00**
1.5	**X**	**X**	**X**	**X**	**X**	**1.00**
1.6	**X**	**X**	**X**	**X**	**X**	**1.00**
1.7	**X**	**X**	**X**	**X**	**X**	**1.00**
1.8	**X**	**X**	X	X	**X**	**1.00**
1.9	**X**	**X**	X	X	**0**	**0.8**
1.10	**X**	**X**	**X**	**X**	**X**	**1.00**
2.1	**X**	**X**	**0**	**X**	**X**	**0.8**
2.2.1	**X**	**X**	**X**	0	**X**	**0.8**
2.2.2	**X**	**X**	**X**	**X**	**X**	**1.00**
2.2.3	**X**	**X**	**X**	**X**	**X**	**1.00**
2.2.4	**X**	**X**	**X**	**X**	**X**	**1.00**
3.1	**X**	**X**	**X**	**X**	X	**1.00**
3.2.1	**X**	**X**	**X**	**X**	**X**	**1.00**
3.2.2	X	X	X	**X**	X	**1.00**
3.3	**X**	**X**	**X**	X	**X**	**1.00**
3.4	**X**	**X**	**X**	X	X	**1.00**
3.5	X	0	X	X	X	**0.8**
OVERALL CVI						**0.95**

Appedix F: **Foromo ya tumelelo ya batswadi**

Monyakišiši: Lehong M.J

University of Limpopo

Masters in Science education

Hlogo ya dinyakišišo: **Seabe sa mokgwa wa thuto woo o bitswago jigsaw dithutong tsa bana.**

Batswadi ba bana ba marematlou ba kgopelwa tumelelo ya go šomiša bana go dira dinyakišišo ka bana. Dipoelo tša dinyakišišo di ile go tliša diphetogo dithutong tsa bana ba lena. Maina a bona a se tšwelešwe ka gare ga dipoelo. Morutabana o tshephisa gore o tla rwala maikarabelo ka moka nakong ya dinyakišišo. Se se ra gore bana ba tla dula ba bolokegile. Ba ile go swarwa ka tekatekano. Motšeakarolo o na le tokelo ya go ka emiša ka dithuto nakong ya dinyakišišo ge go na le mabaka ao a mo šitišago go tšwela pele.

Motwadi ge a badile, a kwešišitše, mme a dumelela ngwana go tšea karolo a ka saena dikgobeng tšeo di latelago.

Motswadi---------------------------------   Monyakišiši---------------------------

Leina:-------------------------------------   Leina:----------------------------------

Mosaeno:--------------------------------   Mosaeno:------------------------------

Tšatšikgwedi:----------------------------   Tšatšikgwedi:-----------------------------------

Nomoro ya mogala--------------------------------   Nomoro ya mogala:**------------------------------**

Appendix G: A consent form for learners

The study you are about to participate in is a classroom research. It implies to explore the effect of Jigsaw Method as a teaching strategy to see how it can enhance learners' learning and performance.

The study employs classroom tasks that have no potential harm to participants, and has been approved.

Should you agree to being in the study, you will be asked to participate in a variety of tasks such as: discussions, presenting information and writing tests.

All data collected from you will be coded in order to protect your identity. Following the study there will be no way to connect your name with your data.

Any additional information about the study results will be provided to you at its conclusion, upon your request.

You are free to withdraw from the study at any time. Should you agree to participate, please, sign your name below, indicating that you have read and understood the nature of the study, and that all your inquiries concerning the activities have been answered to your satisfaction.

Complete the following if you wish to receive a copy of the results of this study.

Learner----------------------------------	Researcher-----------------------------
Name------------------------------------	Name:---------------------------------
Signature--------------------------------	Signature:------------------------------
Date:------------------------------------	Date:----------------------------------

Appendix H A letter to the circuit manager

University of Limpopo (Turfloop Campus)
Private Bag X 1106
SOVENGA
0727
19-July-2016

The Circuit Manager
Private Bag X 5008
Bochum
0790

Dear Sir/Madam

REQUEST TO BE GRANTED PERMISSION TO CONDUCT RESEARCH

The above matter refers. I **Lehong Moyahabo Jeridah** of student number **201108177** request permission to use learners in the study I'm going to conduct. The purpose of the study is to investigate about the effect of Jigsaw Method on reaction rate on Grade 12 science learners. Data will be collected from the tests they are going to write.

Report will be for the fulfilment of the degree requirements. Presentations for the research will be made in the conferences only. Names of people will remain confidential.

I'm looking forward to your response as soon as you receive this letter. Contact me for any question which may arise from this letter at 0763853383.

Yours faithfully

Lehong M.J(Mrs)

Appendix I: A letter to the principal

University of Limpopo (Turfloop Campus)
Private Bag X 1106
SOVENG
0727
27-July-2016

The Principal
Private Bag X 230
Bochum
O790

Dear Sir/Madam

REQUEST TO BE GRANTED PERMISSION TO CONDUCT RESEARCH

The above matter refers. I **Lehong Moyahabo Jeridah** of student number **201108177** request permission to use learners in the study I'm going to conduct. The purpose of the study is to explore Jigsaw Method in Grade 12 science learners. Data will be collected from the tests they are going to write.

Report will be for the fulfilment of the degree requirements. Presentations for the research will be made in the conferences only. Names of people will remain confidential.

I'm looking forward to your response as soon as you receive this letter. Contact me for any question which may arise from this letter at 0763853383.

Yours faithfully
Lehong M.J(Mrs)

Appendix J: Re: statement from the council on proclamation of s71 of National Health Act

University of Limpopo (Turfloop Campus)
Turfloop Research Ethics Committee
(TREC)
Private Bag X 1106
SOVENGA
0727
03 April 2012

Dear Chair: Prof R Howard

REC Reference No: REC-310111-031

RE: STATEMENT FROM THE COUNCIL ON PROCLAMATION OF S71 OF NATIONAL HEALTH ACT

1. The NHREC wishes to inform stakeholders that s71 of the National Health Act (NHA) (2003) was proclaimed with effect from 01 March 2012.
2. S71 introduces a number of new requirements for health research, including (1) written consent (2) consent from a parent or guardian for research with children (3) 'therapeutic research' should be in a child's best interests and (4) consent from the Minister must be obtained for 'non-therapeutic research with children.
3. Regulations are yet to issued providing greater detail and operational guidance to RECs, particularly for the latter requirement.
4. The NHREC is in the process of obtaining clarity on how RECs can meet the new requirements, particularly the latter requirement.
5. The NHREC is aware that there is conflict between the legal requirements and current national ethical guidelines.
6. Regular updates will be posted on the NHREC website informing research stakeholders of new developments.

Please feel free to contact us if you require any additional information.

Yours sincerely,

Prof. D. du Toit
Chairperson: National Health Research Ethics Council

Appendix K: Permission from Circuit

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

MALEBOHO CENTRAL CIRCUIT

22 July 2016

UNIVERSITY OF LIMPOPO

PRIVATE BAG X1106

SOVENGA

0727

Dear Sir / Madam

PERMISSION IS GRANTED FOR LEHONG MJ TO USE LEARNERS TO CONDUCT RESEARCH

Permission is granted for LEHONG MOYAHABO JERIDAH of student no: 201108177 to conduct research in Maleboho Central Circuit

The circuit wish her good luck in her research process.

CIRCUIT MANAGER

LIMPOPO PROVINCE
DEPARTMENT OF EDUCATION
POLOKWANE DISTRICT OFFICE
MALEBOHO CENTRAL CIRCUIT OFFICE
2016 -07- 22
PRIVATE BAG X5003
SENWABARWANA, 0790
KGORO YA THUTO LIMPOPO PROVINCE

Appendix L: Permission from school A

Enquiry: Mothapo FM
Contact: 0834301386

Mahlase Secondary School
P O Box 230
BOCHUM
0790
27 – JULY – 2016

University of Limpopo
Private Bag X 1106
SOVENGA
0727

Dear Madam

ACKNOWLEDGEMENT OF REQUEST LETTER

The following bear reference:

1. The management team of the above acknowledges receipt of your request letter dated 25/07/2016, requesting to conduct a Science research at our school on August 2016.
2. Your request has been thoroughly analysed and considered in line with both your aspiration and your wellbeing of our learners.
3. Therefore, a permission to conduct your research is granted on the condition that:

- Your research is conducted within the school premises.
- Subject periods or free periods are used to avoid interference with the normal day to day lesson.
- You remain obedient to rules and regulations governing any stakeholder within the school premise.

Hoping that your request has been fully catered for.

Yours faithfully

Mothapo FM (Deputy principal)

DEPARTMENT OF EDUCATION
MAHLASE SEN. SEC. SCHOOL
DEPUTY PRINCIPAL
[illegible] - 2016
P.O. BOX 230
BOCHUM. 0790
LIMPOPO PROVINCE

Appendix M: Permission from school B

Enquiry: Manthata DM
Contact: 0725183853

Kgopudi Secondary School
P O Box 1499
BOCHUM
0790
27 – JULY – 2016

University of Limpopo
Private Bag X 1106
SOVENGA
0727

Dear Madam

ACKNOWLEDGEMENT FOR A FORMAL REQUEST TO CONDUCT A RESEARCH

I hereby confirm that our School Management Team received a letter from Lehong MJ requesting to conduct a Science research at our school on August 2016. Your request was taken into consideration and you are therefore granted permission to conduct a research, using our learners.

The following need to be taken into consideration:

- Cooperate well with other teachers
- Do not interfere with school
- Obey all the rules and regulations governing any stakeholder within the school

Yours faithfully
Manthata DM (HOD: Maths and Science)
Signature-----------------

KGOPUDI SEC. SCH
P.O. BOX 1499
BOCHUM. 0790
DATE: 27/07/2016
TEL/CELL: 072 518 3853
H.O.D's OFFICE