

UNIVERSITY OF NAIROBI

**APPLICATION OF PEER ASSESSMENT APPROACHES TO TEACHING
OF MATHEMATICS: THE EFFECTIVENESS AND LEARNER
PERCEPTIONS**

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DECLARATION

This research project is my original work and has not been presented to any other University for any award.

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This research project has been presented for examination with my approval as the University of Nairobi supervisor.

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ABSTRACT

This study sought to establish whether peer assessment approaches to teaching of Mathematics have any effect on the performance of students in secondary schools in Kenya. The objectives were to find out the extent of use of peer assessment as a classroom assessment tool in secondary schools, determine the effectiveness of peer assessment in enhancing performance in mathematics and determine the perceptions of students and teachers towards peer assessment. The study employed quantitative research design as descriptive study approach. The list of school selection was done through simple random method. Purposive sampling was employed to choose groups of respondents from which a sample size was drawn. Primary data was collected by use of questionnaires. The data was organized, coded, and analyzed using Statistical Package for Social Scientist (SPSS 23.) Quantitative data was analyzed using frequencies and percentages.

The study concluded that peer assessment practices are gradually being embraced by schools as a classroom assessment tool since they add value to the learning experience. There is tangible evidence to show that application of peer assessment practices enhances the performance in Mathematics. There is need for sensitisation forums to address perception issues related to peer evaluation and the effective implementation of these approaches to teaching and learning. This study recommends that the ministry of education should create more awareness through in-service training of Mathematics teachers, school Principals and learners on how to apply peer assessment approaches. It should also come up with policies promoting the use of these approaches in order to improve Mathematics performance.

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ACRONYMS

OA	Ordinary-achievers
AfL	Assessment for Learning
AoL	Assessment of Learning
CBC	Competency Based Curriculum
HA	High-achievers
IT	Information technology
KCSE	Kenya Certificate of Secondary Education
LA	Low-achievers
MoE	Ministry of Education
PA	Peer Assessment
ZPD	Zone of Proximal Development
KNEC	Kenya National Examination Council

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CHAPTER ONE

INTRODUCTION

1.1 Background

Educational reforms call for a paradigm shift from traditional teacher-centred to learner-centred approaches to teaching and learning. Vygotsky (1962) stated that we learn through our interactions and communication with others. Gains from learning needs to be measured as the learning occurs and immediate feedback given to learners. This gets Assessment for Learning (AfL) techniques, for example, Peer Assessment and self evaluation.

Peer assessment promotes authentic learning as it allows students to explore, reflect, construct concepts and meaningful relationships in contexts that involve real world situations. Authentic learning is characterised by learners self directing their own learning as they participate in talk and social learning in a very network of students. It includes the usage of open finished request, thinking aptitudes and metacognition. Peer assessment promotes authentic learning as it allows students to explore, reflect, construct concepts and meaningful relationships in contexts that involve real world situations. In order to promote development of skills and competencies in the learners, there is need to realign the current assessment practices by promoting use of AFL strategies. The question is whether stakeholders are ready for this reforms and/or if they are knowledgeable on how to apply this approaches effectively.

Peer evaluation is getting progressively broad in guidance as instructors look to differentiate appraisal techniques and associate understudies inside the appraisal cycle. To reduce teacher work load and enhance students self-learning practice, the Ministry of Education point out the effective way of assessing writing skill that Students should be encouraged to check their own and others' writing before they hand in work (MoE, 2008). Use of peer assessment allows teachers to manage their time more effectively thus relieving them the pressure emanating from poor teacher to student ratio and the need to obtain useful feedback information on what, how much, and how well their students are learning which results in a more efficient classroom setting. Peer assessment is used as a learning tool to give students feedback on the quality of their work, to assist learners with helping each other arrangement their learning, distinguish their qualities and shortcomings, target

zones for therapeutic activity, and create metacognitive and other individual and expert aptitudes. (Wen and Tsai 2006).

Peer appraisal engages understudies to assume liability for their own personal learning and improve comprehension of evaluation rules, scholastic course guidelines and elective ways to deal with scholarly undertakings. It additionally empowers them to create deep rooted appraisal aptitudes, capacity to cause decisions, to legitimize a perspective and offer criticism to peers. One of the manners by which understudies disguise the attributes of value work is by assessing crafted by their companions (Schmid, 2017). To give successful, legitimate and solid criticism to individual students, understudies need clear rules, preparing on evaluation standards and scoring rubrics, at that point practice with models. This will improve understudies' comprehension obviously materials as understudies would be presented to one another's work. For this to be incredible, the learning atmosphere in the homeroom must be consistent. Understudies must feel better and trust one another so as to give legitimate and helpful companion evaluation.

1.2 Statement of the Problem

Ongoing investigations on peer appraisal have reliably recorded the constructive outcomes of peer evaluation, particularly its effect on AfL. However barely any announced investigations surveyed the impact of partner examination on learners with various achievement levels. By the day's end, would peer examination have identical impact on all understudies? Or on the other hand would low-achievers (LA), ordinary achievers (OA) or high-achievers (HA) respond differently to peer assessment? It remains ill defined with respect to what makes fruitful friend examination (Van Zundert, Sluijsmans, and Van Merriënboer 2017), subsequently the need to research this further.

Understanding the nature and the enormity of peer assessment in guidance is fundamental for the "productivity" of enlightening cycles and the progressive arrangement of instructive frameworks. As curriculum developers grapple with the content, resources and approaches required in the curriculum implementation, this study sought to contribute to this area by furthering the discourse on how peer assessment can be instrumental in assessing of skills and competences in order to provide feedback to curriculum designers. This would also provide a useful tool to educational

strategy creators in offering direction to the administration on vital game-plan to take all together to enhance academic performance in Kenyan schools through peer assessment.

1.3 Purpose of the Study

The purpose of the study was to determine the effectiveness and perceptions of peer assessment as applied in teaching of Mathematics in secondary schools.

1.4 Objectives of the Study

- a. Find out the extent of use of peer assessment as a classroom assessment tool in secondary schools.
- b. Determine the effectiveness of peer assessment in enhancing performance in mathematics.
- c. Determine the perceptions of students and teachers towards peer assessment.

1.5 Research Questions

- a. What is the extent of use of peer assessment as a classroom assessment tool in secondary schools?
- b. How effective is peer assessment in enhancing performance in mathematics?
- c. What are the perceptions of students and teachers towards peer assessment?

1.6 Significance of the Study

The discoveries of the investigation would be vital to analysts and researchers to help create a narrative and further the discourse on the effective use of peer assessment approaches in both AfL and AoL in secondary schools. It is likewise trusted that the discoveries will be informative to the ministry of education in terms of creating policies and reflecting on the in-service training needs as regards to use of peer assessment approaches to learning. The investigation discoveries would further inform school heads, teachers and other stakeholders on the current state and recommendations for the full implementation of peer assessment practices approaches in schools.

1.7 Justification of the Study

Important questions about the application of peer assessment approaches to teaching and learning remain open as little research has been conducted in this area in Kenyan secondary schools. Areas

to do with the influence of learner-centred approaches to learning has not been fully explored in the current literature. Peer assessment is a central tenet of the formative assessment process in the competency based curriculum and educators need to integrate these in the learning experiences. It is unclear how these assessments are conducted in various schools and to what extent it is beneficial in teaching and learning coupling with the attitudes and perceptions of the learners.

In order to fully implement the new curriculum (CBC) in terms of evaluation of learning outcomes, the focus has to move from testing to AfL strategies such as peer assessment. As curriculum developers grapple with the content, resources and approaches required in the CBC implementation, this study seeks to contribute to this area by addressing these gaps and furthering the discourse on assessment best practices, provide feedback to curriculum designers on the steps to take in order to enhance academic performance in schools through peer assessment.

1.8 Terminologies

Academic performance:	Marks achieved in end of year examination.
Assessment:	The action of gauging, rating or evaluating a piece of work.
Formative assessment	Assessment for learning.
Summative assessment	Assessment of learning.
National Examination:	An assessment set by the public inspecting body of a nation.
Peers:	Students of the same age and status.
Peer assessment:	Matter of students giving feedback to each other on an assignment.
Students:	Learners in secondary schools.
Mathematics:	One of the areas of study or disciplines in secondary schools.
Perception:	The way something is viewed, understood or interpreted.

CHAPTER TWO

LITERATURE REVIEW

2.1 Related Studies

Omar et. al (2018) did research aimed at determining the effect of use of Peer Assessment on Students' Learning of Geometry. They employed a student centred approach to learning where a learner takes up the role of both teacher and assessor, from the tests administered, there was solid evidence of improvement in Geometry, increased retention of knowledge and increased metacognition and self regulation on the part of the students. The learners expressed a positive attitude towards using peer assessment as a classroom tool even though the assessor feedback given was of low standards. Earlier studies by Onuka (2007) looked at how guided peer assessment programs could improve learning and assessment in Mathematics. Using a sample of 280 participants, he realised that the experimental group that underwent training on peer assessment and feedback giving procedures and rubrics performed better than the control group.

Peer assessment in AFL is essentially a peer tutoring strategy. (Chan, 2013; Donaldson & Topping, 1996). Peer teaching is when learners come together, offer learning support to one another as they engage in peer assessment activities. (Topping, 2005). A study carried out by Oloo (2016) looked at the peer teaching approaches and performance in mathematics. The objective was to determine the effect of peer teaching in the learning process on the students' performance in math. A sample of 176 students, 24 teachers and 12 heads of departments was used in this study. The results from the achievement tests showed a significant improvement of students performance as a result of peer teaching and that all the heads of department supported the fact that the peer teaching approach contributes to these improved mathematics performance. It was concluded that apart from peer teaching through group discussions enhancing understanding of mathematical concepts and removing the negative teacher effects during revision sessions, students stand to gain more when they engage in these discussions in terms of building confidence and increased motivation and love for the subject. A similar study with similar objective was carried out by Abdulkarim (2016) to determine the effects of peer teaching on mathematics performance of 32 students pursuing a degree course on Mathematics. Similar results were recorded to support the notion that this assessment approach is very effective in enhancing performance in mathematics.

Kwok (2008) directed an investigation on understudies' view of friend assessment and instructors' function in workshop conversation. The examination was pointed toward deciding understudies' impression of companion assessment in a workshop conversation with understudies in a higher learning institution. It additionally investigated the educators' part from the understudies' point of view in assessment. The emphasise was on understudies' reactions from two points of view: understudies as evaluators and understudies as evaluatees. It was found that most of understudies partaking as evaluatees "considered the remarks and input reasonable". Understudies saw the experience of companion assessment as upgrading their certainty and giving them the occasion to practice intensity of making decisions about their friends. Notwithstanding, a few understudies viewed themselves as ill-equipped to survey peers when contrasted with the educator who has more insight and gives proficient counsel. Also, understudies' discernments as evaluators showed that understudies making the most of their experience of watching, tuning in to different understudies, deciding, giving remarks and reviewing.

Then again, Kaufman et al. (2010) did an examination to explore understudies' negative recognitions about an online friend evaluation framework called SWORD for undergrad composing tasks. They thought about the idea of understudies' protection from peer evaluation, what variables impact that obstruction and how understudies' discernments sway on their update work. The discoveries demonstrated that understudies' negative view of SWORD were most grounded in those courses where grades for composing were given simply by peers. They favored the educator to review their work instead of friends. In the function where there is no teacher evaluating, understudies now and then viewed peer appraisal as unjustifiable and frequently accepted that friends were inadequate to audit and survey understudies' work. These observations dropped fundamentally as the understudies increased their involvement with peer evaluation. This infers that recognitions rely upon the degree to which peer criticism is helpful and positive.

Essentially, Jingyan et al. (2011) did an investigation on impacts of online companion evaluation, as friend reviewing and peer input, on understudies' picking up utilizing an online framework - iLap. The investigation zeroed in on how companion reviewing exercises and various sorts of friend intellectual and full of feeling criticism identified with the nature of the last tasks for the two assessors and assessees. The quantity of evaluation giving and grade-getting encounters was

inspected and the companion input was coded by various intellectual and full of feeling measurements. The results demonstrated that the course of action by understudy assessors of information that perceived issues and gave proposition was a basic pointer of the introduction of the assessors themselves, positive passionate information was related to the show of assesseees. Besides, peer exploring rehearses were not a basic pointer of undertaking execution. Other explores upholding these are Obedeagu (1991), Duruamaku (2012), Ndifon (2013) and Ukpong (2009).

A later report was completed by Adeyemi Alaba in 2015 to inspect the impact of companion appraisal on understudies' numerical maintenance capacity and decide the impact of friend evaluation practice on the understudies' mentality towards arithmetic learning. The investigation appeared to build up the connection between understudies' disposition towards arithmetic learning and friend appraisal practice. These were with the end goal of improving understudies' learning of arithmetic. The outcomes indicated that the companion appraisal practice significantly affected the support limit of the understudies ($t = 1.83$, $df = 44$, $p > .05$) and ($r = 0.97$, $p < .05$). The results moreover showed that the effect of friend assessment practice on understudies' disposition towards number juggling learning is colossal ($t = 11.46$, $df = 44$, $p < .05$). Also, the results showed that there is no tremendous association between understudies' post planning mindset towards science and manner towards peer examination practice ($r = - 0.064$, $p > .05$). This deduces that peer examination as an elective evaluation technique can achieve improvement in understudies' learning of arithmetic.

Kit et al. (2018) researched on The Impact of Peer Assessment on Academic Performance. It was pointed toward assessing the impact of peer evaluation mediations on scholastic execution comparative with some watched examination gatherings and the attributes that moderate the adequacy of peer appraisal. The outcomes recommended that peer evaluation improves scholarly execution contrasted and no appraisal ($g = 0.54$, $p < .001$), however was not fundamentally extraordinary in its impact from either educator evaluation ($g = 0.20$, $p = .059$) or self-appraisal ($g = 0.22$, $p = .238$). Moreover, meta-relapses analyzed the directing impacts of a few criticism and instructive attributes, which indicated that the adequacy of friend appraisal was astoundingly high over a wide scope of settings.

2.1.1 Summary

The following can be deduced from the nine studies featured above;

- Majority upheld the way that peer assessment approaches positively enhanced understudies scholarly accomplishments and has some significant effect in creating a positive attitude towards learning mathematics when used for formative functions.
- Its effectiveness for classroom instruction was evident in various studies that compared online versus offline, frequency, education level amongst other factors.
- There were some negative attributes detailed like poor quality peer feedback, assessing having a bigger impact than being assessed and peer criticism being more powerful than peer review.
- Peer grading approach to assessment does not enhance students academic achievement more than teacher grading. Although the students found the peer assessment fair, useful and sufficient, they preferred teachers to evaluate their performance more than their peers. They felt that peers had minimal training on the assessment criteria and unqualified to assess.

So based on these studies, it is clear that peer assessment is beneficial but more research needs to be carried out on students' attitudes and perceptions about peer-assessment.

2.2 Related Literature

2.2.1 Peer Assessment

Peer appraisal is the route toward gauging the quality or achievement of the consequences of a partner or companions which is followed by the plan of analysis (Van Den Berg, Admiraal and Pilot, 2016). To the companion being surveyed, the arrangement of input is helpful for permit them the occasion to improve; in any case, this isn't really the most valuable advantage of friend evaluation. The assessment cycle that an understudy must draw in with so as to give input is seemingly the main part of friend appraisal (Ljungman and Silen, 2018). Anderson, Howe, Soden, Halliday, and Low (2016) adds that this is so on the grounds that it manages the cost of the understudy the occasion to rehearse the abilities important to assess their very own work and in this way peer-assessment aim is to enhance aptitudes in self-examination (Anderson, Howe, Soden, Halliday, and Low, 2016).

2.2.2 Use of Peer Assessment as a Classroom Tool

O'Donovan, Price and Rust (2014) commented that when understudies are completely occupied with the stamping cycle, they can change the appraisal of learning (AFL) into evaluation for learning (AOL) and along these lines acquire an ability to improve their scholarly presentation. Friend evaluation procedure upgrades self-rule in understudies' learning and help to cultivate a metacognitive range of abilities (Elwood and Klenowski, 2012). Candy et al. (2014) feature the significance of companion evaluation in their finding that recognizable proof of instructive needs is key to fruitful long lasting learning. Harlen (2017) also portrays the prerequisite of obligation an understudy has for their very own learning as it can benefit, the understudy's life after school just as, overall society.

Learners who are told through friend evaluation strategy have been demonstrated to be cognisant of the advantages. The perspectives on grade school understudies to peer-evaluation were researched by Bryant and Carless (2019) and an exceptionally certain gathering was shown when the understudies were given the office to gain from one another while assuming liability for their own personal work came about. Bryant and Carless' examination likewise found that a few understudies were intensely mindful of the preferences that peer appraisal brought as they could distinguish mistakes in their work and along these lines dodge them in future. Peterson and Irving (2018) found that optional school understudies accepted that criticism gave through companion evaluation was persuasive and urged them to search out arrangements in improvement of their mistakes. The more extensive advantages of companion appraisal are not lost on secondary school understudies; White (2019) reports that the occasion to improve abilities which are useful for their future profession was huge inspiration. McDonald and Boud (2013) have contended that the aptitudes created through friend evaluation are critical all through all phases of schooling. These positive perspectives on peer appraisal are approved by and by: Rust et al. (2013) and O'Donovan et al. (2014) exhibited that cooperation in a companion evaluation program toward the start of a course of study brought about an upgrade in execution over those understudies who didn't take an interest.

While the upsides of friend appraisal are critical, there are various issues that must be considered in its resistance. Wen and Tsai (2016) found that college understudies' perspectives towards peer-appraisal were commonly certain; notwithstanding, there was an absence of self-assurance in their capacity to stamp their colleagues' work and, proportionally, they were uneasy about companion

analysis. Karaca (2019) experienced comparable outcomes when doing an investigation into instructor student's assessments of friend evaluation. It was proposed that understudies think that it's hard to assess their friends' work viably, prompting the arrangement of harmful input. Karaca likewise found that understudies' assessments could be affected by their social associations with their companions: inviting understudies were inclined to giving excessively certain criticism; contrariwise, rivalrous understudies expanded their arrangement of negative input. Ballantyne, Hughes and Mylonas (2012) have additionally detailed that understudies can be worried about the tedious idea of friend appraisal.

White (2019) state that legitimacy and dependability of companion evaluation might be an issue as the input given may not be exact or important and even that a few understudies may not pay attention to the appraisal cycle. Also, they agree with Karaca (2019) in that understudies are not really talented enough to viably assess one another and that a few understudies might be affected by social standing. White (2019) further note that a nonappearance of educator contribution to the assessment cycle could prompt the arrangement of mis-data.

Kearney (2013) contends that evaluation prerequisites are a center portion of the learning cycle and the overwhelming concentration for some understudies. Referring to explore did by Bloxham and West (2014), which found that peer appraisal helped understudies learn, built up their basic reasoning abilities and improved their comprehension of evaluation guidelines, Kearney fights that instructors should plan evaluations that include and connect with understudies and that manufacture fundamental aptitudes, for example, 'basic reasoning and self-sufficient learning', while likewise motivating 'development and innovativeness' (Kearney 2013).

2.2.3 Peer Assessment and Formative Assessment

Peer appraisal is a type of developmental evaluation or evaluation for discovering that is used as a learning instrument and no new in the field of instructing and learning. In enlightening setting, the methods for companion assessment measure are summarized in conscious solicitation as follows: set up similarity, give out endeavors to be overviewed, suitable rubric and execution rules, peer appraisal questioning, preparing utilizing test work, conversation and work modification (Black and William, 2018). The productive criticism from the assessment is the normal result that should

fill supportive need towards the assessee's self-improvements. Companion appraisal comes in different organizations regarding its usage and assessment measure. In learning setting, it goes from simply a basic stamping of other's work for diminishing instructors' heap to evaluating companions' exhibition and commitment towards bunch venture.

In a conventional homeroom setting, understudies are told to do a learning task and present the finished assignment where an instructor will be accountable for making judgment and stamping measure. Once returned, there is likely understudies won't peruse the composed input, as per Thomas, Martin and Pleasants (2016) once the work is off from the understudies' brain, they are not, at this point drew in with the work. Understudies are maybe outwardly spurred to finish or constrained to do learning errands because of factor of limited time or fear of orders. Consequently, they develop to less savvy in achieving the work and uninformed in regard what constitutes a quality work. In peer evaluation, the understudies in an indirect way achieve importance for being insightful when judging or signifying buddy's work. The understudies can get snappy contribution about their works.

An assessment done by Adediwura (2015) on the usage of friend assessment in Secondary Mathematics study corridor, the disclosures indicated that the intercession had beneficial outcome on the understudies' learning consistency standard. In Nigeria, the examination of 212 Secondary Mathematics understudies (Chukwuyenum and Adeleye, 2013) showed, the mediation had shown a tremendous enhancement in the post-tests scores. Moreover, understudies made persuasive attitudes, rehearses and ended up being more busy with the learning cycle in the wake of being introduced to this learning approach (Kearney and Perkins, 2013). An examination by Chan (2013) in 8 grade Mathematics homeroom in Macau showed enhancement in a couple of parts of understudies learning; mathematical reasoning inclination, knowledge of determined and procedural data and positive advancement of mien towards Mathematics. These revelations further assistance the upsides of companion evaluation. As indicated by Logan (2019), the improved scholarly accomplishment is come about because of the mindfulness and basic reasoning that created from the cycle.

In contemplates where understudy interest in peer-appraisal measures zeroed in on denoting a paper or composed task, understudies apparent that the movement had brought expanded certainty and upgraded subject information, just as valuation for the complexities of evaluating their own and friends' work. One study that affirms this observation is that led by Vickerman (2009), which investigates the discernments and encounters of 90 level-two undergrad sports understudies, and included the developmental friend appraisal of two explained book indices. This examination demonstrated that understudies evaluating crafted by their companions are some of the time occupied with an intellectually requesting action that expands their comprehension of the topic. Comparable to this cycle of developmental evaluation, around 60% of the understudies thought about that peer-appraisal had helped them get a more noteworthy feeling of the appraisal cycle.

As to's view of summative friend appraisal in oral introduction aptitudes, De Grez, Valcke and Roozen (2012) recorded the impression of 57 college understudies enlisted on a Business Administration initial course to brain research. The outcomes show an exceptionally uplifting disposition towards the estimation of companion appraisal and a serious level of gaining from criticism. Langan et al. (2018) reached similar determinations from organized meetings with 12 understudies partaking in the summative companion/self appraisal of oral introductions on a private field course. All respondents accepted that both self and companion appraisal were helpful encounters that impel reflection. Notwithstanding, a portion of the understudies additionally noticed the trouble of concentrating realizing that individual understudies were evaluating them.

2.2.4 Peer Assessment and Summative Assessment

Friend evaluation is definitely not a mainstream alternative when utilized for summative purposes. Spiller (2019) demonstrated that understudies frequently have worries about the summative assessment measures, so it isn't astonishing that there is a few waverings or fears about understudies indicating their work to other people, so they believe that their companions are not able to survey their work, and that solitary instructors are allotted to the assessment cycle. These worries are decreased when the companion appraisal movement is developmental as opposed to summative, yet there is sufficient proof that peer evaluation can be utilized dependably for summative work (Gielen and Wever, 2011).

A few examinations contend that there is a worry that understudies may give overstated discernments, unnecessary, or disparaged recognitions in assessing the accomplishments of their companions. These worries, from the viewpoint of estimation, demonstrate the expansion conversely proportion, which undermines the believability of evaluations (Ross, 2016.). While trying to guarantee a reasonable climate for peer learning, Spiller (2019) contends that the presentation of evaluating in peer appraisal may make another arrangement of complex issues, for example, if peers choose to give their friends the evaluations they merited. These evaluations must be just one of various evaluations granted for a particular assignment or cycle. As the examination concerning the ramifications of friend appraisal on close to home factors, for example, mental wellbeing, relationship, trust, and narcissism, and the impacts of various sorts of criticism that have some negative impacts, should be gone to positively affect learning (Kollar and Fisher, 2012). That can be conceivable by detailing assessment rules to lessen inclination and slip-ups in reviewing (Elander, 2014).

In another investigation directed by Falchikov (2016) on a consolidated developmental and summative experience including friend, self and guide evaluated articles, the 48 members thought about that self and companion appraisal made them think, find out more and be more organized than some coach based appraisals. As indicated by this writer, among those perspectives that stand apart most decidedly are arrangement of a diagram as a guide to composing the exposition and expanded mindfulness and advantages of perusing a companion paper.

Utilization of the friend appraisals for summative purposes can be powerful relying upon how one methodologies it. The outcomes with respect to exactness (Horgan et al., 2017) show that peer evaluation can be utilized for summative purposes as a piece of the companion appraisal. In this manner the customary appraisal, where the coach settles on a self-governing choice, isn't tantamount with peer evaluation. peer appraisal makes guides and understudies cooperate in a helpful manner and therefore they come to more significant levels of comprehension by exchange. Companion evaluation is reliable with the standards of andragogy. As such, peer appraisal takes assessment from "instructor driven" to "student driven". By removing appraisal from the instructor's hands, understudies have one more learning open door since this job change gives them bits of

knowledge into the evaluation cycle. The examinations with respect to exactness show the significance of the setting of rules, together by companions and educator or by the understudies independently. Horgan et al. (2015) furthermore stress the impact of time and preparing.

Where utilization of self-evaluation and companion appraisal has been generally utilized for developmental purposes, blends of these structures with peer evaluation do seem to have worked out well for summative appraisals. There are different prospects, in the mix of various methodologies, going from utilizing the friend appraisals as a commitment of, state, 25% to the general score, to utilizing peer evaluations as a remedy score for coach appraisal. Improvements here do unmistakably open up the chance of evaluating aptitudes and capacities in conditions in which advanced education has customarily had issues, they may likewise assist with holding down the expenses of surveying.

2.2.5 Student's Perception towards Peer Assessment

Bryant and Carless (2019) discovered that learner's view of peer appraisal contrast dependent on capacity language and communication skills of the learners. The people evaluated by companions of pervasive language capacity demonstrated that it is challenging to review their partner's work in light of the capacity distinction; contrariwise, highly capable understudies revealed that their companions couldn't give noteworthy input. Bryant and Carless declared that instructors were more solid wellspring of criticism.

Genuineness and believability are proportions of consistency of companion evaluation, and huge consistency the less is variety. Consequently, the undertaking of enhancing friend evaluation frameworks doesn't have a significant level of sincerely when evaluations are the main target to the detriment of different factors, for example, various responses to a specific errand, which needs exploring on the best way to improve understudies' discernments about companion survey rules, and abstain from singular appraisals that could prompt scrutinizing the believability of this evaluation (Cho et al., 2016). Numerous examinations affirm that trustworthiness and validity are troublesome in understudy appraisal (Elander, 2014; Rust et al., 2013), which needs plan of assessment measures to diminish predisposition and blunders in evaluating (Elander, 2014).

Between the numerous reactions coordinated evaluation of peer is the trouble of accomplishing adequate degrees of legit and solid appraisal outcomes, which need evaluation of peer to be viewed as a way of learning enhancement as opposed to an objective in itself. An examination done by Marsh et al., (2018) affirmed the significance of building up basic principles to incorporate populaces from various foundations, just as pertinent outside norms to affirm the validity of companion appraisal findings and test possible biasness by populaces. Chang (2015) introduced successful strategies that assist advance the believability of companion appraisal results, for example, profound comprehension of the motivation behind assessment, and the utilization advancement and variety techniques in the degrees of the members in assessment. The trouble of agreeing among populaces may prompt helpless companion evaluation outcomes, which needs a specific group of individuals to accomplish a more satisfactory believability (Marsh et al., 2018).

Race (2014) contends that friends must be picked indiscriminately on the grounds that they are more averse to be one-sided, and can accomplish more fair outcomes. He likewise feels that peer work is more compelling when every component is assessed as per the assessment rules so as to accomplish a significant level of consistency. Cho and MacArthur (2016) affirm that the individuals who get criticism from peers enhance exhibition more than understudies who get input from one friend, and this accomplishes an elevated level of unwavering quality that needs a level of understanding and consistency among the different appraisals of companions in each understudy, which speaks to a variable imperative to expand the degree of trust in assessment results (Elander, 2014).

Hanrahan and Isaacs (2016) did an examination on understudies' impression of a person and friend appraisal, with cooperation of 233 understudies from a third-year tertiary wellbeing brain science discipline (peer-evaluation of a 1,500 word research article). The subjective methodology utilized by Hanrahan and Isaacs in their examination gives more insights about the advantages and downsides understudies find in companion and self-appraisal. These writers examined understudies' discernments based on an inductive substance examination, which uncovered eight general measurements: trouble, increased better comprehension of stamping, distress, gainful, issues with execution, perused others work, created compassion, and inspiration. These discoveries were affirmed

by Lindblom-Ylänne, Pihlajamäki and Kotkas (2016), who included 15 law undergraduates in a developmental exercise focused on friend and self-evaluation of expositions. Undergraduates saw the cycle of friend appraisal as good and felt that their very own companion's evaluation article was reasonable, albeit a few undergraduates thought that it was hard to be basic towards a friend.

Having introduced the positive perspectives, we will currently consider how peer-appraisal might be seen as negative. In a few cases, undergraduates express that this sort of assessment has upset their associations with peers and reprimanded the absence of objectivity in individual undergraduates' appraisals (Carver et al. 2016; Lindblom-Ylänne, Pihlajamäki and Kotkas 2016). Now and again, they additionally observe a downside in not having the option to safeguard their work before the assessor, as seen in an investigation including four unique subjects and a sum of 340 undergraduates on various degree courses at the University of Málaga, Spain, in which undergraduates needed to self and companion evaluate answers to handy activities and issues in a developmental and summative friend appraisal measure (Carver et al 2016). Another angle featured by undergraduates taking an interest in exercises identified with companion and self-appraisal articles is the trouble associated with this kind of work (Falchikov 2016). Besides, undergraduates' inclinations in regards to evaluation don't generally liken with their recognitions with respect to the propriety of friend appraisal. In his survey of friend evaluation research, Topping (2019) noticed that undergraduates' acknowledgment of companion appraisal is very autonomous from their insight into the exhibited dependability and legitimacy of that evaluation. One of the main viewpoints is their relationship with their friend evaluation associates. Undergraduates will in general build/decline the imprint contingent upon the specific situation and their own relations. In addition, their observation can change during the general cycle.

2.2.6 Peer Assessment and Performance in Mathematics

Arithmetic is an instrument and language of practically in science fields. It causes us perceive designs and comprehend our general surroundings. Numerous undergraduates in rudimentary, secondary school and even at the college level find that arithmetic is troublesome and testing since it is a theoretical order. Hence, science teachers attempt to establish a math-accommodating climate to enable their undergraduates to address this difficulty. One approach to accomplish this is by allowing undergraduates a chance to learn by surveying one another. It has been set up that Friend evaluation

using Instructional Rubrics in preparing Mathematics have been used as one of the huge examination tools that have added to extraordinary execution in Mathematics among assistant school understudies. (Schafer, Ben and Newbery, 2001; Sadler and Eddie, 2006; Andrade and Du, 2005). Apata (2016) expressed that a sound comprehension of fundamental numerical abilities is important for understudies to draw in with mathematical critical thinking ideas as applied in different subjects. He likewise remarked that numerous understudies don't have these essential numerical aptitudes (WACE, 2014). In an offer to enhance science execution, instructors are gradually grasping form appraisal to survey learning as it happens. Understudies will in general utilize peer evaluation casually during bunch work, class introductions, venture work and the less proper oral and composing tests. The degree of utilization and its effect on scholarly execution in Kenyan secondary schools anyway is yet to be set up.

A sound comprehension of essential numerical directors is key to have the option to see most logical wonders. Secondary school understudies' absence of this essential numerical comprehension, also, its effect on science, is the point of convergence of media (Royal Society of Chemistry, 2009a); additionally, a progressing report from SCORE (Science Community Representing Education, 2016), an organized exertion of science relationship interested in guidance, has included that an immense degree of mathematical necessities of auxiliary courses of school of science are not evaluated. The essentialness of perceiving and enhancing mathematical insufficiencies has incited the progression of a couple of exercises by people from SCORE in addressing the concern (Royal Society of Chemistry, 2009b-c).

The issue of mathematical critical thinking has been all around recorded inside science instruction research. This is especially the situation for material science and science schooling research; the writing in science training research reports mathematical capability as an issue however is restricted by examination. Analysts in the field of material science instruction have examined mathematical critical thinking for in any event thirty years (Hsu, Brewster, Foster and Harper, 2014). The focus is on the significance of issues in material science (Heller and Reif, 2014), the assessment of how understudies tackle issues (Larkin, McDermott, Simon and Simon, 2018), and the headway of ground-breaking instructional strategy to affect significant learning (Pawl, Barrantes, and Pritchard, 2019). It has been fought that the use of science in actual science is more complicated than

the utilization of chooses and includes that understudies are told in a number juggling class (Bing and Redish, 2019).

2.2.7 Peer Assessment and Student Achievement Levels

Mary et al. (2013) investigated the study hall peer impacts and understudy accomplishment and discovered that understudies with low introductory accomplishment levels seem to profit less, and may even experience negative impacts, from an expansion in the normal capacity of their friend bunch than do those with higher starting scores. High capacity understudies advantage more than others from increments in the portion of high-capacity peers. The investigation proposed that homeroom task arrangements including some level of following by capacity, for example, parting understudies into two tracks, ought to be liked to approaches in which all study halls contain an expansive blend of understudies. In the event that the objective is to raise accomplishment among the most minimal scorers, spotlight ought to be set on coordinating such understudies with others of unassumingly higher capacity instead of with the top understudies. A comparable examination which uphold this discoveries was finished by Victor et al. (2012) who did an investigation on capacity peer impacts in English auxiliary schools.

2.2.8 Application of Peer Assessment Practices

Peer appraisal to advance meta intellectual deduction: According to Topping (2019), peer evaluation has effects on the accompanying areas to be specific "cognizance and metacognition, influence, social and adaptable aptitudes". As showed up in the examination by Pantiwati and Husamah (2015) on school understudies undertaking Science courses, the usage of companion assessment had impacts on their meta psychological reasoning. Moreover, peer appraisal is a functioning learning model, which causes understudies to create community and intelligent abilities through the consequence of meta intellectual cycles (Husamah, 2015). Henceforth, peer evaluation urges understudies to be responsible of their learning (Langan and Wheeler, 2018) and prompts improvement of self guideline, self-guideline and reflection (Egodawatte, 2010). In addition, this might improve learning as it includes an undertaking expecting understudies to connect with and urging them to think about the nature of work for impromptu creation (Chukwuyenum and Adeleye, 2013).

Peer evaluation as a stage for their mentoring: appraisal may be viewed as a feature of companion coaching measure (Chan, 2013). The attribute of understudies connecting, supporting and gaining from one another during the companion evaluation mirrors those of a friend coaching action (Topping, 2019). The understudies may not be interfacing genuinely through verbal input yet evaluating their friends' jobs and providing analysis in the title are starting at now seen as partner participation. In the assessment, the understudies would expect the elements of both 'assessor' and 'assesse', which takes in the wake of comparing friend training (Chan, 2013). As shown by Medcalf (2012), supportive learning is described as an approach that enables the companions of learning or friend instructing. This in an indirect manner recommends peer assessment is a kind of accommodating acknowledging, which has tantamount part to peer instructing. While the analysis intends to assist companions with improving their inclination of works and survey their knowledge, the show of offering contribution to peers wires interest sentiment and moreover organized exertion as it incorporates association between at least two (Kollar and Fischer, 2012). As a result, it animates inspiration among bunch individuals for peer mentoring and peer appraisal, along these lines revision, which provide upgraded learning (Slavin, 2016).

Peer appraisal as observational learning: A typical element of friend evaluation is making judgment/assessment of others works. Not just this specific errand gives occasion to understudies to investigate others' work, understudies will screen their present learning execution. This empowers understudies to assess and make judgment by intuition basically and be intelligent on the work, which transforms into a learning open entryway for the understudies. An examination by Logan (2019) on completing self and partner evaluation on 11 progressed instruction understudies revealed that a lot of understudies found they had the alternative to acquire from observing a combination of companion's works. An examination by Wood and Kurzel (2018) itemized that understudy comprehended the advantage of carrying out an assessment. This offers events to understudies to pick up from made mistakes and the principles that create a model work by presentation of varied companions' works. By introducing understudies to others works and preparing them to decide, it offers an opportunity to widen their understanding and observe the varied procedures made by their companions (Logan, 2019). An assessment by Tsivitanidou et al. (2018) furthermore indicated equivalent results on the usage of reciprocal friend evaluation on Secondary school understudy Physics learning.

Input: In assessment of peers, analysis is the middle piece of the cycle inferred for associates (Topping, 2019). As shown by Gielen et al. (2011), the bidirectional thought of providing and getting input conceivably improves understudies' taking in as understudies could gain from various models and approaches simultaneously. A study hall frequently comprises of understudies originating from various scholarly capacity and maybe may have various recognitions towards peer appraisal due to related knowledge. Subsequently, the nature of companion criticism created from the assessor is probably going to be influenced by their space information (Patchan and Schunn, 2015; Van Zundert et al., 2012). This provides explanation about the exactness of info conveyed by peers nitty gritty in a couple of assessments (Alqassab et al., 2018). This is in light of the fact that contribution to be efficient on understudies' education lies on the ability of assessor's to essentially interface their prior data with work (Liu and Carless, 2016).

Usage of rubrics in learning: It is described as a structure to examine a learning activity, which may be grasped or altered by educator (Kulm, 2014). It has been used to review work for understudies' over any disciplinary subject, every now and again used to condemn nature of execution or if the principles are met. Rubrics are adapted to assists instructors with researching the data about understudies' knowledge from execution based task. They are ordered into varied sorts as demonstrated by its abilities, for instance, anaholistic rubric, measure rubric and indicative rubric (Kulm, 2014). At that point, in an assessment by Idris et al. (2017) on usage of rubric in presentation of history of Year 10 understudy, revealed that understudies were animated and anticipation of usage of rubric that assist in completion the endeavor by understanding educator's cravings. The unequivocality of learning and activity want rubrics set is a touch of elbowroom for understudies in observing evidently of the learning goals (Andrade and Ying, 2005). Idris and accomplices communicated that rubrics usage engaged educators do effective appraisal of their understudies' task and add to the understudies' learning cycle by beneficial information. Chong et al. (2017) used observational rubrics to screen understudies' progress of learning and measure understudies' solicitation capacity in the solicitation based learning of prohibitive probability.

2.3 Theoretical Perspective

In a broad survey of articles on peer evaluation, Thurlings et al asserts that five learning hypotheses could be recognized speaking to an ordered advancement of the hypothetical ideas of learning (Thurlings et al., 2013). Each learning hypothesis exhibits qualities of a successful peer appraisal.

2.3.1 Learning Theories

2.3.1.1 Social Constructivist Theory of Learning

This investigation is grounded on the social constructivist theory of learning. One of the norms of this speculation is that learning and progression is a social, synergistic activity. It underscores how suggestions and understandings grow out of social encounters. The primary bases of a social constructivist theory were set some place close to Vygotsky in his speculation of the Zone of Proximal Development (ZPD). The possibility of the Zone of Proximal Development is obviously the fundamental responsibility of Vygotsky's work, the likelihood that human improvement is a social cycle wherein understudies use more capable allies to push their very own academic new development. Vygotsky describes Zone of Proximal Development as "the detachment between the genuine headway level as directed via independent basic reasoning and the level of anticipated improvement as chosen through basic suspecting under adult bearing or in a joint exertion with more capable partners". For Vygotsky, progression and learning are not the same; they are dynamic cycles that achieve these openings of progress level that must be tended to through social investment and collaboration with more fit companions or adults. Understudies with different capacities and establishments should collaborate in tasks and discussions in order to appear at a shared appreciation of reality in a specific field (Duffy and Jonassen, 2012). Most social constructivist models also pressure the necessity for facilitated exertion among understudies, in direct irregularity to customary genuine techniques.

Social constructivists as Black and Wiliam, Hattie and Timperley and much more are based on how understudies gain from peer evaluation. Prior data is the early phase for learning. They stress the importance of partner assessment from peers, and of understudies looking for peer appraisal from numerous sources (P. Dark and Wiliam, 1998; P. J. Dark et al., 2003). Companion appraisal

can prompt a more profound comprehension of a subject by assessing crafted by others. By rehearsing peer evaluation, understudies can find different perspectives, assessments and points of view on a subject which can expand their comprehension.

2.3.1.2 Constructivism Theory

Bruner (1966) stated that the support of constructivism is that individuals create their own appreciation and the world data, by facing things and thinking about individual's experiences. At the point when understudies face a new thing, they oblige it with previous data and experiences. They may change what they recognize, or they may discard novel information as inappropriate. To be dynamic creators of their understanding in any case, they ought to have the choice to present requests, examine and study what they know. In the homeroom, the constructivist point of view on learning infers encouraging understudies to use dynamic techniques, for instance, peer examinations, experimentation and genuine basic reasoning using real data if possible, and to make data and contemplate their perception.

Constructivism alters the teacher's part with educator's goal that assists understudies to form information other than copy real factors movement. The instructor in constructivism provides mechanical assemblies, for example, normal solicitation and reasoning in line with education practices such as game plan e-learning with an aim that understudies can characterize and examine particular thoughts, provide conclusions and allowances, and transmit understanding in a learning atmosphere. The instructor should understand the past starts of under studies and direct the undertakings to in addressing data and a short time later create it. Teachers in Constructivism inspire understudies to study how the task is assisting them enhance their knowledge. By treating themselves and their procedures, understudies become ace understudies as they sort out some way to learn, by use of PCs on the web and furthermore disengaged. The understudies by then have the instruments critical to turn out to be profound established understudies.

2.3.1.3 Cognitivism

In cognitivism, the center is the understudies' data handling and instances of types are Kluger and DeNisi (1996) and Ferreira et al (2007). Peer evaluation gives data that incites the understudy's own personal information building.

Peer appraisal cultivates metacognition, which is an information or familiarity with one's own personal learning measures. By taking an interest in peer evaluation, understudies are in a superior situation to comprehend the reviewing standards. Accordingly, they would then be able to disguise this comprehension and apply it to their future work and to improve their own personal exhibition.

2.3.1.4 Meta-Cognitivism

Three articles depend on meta-cognitivism: Sadler (1989), Nicol and McFarlane-Dick (2006), and Timperley and Parr (2007) concur that the point of companion evaluation for the understudies is to become self-controlled students. Companion appraisal measure is cyclic, as the understudies on various phases of their advancement screen their learning and connect for peer evaluation. This conviction is upheld by an actually expanding specialists field (Boud, 2000; Boud and Falchikov, 2016; Boud and Molloy, 2013; Carless, Salter, Yang, and Lam, 2011; Hounsell, 2003). So as to get manageable, the friend evaluation must show the understudies self-judgment (D. Nicol, Thomson, and Breslin, 2014).

2.4 Conceptual Framework

The conceptual framework is guided by the social constructivist theory which advances that learning grow out of social encounters. The framework establishes the relationship between independent variables and dependant variables to produce the overall outcome.

Table 2.1: Conceptual Framework

Independent Variable	Intervening Variables	Dependant Variable	OVERALL OUTCOME
<ul style="list-style-type: none"> • The extent of using Peer Assessment as a classroom assessment tool. • Effectiveness of peer assessment approaches in teaching of mathematics. • The perceptions towards peer assessment. 	<ul style="list-style-type: none"> • Classification of school in terms of district, county or national school. • Students 'level of achievement in terms of (LA), (OA) or (HA) learners. 	<ul style="list-style-type: none"> • Peer assessment. • Improved performance in Mathematics. 	<ul style="list-style-type: none"> • Effective application of peer assessment approaches in enhancing performance in Mathematics.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Context of the Research

The section depicts the examination plan yet on the grounds that the strategies that were wont to test the populace and consequently the objective populace drawing out the example size. The section additionally looked at techniques for data assortment, research instruments, their legitimacy and unwavering quality and strategies for information examination.

3.2 Research Design

This research used a qualitative research design approach. Qualitative research design aims at obtaining and processing non numeric data from open-ended conversational encounters. These methods are designed to uncover behaviour and attitudes of the targeted population. It is likened to a rough sketch to be completed in the course of research. (Frankel & Devers, 2000). The examination utilized quantitative exploration plan as graphic investigation approach is embraced in light of the fact that it's suitable and aides in getting the data as is needed for by the examination. This exploration configuration is that the best on the grounds that the investigation tried to clarify the current circumstance of study halls regarding understudies' discernments about friend evaluation, their abilities and capabilities in appraisal likewise on the grounds that the practices utilized by instructors to pass judgment on understudies learning.

3.3 Sample of the Study

The sample is gotten from secondary school learners in Kenya aged between 12 to 20 years old who have been taught using teachers trained in learning and pedagogy using a standard KNEC syllabus.

3.3.1 Sample Size

According to the County Government of Kiambu website's Education and Literacy page, there are approximately 189 secondary schools in Thika sub-County. Out of those, two are National schools, 5 are additional district schools, 12 region schools, 152 are sub-area schools and 18 are tuition based schools. A total populace of 15,065 are structure fours (MOE measurements, 2019). Mbo-

kane (2009) characterizes a populace as a total or entirety of the apparent multitude of items, subjects or individuals that adjust to a gathering of particulars. From these, a sample of 9 schools was selected.

3.3.2 Sampling Procedure

Purposive sampling was employed to decide on groups of respondents from which a sample size was drawn. A random sample of fifty are chosen. The reasoning for picking this example size is to allow the specialist to draw a tiny low and sensible number of schools from each school category supported the time and financial constraints. The study adopted sampling technique because the technique was efficient and value effective and allowed application of statistical methods to the info, including identifying the degree of error. Yamane's formula 2001 was used to determine the sample size from the population of 15 065 students.

3.4 Data Collection Instruments

The data collection instrument was adapted from an already developed and used instrument from the research thesis of Elizabeth Oloo (2016). Of the four instrument used in her research, the 'Students Questionnaire was adopted for this project. It is designed to capture the primary data from students. A part of the 'Mathematics teachers questionnaire' was also adopted to collect views in the Teachers interview guide. The questionnaire has the following sections:

It is designed to capture the primary data. The questionnaire has the following sections :

- a) Demographic Information
- b) Extent of use of peer assessment as a classroom assessment tool in secondary schools
- c) Effectiveness of peer assessment in enhancing performance in mathematics
- d) Students and teachers' perceptions towards peer teaching methods.

Table 3.1: Summary of data collection instruments

Objective	Data Collecting Instrument	Approach
Determine the extent of use of peer assessment as a classroom assessment tool in secondary schools.	Student's questionnaire Teachers' Interview Guide	Qualitative
Determine the effectiveness of peer assessment in enhancing performance in Mathematics.	Student's questionnaire Teachers' Interview Guide	Qualitative
Determine the perceptions of students and teachers towards peer assessment.	Student's questionnaire Teachers' Interview Guide	Qualitative

3.4.1 Piloting

The instrument was piloted to determine its utility in a different context. The instrument was found suitable for use in this research due to the relatedness of the areas of research to the current research.

3.4.2 Validity of research instruments

To ensure measurement errors are kept to a minimum. It had been necessary to work out properties of the measure that offers certainty that the instrument is taking care of its responsibility appropriately. The essential property is legitimacy, which is whether an instrument estimates what it sets bowed measure. The second is dependability, which is whether an instrument can decipher reliably across various circumstances (Andy, 2013).

3.4.3 Reliability of the Research Instruments

Validity may be an important however not adequate state of a measure. A subsequent thought is dependability, which is that the capacity of a measure to give the indistinguishable outcomes under the indistinguishable conditions (Andy, 2013). The reliability of the questionnaire was pegged on the initial research findings where the reliability index was calculated to be 0.811, of which according to Orodho (2005), a correlation coefficient of over 0.75 is high enough to prove reliability.

3.5 Data Collection Procedure

Consent to hold out the investigation was needed introduction of study proposition to the bosses at the University of Nairobi. The goal of the investigation was disclosed to participants by the scientist. The applying structure was filled by the scientist for a chase grant and provided two duplicates of endorsed study proposition, a banks check of 1 thousand shillings, continue, two photograph travel papers and a copy of the National card to the Council for Science and Technology corresponding to the University moral contemplations. After fortnight the analyst got the grant to hold out the examination. Questionnaires were hand distributed to the respondents to be filled and picked on the identical day.

3.6 Data Analysis Procedure

Analysis of information began with cleaning information for accuracy and completeness. The information gathered was altered, coded and broke down utilizing both illustrative and inferential measurements. This included utilization of measurers of dispersions and introduction of information in APA tables. The information was organized, coded, and analyzed using Statistical Package for scientist (SPSS 23.) Quantitative data was analyzed using frequencies and percentages. Qualitative data was utilized in developing narratives so as to draw conclusions. The results were also represented in styles of tables

3.7 Ethical Considerations of the Study

The researcher obtained a research clearance and a written permission from University of Nairobi to conduct the research. one in all the foremost important principles in ethical research is respect for persons. To fits ethical standards, the researcher sought a document consent among the participants within the study without giving reasons for his or her decision to prevent participation. To maintain high standards of research ethics consideration, a high level of confidentiality was maintained. Personalized information like name, number within the questionnaire wasn't included. To be compliant with the government`s policy on research, a pursuit permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI) (Appendix V). This assured the respondents that the research was purely for tutorial purpose. The researcher

obtained consent from the organizations which the study was done out (Appendix III). The researcher maintained high ethical standards by ensuring that data employed in the study is solely obtained from the targeted respondents.

CHAPTER FOUR RESULTS AND FINDINGS

4.1 Introduction

Chapter four presents the respondents' profile and results based on descriptive and inferential statistical data. Descriptive analysis involved frequencies and graphs. The inferential analysis involved the regression of selected independent variables on the dependent variable to address objectives of the study.

4.2 Respondents Profile

Findings on the respondents' profile include the presentation of response rates and demographics. Out of the targeted 93 questionnaires, students from Thika Sub County, 76 participated in the research, representing as 81.72% response rate. Seventeen (17) questionnaire returned either had no response or had more than 70% incomplete responses.

Table 4.1: Demographic Information

	Frequency	Percent
Age		
12 – 15	15	19.74
16 – 20	58	76.32
>20	3	3.95
Total	76	100.00
Sex		
Male	34	44.74
Female	42	55.26
Total	76	100.00
Classification of school		
Sub county	35	46.05
County	23	30.26
Extra county	10	13.16

National	9	11.84
Total	76	100.00
Type of your school		
Public	68	89.47
Private	8	10.53
Total	76	100.00
Academic performance in terms of mean score		
Above average	15	19.74
Average	24	31.58
Below average	37	48.68
Total	76	100.00

Demographic information of the students was captured in the study. According to the findings, 76.32% of the students were aged 16 – 20 years, 19.74% were aged 12 – 15 years and 3.95% were aged above 20 years. The results indicated that 55.26% of the students were female and 44.74% were male. Concerning the classification of the schools, 46.05% came from sub county schools, 30.26% from county schools, 13.16% from extra county schools and 11.84% from national schools. Regarding the type of school, 89.47% were in public schools while 10.53% were in private schools. Finally academic performance in terms of mean score was sought. The results showed that 48.68% of the students' academic performance was below average, 31.58% of the students' academic performance was average and 19.74% of the students' academic performance was above average.

4.3 Research Results

4.3.1 Objective One: Extent of use of Peer Assessment as a Classroom Assessment Tool in Secondary Schools

Table 4.2: Whether Peer Teaching Used on Mathematics Concepts

	Frequency	Percent
Yes	67	88.16
No	9	11.84
Total	76	100.00

It was important to find out whether peer teaching was used on mathematics concepts. According to the findings, 88.16% of the students indicated that peer teaching was used on mathematics concepts while 11.84% indicated that peer teaching was not used on mathematics concepts. It was also noted that of the 88.18% that was using peer teaching, 72.46% came from extra-county and national schools. This shows that schools are progressively embracing peer assessment approaches to teaching and learning.

Table 4.3: Concepts better understood when students explain or demonstrate to one another

	Frequency	Percent
Yes	52	68.42
No	24	31.58
Total	76	100.00

The study sought to find out if there were concepts better understood when students explained or demonstrated to one another. From the findings, 68.14% indicated that there were concepts better understood when students explained or demonstrated to one another while 31.58% indicated that there were no concepts better understood when students explained or demonstrated to one another.

Table 4.4: Concepts Better Understood When Explained by Students

Concepts	(f) /76	(%)
Angles and plane figures	52	68.42
Geometry	60	78.95
Indices and logarithms	40	52.63
Matrices and transformation	45	59.21
Integers	32	42.11
Algebra	24	31.58
Sequence and series	38	50.00
Rotation	19	25.00
Similarity and enlargement	56	73.68

The study sought to find out the concepts better understood when explained by fellow students. The students indicated that Geometry, Similarity and enlargement and Angles and plane figures were the best understood as shown by a percentage of 78.95%, 73.68% and 68.42% respectively. Integers, Algebra and Rotation were not understood well as shown by a percentage of 42.11%, 31.58% and 25.00% respectively.

Table 4.5: Is peer teaching is of great value to the teaching of mathematics

	Frequency	Percent
Yes	40	52.63
No	36	47.37
Total	76	100.00

If peer teaching was of great value to the teaching of mathematics was sought. The findings illustrated in the table indicated that 52.63% of the students said that peer teaching was of great value to the teaching of mathematics while 47.37% said that peer teaching was not of great value to the teaching of mathematics.

Table 4.6: Summary of Extent of use of Peer Assessment

		YES		NO	
		(f)	(%)	(f)	(%)
Extent of use of Peer Assessment	If Peer Assessment is used on Maths concepts	67	88.16	9	11.84
	Concepts Better Understood [Yes/No] Which ones	52	68.42	24	31.58
	Peer Assessment is of great value[Yes/No]	40	52.63	36	47.37

Reasons why teachers do not involve students in peer assessment

It was noted that teachers were not keen at consistently implementing peer assessment approaches to teaching and learning despite the positive sentiments given by students indicating that they enjoy and benefit from these exercise as shown in the table below:

Table 4.7: Summary of Reasons why students prefer being taught by peers.

Reasons why you get to understand when taught by peers	(f)
Because some of my peers can explain for me concepts or the procedures of the working not understood from class.	12
Because it gives me a chance to get corrected where wrong where by understanding comes easier.	4
Peers are friendly and they use simple language that is friendly and are more enjoyable than the teacher.	17
I am more free with the peers than teachers to ask both formal and informal questions.	7
I get helped by the different opinions of the students.	4
Because I can relate their work with mine.	2
Because of the strong bondage compared to the teacher.	1
They are empathetic, they know what it feels not to understand a certain concept because they have been there themselves some time back.	5
Because it enables one to learn through team work.	8
Enhance students learning through knowledge diffusion and exchange of ideas because we are of the same age group.	1
You can have chances to ask more questions as possible without limited time.	6
Students are more available than teachers for consultation.	9

The instructors demonstrated that there was absence of mindfulness to the extent peer assessment application is stressed in schools. The large class sizes was likewise referred to commonly of the main constraints in use of these strategies. The huge number of students made the educators to not utilize a few strategies for assessment like paired assessment. Time was additionally referenced to as one more explanation that made the tutors to not involve understudies in the activity. The respondents demonstrated that they need such a great deal time that can't permit them to rehearse peer assessment.

The respondents additionally demonstrated that the methodology probably won't be pertinent to make one understudies since they're simply learning essential ideas. They anyway concurred that this strategy for assessment would be more significant and relevant at structure threes and fours where understudies are learning more mind boggling content. The respondents likewise demonstrated that the friend assessment isn't a requirement in the summative exams from Kenya National Examination Council. They contended that it totally was hard for them to utilize a way which wasn't suggested by the school policies. To have the strategy work, they recommended that the auxiliary schools expected to align their exam policies to incorporate the strategy. Foundation was additionally referenced in show of the main reasons why instructors don't appear to be enthusiastic about this strategy. Most educators need to follow convention that has consistently been the norm. They are doing not have any desire to grasp change. They likewise referenced that even understudies themselves are hesitant to totally acknowledge the methodology.

4.3.2 Objective Two: Effectiveness of Peer Assessment in Enhancing Performance in Mathematics

Table 4.8: If learning of mathematics done by being taught by their peers helped them to understand and learn better

	Frequency	Percent
Yes	40	52.63
No	36	47.37
Total	76	100.00

The study sought to find out whether learning of mathematics done by being taught by their peers helped them to understand and learn better. According to the findings, 52.63% of the students indicated that learning of mathematics done by being taught by their peers helped them to understand and learn better while 47.37% indicated that learning of mathematics done by being taught by their peers did not help them to understand and learn better. The results are in agreement with Volante (2015) who indicated that the employment of developmental evaluation strategies identified with enhancements in understudy learning and accomplishment. Numerous instructors noted

pressures in using specific developmental appraisal procedures like friend evaluation and self-evaluation.

Table 4.9: Whether students’ grades had improved the previous term as a result of being taught by their peers

	Frequency	Percent
Yes	48	63.16
No	28	36.84
Total	76	100.00

It was important to find out if the students’ grades had improved the previous term as a result of being taught by their peers. From the findings, 63.16% of the students indicated that their grades improved the previous term as a result of being taught by their peers and 36.84% indicated that their grades had not improved the previous term as a result of being taught by their peers. The results differed with those of Black and Wiliam (2018), who showed that when educators adequately use developmental appraisal systems, understudy learning increments essentially was directed. Yet, the specialists additionally found a "neediness of training" among educators, in this couple of completely comprehended an approach to actualize homeroom peer evaluation.

Table 4.10: Complex mathematics questions become clearer after being taught by peers in small group discussions

	Frequency	Percent
Yes	50	65.79
No	26	34.21
Total	76	100.00

The study sought to find out if complex mathematics questions became clearer after being taught by peers in small group discussions. According to the findings, 65.79% indicated that complex mathematics questions became clearer after being taught by peers in small group discussions while 34.21% indicated that complex mathematics questions did not become clearer after being taught by peers in small group discussions.

Table 4.11: Do you understand when taught by your peers during mathematics lessons

	Frequency	Percent
Yes	52	68.42
No	24	31.58
Total	76	100.00

It was important to find out whether the students understood when taught by their peers during mathematics lessons. The findings indicated that 68.42% students understood when taught by their peers during mathematics lessons while 31.58% students did not understand when taught by their peers during mathematics lessons. Among the present-day methods for upgrading understudy learning, peer evaluation is maybe one of the most significant and successful. While peer evaluation thoughts and practices are appeared to claim a demonstrated record improving understudy learning, these practices are delayed to be completely coordinated into educators' everyday homeroom rehearses (Reed, 2014).

Table 4.12: Summary of Effectiveness of Peer Assessment in Enhancing Performance in Mathematics

Effectiveness of Peer Assessment in Enhancing Performance in Mathematics		YES		NO	
		(f)	(%)	(f)	(%)
	If Learning Mathematics happens through Peer process	40	52.63	36	47.37
	If grades improve as a result of Peer process	48	63.16	28	36.84
	If complex Mathematics become clearer through Peer process	50	65.79	26	34.21
	If understanding happens with Peer process	52	68.42	24	31.58

4.3.3 Objective Three: Perceptions towards Peer Assessment

Table 4.13: Students' Perceptions towards Peer Teaching Methods

	Strongly Agree		Agree		Not sure		Disagree		Strongly Disagree		Mean	Stdev
	F	%	F	%	F	%	F	%	F	%		
	Mathematics becomes easy when taught by my classmates	42	55	20	26	11	14	3	4	-		
Mathematics is theoretical and complex to be taught by my classmates	1	1	3	4	7	9	55	72	10	13	2.08	0.31
Small group discussion improves my understanding of mathematics	56	74	12	16	5	7	2	3	1	1	4.58	0.14

I seek assistance from my classmates when unable to solve a mathematics problem	58	76	13	17	4	5	1	1	-	-	4.68	0.47
My interest increases when a fellow student solves a mathematics problem on the board	42	55	23	30	7	9	3	4	1	1	4.34	0.28

The study sought to find out the students' agreement level with peer teaching methods. A five-likert scale was used where 1-1.49 represented strongly disagree; 1.5-2.49 represented disagree; 2.50-3.49 represented not sure; 3.5-4.49 represented agree and 4.5 -5.0 represented strongly agree. From the findings, the students agreed that mathematics becomes easy when taught by their classmates as indicated by a mean of 4.33 and standard deviation of 0.52. The students disagreed that mathematics is theoretical and complex to be taught by their classmates as indicated by a mean of 2.08 and standard deviation of 0.31. The students strongly agreed that small group discussion improves their understanding of mathematics as indicated by a mean of 4.58 and standard deviation of 0.14. The students strongly agreed that they sought assistance from their classmates when unable to solve a mathematics problem as indicated by a mean of 4.68 and standard deviation of 0.47. The students agreed that their interest increases when a fellow student solves a mathematics problem on the board as indicated by a mean of 4.34 and standard deviation of 0.28.

Problems encountered in peer assessment

The educators demonstrated that trouble from both the researchers and in this way the instructors was a major issue that they encountered during the friend appraisal work out. They contended that the measure of collaboration was needing and there was must improve the indistinguishable from empower the system work better. there's must have an arrangement between the researchers while in transit to lead peer assessment, the best approach to moderate biasness and in this way the measures to put in situ in order to broaden its straightforwardness and effectiveness. Another issue the respondents distinguished was absence of appropriate comprehension of the elements utilized

in peer assessment. The respondents demonstrated that they are doing not completely comprehend the elements and far must be done to sharpen them on how the methodology ought to be utilized. Absence of trust among the researchers themselves was additionally referenced joined of the issues that were experienced during the companion assessment work out. A few respondents neglected to completely believe that their kindred understudies may have the option to do a right and solid appraisal of their work.

Ways of improving peer assessment

The respondents demonstrated that there was need to direct instructional meetings for instructors to make them see how the strategy functions. This may effectively empower them to realize an approach to utilize this strategy in school. The necessity to modify lyceum test approaches was likewise referenced as a significant factor that must be thought of. The schools need to change their arrangements to consolidate peer appraisal in show of the suggested techniques for evaluation at optional school level. The respondents additionally proposed that there's must make gatherings where educators will have the option to consider on some of the assessment techniques before they're completely embraced into the lycee. The respondents proposed that there's need to give data materials like leaflets to the researchers with subtleties on how peer appraisal ought to be affected. This may empower them to higher see how the strategy functions. The respondents likewise recommended that there's need to lead some preparation on how the procedure functions.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The findings were summarised in this chapter. In addition, conclusions and the recommendations were presented.

5.2 Summary of the Findings

The study employed quantitative research design as descriptive study approach. The list of teacher selection was done through sampling method. Purposive sampling was employed to settle on groups of respondents from which a sample size was drawn. A random sample of fifty are going to be selected. Yamane's formula 2001 was accustomed determine the sample size from the population of 15 065 students. A sample of 93 students was sampled. Two teachers were sampled from each school. A questionnaire and a performance test was used because the data collection tools for this study. The study used primary data that was collected from the scholars. Questionnaires were hand distributed to the respondents to be filled and picked on the identical day. The info was organized, coded, and analyzed using Statistical Package for scientist (SPSS 23.) Quantitative data was analyzed using frequencies and percentages.

5.2.1 Extent of use of Peer Assessment as a Classroom Assessment Tool in Secondary Schools

This study revealed that 88.16% of the scholars indicated that peer teaching was used on mathematics concepts. This gives an indication that schools are gradually embracing Peer assessment as a classroom learning tool as opposed to earlier researches on classroom assessment practices done by Kemboi (2015) who asserted that the alternative classroom assessment practices (CAPS) like self assessment, peer assessment and use of portfolios were hardly used by Mathematics teachers. Also he revealed that mathematics teachers had little experience or no training on the employment of those forms of CAPS, teacher made tests are widely utilized in schools and in classroom. He further asserted that mathematics teachers seldom use the knowledge from CAPS to plan for future lessons.

Using Peer assessment as a learning tool helps students to criticise the standards of their work, helps them offer assistance to one another, recognize innate qualities and shortcomings, plan areas for revision activity, and build metacognitive and and proficient abilities. Additionally, 68.14% indicated that there have been concepts better understood when students explained or demonstrated to at least one another. Moreover, 52.63% of the scholars said that peer teaching was of great value to the teaching of mathematics. This proves that Peer assessment, as identified as one of the methods for delivering feedback efficiently and effectively to learners promotes authentic learning because it allows students to explore, reflect, construct concepts and meaningful relationships in contexts that involve globe situations.

5.2.2 Effectiveness of Peer Assessment in Enhancing Performance in Mathematics

The study revealed that 52.63% of the scholars indicated that learning of mathematics done by being taught by their peers helped them to grasp concepts and learn better hence acting as scaffolds in the process of construction of new knowledge. It enables them to develop life-long assessment skills, ability to form judgments, justify a degree of view and provides feedback to peers. Additionally, 63.16% of the scholars indicated that their grades improved the previous term as a results of being taught by their peers. Peer assessment empowers students to require responsibility for his or her own learning and enhance understanding of assessment criteria, academic standards of the course and alternative approaches to academic tasks. Moreover, 65.79% indicated that complex mathematics questions became clearer after being taught by peers in small group discussions. Finally, 68.42% students understood when taught by their peers during mathematics lessons. This is supported by the socio-constructivism theory that asserts that learning in a social context enhances understanding and gaining of knowledge. As learners evaluate and feedback one another, they get to learn the benchmarks of quality work.

5.2.3 Perceptions of Students and Teachers towards Peer Assessment

The study found that the scholars agreed that mathematics becomes easy when taught by their classmates while teachers felt that they represented a more reliable source of feedback. The scholars disagreed that mathematics is theoretical and complicated to be taught by their classmates while the teachers felt that some topics require more of teacher input than the learner input. Both

teachers and scholars strongly agreed that little discussion improves their understanding of mathematics. Mathematics instructors attempt to create a math-friendly environment to assist their students meet this challenge. The scholars strongly agreed that they sought assistance from their classmates when unable to unravel a mathematics problem. The scholars agreed that their interest increases when a fellow student solves a mathematics problem on the board. Problems with honesty and credibility are the foremost difficult in student assessment.

5.3 Discussion

Studies perceive investigation of expert devices of educators as a part of an instructor assessment, Wanzare (2002) and Tennessee State Board of Education (2006), among others, report that any educator assessment vigorously relies upon perception of instructors during guidelines. This is intelligent thinking about that perception of educators can just occur during educational plan execution which is center to training measure. Examination of expert apparatuses alone may not uncover viewpoints, for example, educator communication and compatibility with students separated from content authority and the capacity to open that substance to students.

The discoveries uncovered that understaffing, as revealed by educators during the meetings, was the principle reasons keeping the instructors from participating in peer appraisal. In light of understaffing, instructors had hefty outstanding burden which didn't permit them sufficient opportunity to take part in peer appraisal. Time factor is extremely pivotal in peer evaluation and that is the reason it might represent an issue to schools that are understaffed particularly if the exercises are not appropriately arranged or arranged by any means. In spite of the fact that reviews by Barber and Klein (1983) and Elliot and Chadley (1985) welcome the developmental part of companion appraisal, they caution that time utilization and potential clashes as unavoidable issues. To control the issue, Elliot (1979), McCormick (1989) and Nevo (1995) prompt that peer appraisal ought to be customized alongside different exercises, a training that was noted in schools where peer evaluation was drilled.

5.4 Conclusions

Peer assessment as practiced offers occasion to improve the learning experience and enhance academic performance. Mathematics revision strategies should be inclined to learner centred activities

which involve various peers supporting each other in and out of class, both online and offline by applying various peer assessment approaches to further their learning. The various approaches involved serves to improve the learners aptitude, retention abilities and metacognitive skills like organising their learning experiences, monitoring their learning progress, self examination and independence in learning.

Peer assessment as practiced promotes authentic learning since it allows the learner to explore, reflect on the learning, construct knowledge in real life contexts. Peer assessment practices throws learners in a learning pit where they need to collaborate with each other to provide solutions to the problems just like in real life scenarios. With correct guidance and consistence of use, learners show positive attitude towards peer assessment practices. Involving learners in giving corrective feedback is more significant than peer appraisal. Peer grading offers very minimal benefits in the learning and should be approached with caution coupled with thorough training on the assessment criteria when assessing low stakes AFL tests.

5.5 Recommendations

Based on the research findings, it is recommended that:

- a. Peer assessment practice be supported and promoted by all institutions of learning due to the positive effects the approaches bring to the classroom learning environment. Teachers should be encouraged to vary their teaching methods to involve learner centred activities like paired discussions, group discussions, peer tutoring, peer reviews and feedback to enrich the learning experience.
- b. On enhancing performance in academics, schools are urged to fully embrace and consistently use these AFL approaches to learning in order to realise improved academic results. Heads of institutions should spearhead adoption of these alternative approaches in their schools and allocate sufficient time and resources for practice of such approaches in Mathematics instruction.
- c. The ministry of education should create policies promoting application of peer assessment approaches in schools. It should create more awareness and understanding of peer assessment through in-service training of teachers and school Principals on the way to use peer assessment to maximise their learning experience.

- d. On capacity building, teacher training institutions and universities should review their instructional methods and embrace the utilization of peer assessment so as to supply well equipped teachers. Teacher trainees should be assessed on teacher expertise and knowledge on use of peer assessment. Teachers' professional Learning Communities should be started so as to address perception issues, coach and support teachers on effective use of peer assessment strategies in mathematics instruction.
- e. Further research could be carried out in other sub counties to find out whether the same results to this study will be obtained and even for other subjects so as to allow for generalization of results. Research is can also be carried out to establish the connection between peer assessment and academic performance in primary schools.

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APPENDICES

Appendix I: Permission to Borrow a Data Collection Instrument




Permission to borrow a data collection instrument.  

Inbox

 me 31 May  
to elizabetholoo ▾

Hi Madam,
My name is Asenath Ngonche. I am a student in the University of Nairobi. I am currently doing a research project on Peer Assessment. As i was doing research, I came across your work on 'Effect Of Peer Teaching Among Students On Their Performance In Mathematics' and i realised the relatedness to my area of research. Allow me to say that i was truly impressed with your research. My request is if you would allow me to borrow and adopt the questionnaire used therein for my current research.
Looking forward for your feedback. Thank you in advance.

Yours faithfully,
Asenath Ngonche
E58/78887/2015

 Elizabeth Oloo 31 May  
to me ▾

Thank you Asenath for appreciating my work
You can adopt some of the questions in the questionnaires
Looks you' ve also picked some literature and I hope you will do due reference to the same
Thanks for the courtesy all the same
Good luck in your studies
Regards
Elizabeth

Appendix II: Students' Questionnaire

Thank you for your interest in participating in this survey. The purpose of this study is to collect data on the effects of peer assessment on students' academic performance. This Questionnaire is a part of Masters degree project at the University of Nairobi, and is completely for academic purposes. Your answers will be treated with confidentiality. Please indicate the correct option as honestly and as accurately as possible by putting a tick (√) on one of the options. For the questions that require your opinion, please complete the blank space.

Section A: Demographic Information

Age	12 – 15	16 – 20	>20		
Sex	M	F			
Classification of school	Sub County	County	Extra county	National	Other
Type of your school	Public	Private	Other		
Academic performance in terms of mean score	Above average	Average	Below average		

Section B: Extent of use of peer assessment as a classroom assessment tool in secondary schools

Is peer assessment used on mathematics concepts?

Yes ()

No ()

Are there concepts better understood when students explain or demonstrate to one another?

Yes ()

No ()

Which ones

.....
.....

Is peer teaching is of great value to the teaching of mathematics?

Yes ()

No ()

Section C: Effectiveness of peer assessment in enhancing performance in mathematics.

Does learning of mathematics by being taught by your peers help you to understand and learn better?

Yes ()

No ()

Have your grades improved from the previous term as a result of being taught by your peers?

Yes ()

No ()

Does complex mathematics questions become clearer after being taught by peers in small group discussions?

Yes ()

No ()

Do you understand when taught by your peers during mathematics lessons?

Yes ()

No ()

What are the reasons why you get to understand when taught by peers during mathematics lessons?

.....

.....

Section D: Perceptions of students towards peer assessment.

To what extent do you agree with the Students 'perceptions towards peer teaching methods

	Strongly Agree	Agree	Not sure	Disagree	Strongly Disagree
Mathematics becomes easy when taught by my classmates					
Mathematics is theoretical and complex to be taught by my classmates					
Small group discussion improves my understanding of mathematics					
I seek assistance from my classmates when unable to solve a mathematics problem					
My interest increases when a fellow student solves a mathematics problem on the board					

Appendix III: Teachers' Interview Guide

This survey is to be applied for a research study on teachers' use of peer assessment in the school. Hence, your opinions are highly valued not only for the study but for the institution as well. The results will be shared after the study. Thank you a lot for your cooperation.

PART A. Please complete the following items

1. Please indicate by ticking the following

Gender

- Male
- Female

2. Years of Experience

- 0 – 5
- 6 – 10
- 11 and above

3. Students per class

- Below 20
- 21 – 40
- 41- 60
- 60 and above

4. Hours taught per week

- 8 – 12
- 13 – 17
- 18 and above

Part B

5. Do you use peer assessment approaches to teaching mathematics concepts?

- Yes
- No

6. Peer assessment describes a range of activities in which students evaluate and provide feedback in the work of their peers: which of the following peer assessment approach do you use.

- Formative feedback
- Peer grading
- Peer assessment of group work participation
- Depends on the subject

7. Which topics do you mostly use peer teaching to teach?

.....
.....

Please circle one of the numbers that show your agreement or disagreement.

1= Strongly Disagree

2= Disagree


3 = Neutral


4 = Agree

5 = Strongly Agree

Items	1	2	3	4	5
8. Peer assessment is enhances participation in group work.					
9. I frequently use peer teaching as a class room assessment tool.					
10. Peer teaching helps improve mathematics performance.					
11. Peer assessment is effective in giving formative assessment feedback.					


Appendix IV: Licence from National Commission for Science, Technology & Innovation


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