PERCEPTIONS OF STAKEHOLDERS TOWARDS THE PRACTICES OF GEOGEBRA AT SECONDARY LEVEL MATHEMATICS

A

THESIS

BY

PRADIP ACHARYA

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LETTER OF CERTIFICATE

This is to certify that Mr. Pradip Acharya, a student of academic year 2076/077 with thesis number 1809, Exam Roll No. 7628201 and T.U. Registration No. 9-2-571-62-2015 has completed his thesis under supervision of Asst. Prof. Lok Nath Bhattrai, during the period prescribed by the rules and regulations of Tribhuvan University, Nepal. The thesis entitled "perceptions of stakeholders towards the practices of GeoGebra at secondary level mathematics" has been prepared based on the results of his investigation conducted during the period of December 2023 to June 2024 under the Department of Mathematics Education, University Campus, Tribhuvan University, Kirtipur, Kathmandu. I recommend and forward his thesis for the evaluation as the partial requirements to award the Degree of Master of Mathematics Education.

……

Mr. Abatar Subedi

(Head)

Date:-

LETTER OF APPROVAL

This thesis entitled “perceptions of stakeholders towards the practices of GeoGebra at secondary level mathematics” submitted by Mr. Pradip Acharya in partial fulfillment of the requirement for the Master's Degree in Mathematics Education has approved.

Viva-Voce Committee	**Signatures**
Asst. Prof. Abatar Subedi (Chairman)	...……..
Prof. Dr. Eka Ratna Acharya (External Supervisor)	...……..
Asst. Prof. Lok Nath Bhattrai (Supervisor)	...……..

Date:- 5th June 2024

RECOMMENDATION FOR ACCEPTANCE

This is to certify that Mr. Pradip Acharya has completed his M.Ed. thesis entitled "perceptions of stakeholders towards the practices of GeoGebra at secondary level mathematics" under my supervision during the period prescribed the rules and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. The study embodies the result of investigation conducting during the period of 2023-2024 under the Department of Mathematics Education, University Campus, Tribhuvan University, Kirtipur, Kathmandu. I recommend and forward his thesis to the Department of Mathematics Education for the final viva-voice.

……

Asst. Prof. Lok Nath Bhattrai

Supervisor

Date:-……..

DEDICATION

This thesis is dedicated to my respected father ***Mr. Bhumishwar Upadhyay*** *and*

my respected mother ***Mrs. Sumitra Acharya***

And all-family and friends whose support, love encouragement and sacrifices made me a person who I am now.

DECLARATION

I, Pradip Acharya, declare that the work presented in this thesis titled "Perceptions of Stakeholders towards the Practices of GeoGebra at Secondary Level Mathematics" is my own original work. I affirm that this thesis has not been submitted previously for any academic degree or qualification at any other institution. All sources of information have been acknowledged through appropriate citations, and any work conducted jointly with others has been explicitly indicated.

…….……

(Mr. Pradip Acharya)

Date:

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ABSTRACT

This thesis, entitled "Perceptions of Stakeholders towards the Practices of GeoGebra at Secondary Level Mathematics," explores the perceptions of students, teachers and administrators towards the use of GeoGebra software in class by mathematics teacher in Kathmandu, Nepal. This study aims to explore the perception of stakeholders about the use of GeoGebra at secondary level mathematics classes and to identify opportunity and challenges on the practices of GeoGebra in secondary level mathematics classes. A convergent parallel mixed-methods approach employed surveys and interviews, with 92 students, 3 mathematics teachers and 2 administrators to collect the data. In this study questionnaire used by survey for students and interview for teachers and school administrators. SPSS software used for quantitative data analysis through descriptive statistics and thematic analysis for qualitative data. Findings indicate GeoGebra significantly enhances student engagement and understanding through dynamic visualization and interactivity. GeoGebra improved conceptual grasp of geometry and algebra, promoting active learning and critical thinking. However, challenges such as the need for sufficient training, technological fluency and resource availability were needed. Administrators concerns about initial costs and ongoing support for effective integration. With sufficient training and resource allocation, GeoGebra can enhance secondary mathematics teaching, improving learning outcomes and student interest.

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Chapter I
Introduction

The introduction serves as the gateway to the study, providing an overview of the research topic, background of the study, statement of the problem, objectives of the study, research questions of the study and its significance.

Background of the Study

The rapid development of technology always adjust to improve quality of education. These demands necessitate educators to be innovative and creative in their approach to implementing learning. This includes developing a technology-based learning system that is centered on the needs of the students. However, the fact reveals that students' mathematics learning outcomes lack optimal, so that the development of technology can be utilized to enhance learning outcomes. In this case, a computer with various applications, web-based, or related software can be used (Tamam & Dasari, 2021).

Technology influences students' learning styles such that they prefer to see, to touch and experience the topics they encounter in school. Through modeling, simulation and visualization, technology makes it possible for teachers and students to communicate traditionally abstract concepts in conceptually rich and accessible ways. Technology also gives opportunities for students to construct knowledge and explore new approaches to problem-solving. Technological literacy is an essential skill that should be promoted in the mathematics classroom. Teachers need a deep understanding of the mathematical technologies at their disposal in order to fully exploit their possibilities to design tasks that fully engage students in learning (Abera and Awgichew, 2021).

Today young people are accustomed to pictorial culture through a wide access to social mediasuch as Facebook, twitter or YouTube. A diverse range of media

formats are employed, encompassing text, audio, graphics, animation, video and virtual reality. Additionally, Internet in combination with its increasing accessibility for the public has opened up a whole new digital world. This makes that in learning process students are increasingly inclined to accept the content given to them in this way. Especially in mathematics where a number of issues require a lot of imagination, students are discouraged to learn the subject when it is not provided in a modern and accessible way (Majerek, 2014).

GeoGebra aligns with the pedagogical shift towards inquiry-based and constructivist learning, promoting active engagement and conceptual understanding (Bozkurt & Dönmez, 2019). It empowers educators to create interactive lessons that cater to diverse learning styles, enhancing accessibility and inclusivity in the classroom. In the era of digitalization, GeoGebra equips students with digital literacy skills, essential for navigating modern information landscapes (Acarli & Ozel, 2020).

Ohenwarter et al. (2010) found that dynamic geometry software (DGS), such as GeoGebra, can have a positive impact on students' learning of mathematics. However, the authors also noted that the effectiveness of DGS can vary depending on a number of factors, such as the teacher's training, the students' prior knowledge and the availability of resources.

A case study by Osman (2006) found that the use of GeoGebra can help students to visualize mathematical concepts and develop problem-solving skills. However, the study also found that some students found it difficult to use the software and that teachers need to be trained in how to use it effectively.

Preiner (2008) reviewed recent research on the use of DGS in mathematics education and found that there is a growing body of evidence to support its

effectiveness. However, the author also noted that more research is needed to understand the factors that contribute to its effectiveness.

Statement of the Problem

Technology has transformed into an indispensable resource for education. The advancement of technology in the teaching and learning process has experienced exponential growth. There was a lot of Mathematics software have been developed to teaching and learning, including GeoGebra and Mathematica. GeoGebra software has been subjected to extensive research examining various facets of learning. GeoGebra has become a tool that can help teachers to design effective instructional lessons (Nazihatulhasanah and Nurbiha ,2014).

GeoGebra stands as crucial software in the contemporary era, revolutionizing mathematics education and learning experiences. Its significance lies in its ability to seamlessly integrate dynamic visualization and algebraic computations, enabling students to explore and comprehend complex mathematical concepts in an interactive manner (Cheng & Qian, 2019). As technology becomes increasingly integrated into education, Geogebra's versatility bridges the gap between theoretical abstractions and practical applications, preparing students for real-world problem-solving (Burt et al., 2019).

In present era the accessibility of resources-computers, awareness of stakeholders, pedagogical knowledge to integrate GeoGebra, student class ratio and technological fluency of users are some of the challenges to deliver effective GeoGebra integrated math education. Actually, getting the resources is not the end goal and a guarantee for securing the objectives of lessons. They are rather vehicles to the destination. It is reasonable to say that there is no technology satisfies all the needs of its users. It requires smart use of GeoGebra (Abera and Awgichew, 2019).

Nazihatulhasanah & Nurbiha (2014), found that GeoGebra software has a positive impact on students' achievement in the topic Statistics. The students also have positive perceptions on GeoGebra software in terms of enthusiasm, confidence and motivation. GeoGebra software should be integrated into the Mathematics curriculum to provide students with a broader exploration of the subject and foster critical and creative thinking skills.

Some research shows that it impacts positively in learning mathematics. This software is being popular in Nepal But there are not sufficient research on the perception of stakeholders towards the practice of GeoGebra at secondary level in the context of Nepal. As being, very useful software for teaching mathematical concept in secondary level this application is used by only some teachers in classroom. We are using GeoGebra against traditional teaching learning method which is totally focused on white board and marker. To find the benefits of GeoGebra I intends to study about the experience of the teachers, students and school administrations for betterment the achievement of mathematics at secondary level. In addition, to sustain GeoGebra as a useful and effective teaching and learning material in the present era, it's important to consider how students perceive the software, the challenges teachers face when using it and how administrators view its use in mathematics classes. Therefore, we need to identify the perceptions of students, teachers and administrators regarding the use of GeoGebra in math education.

Objective of the Study

The objective of the study were as follows:-

- To explore the perception of stakeholders towards the use of GeoGebra software at secondary level mathematics classes.

- To identify opportunity and challenges on the practices of GeoGebra in secondary level mathematics classes.

Research Question of the Study

The following research questions were constructed to complete objective in this study.

- What is the perception of stakeholders towards the use of GeoGebra software at secondary level mathematics classes?
- What are the opportunity and challenges to use of Geogebra in Mathematics classes of secondary level?

Rational of the Study

Mathematics education at the secondary level presents challenges in engaging students and fostering deep understanding. As an innovative technology, GeoGebra offers dynamic visualization tools to explore mathematical concepts, potentially addressing these challenges. GeoGebra's interactive capabilities empower educators and learners to visualize abstract concepts, thereby enhancing comprehension (Abera and Awgichew, 2019). The study aims to investigate how GeoGebra's incorporation can improve students' understanding of secondary level mathematical content. Engagement is pivotal for effective learning (Hohenwarter et al, 2010). GeoGebra's interactive nature holds the potential to captivate students, transforming mathematical learning from passive consumption to active exploration. This study seeks to explore the impact of GeoGebra on student engagement and its correlation with learning outcomes.

Integrating technology like GeoGebra necessitates innovative teaching approaches (Tamam & Dasari, 2021). This research endeavors to identify effective pedagogical strategies that optimize the software's potential in conveying complex mathematical ideas. While GeoGebra offers promising benefits, challenges such as

teacher proficiency, technological access and potential technical glitches must be addressed (Abera and Awgichew, 2019). This study was analyzed these challenges and propose strategies for their mitigation. Equipping educators with the skills to leverage GeoGebra effectively is essential. This research was delved into the methodologies and best practices for training teachers to adeptly incorporate GeoGebra in their curriculum. Empirical data on the effectiveness of GeoGebra in enhancing mathematical understanding is crucial. Through qualitative analysis, this study seeks to establish a robust foundation of evidence supporting the software's positive impact.

This study was provided the perception of stakeholders to the practice of GeoGebra at the secondary level. This information can be used to develop strategies to promote the effective use of GeoGebra in the classroom. The study was identified opportunities and challenges to the use of GeoGebra in mathematics at the secondary level. This information can be used to develop resources and support for teachers and students to help them overcome these challenges. The study was contributed to the existing body of knowledge on the use of GeoGebra in mathematics education. This knowledge can be used by researchers and policymakers to inform future research and policy development in this area. Beside these the major significance of this study would be as follows:-

- It would be helpful for Mathematics teachers to use the findings to understand the benefits and challenges of incorporating GeoGebra into their classroom practice.
- It would be helpful for curriculum designers to adjust the features of GeoGebra and possibilities of its use on the development of curriculum.

- Educational policymakers can consider the findings when making decisions about the integration of technology in secondary mathematics education.
- It would be beneficial to the other researchers in the field of mathematics education for further research on the use of technology in the classroom.
- It would be helpful for the organizations or individuals offering professional development training for mathematics teachers to lunch GeoGebra software for effective mathematics classes.

Delimitation of the Study

The delimitation of a study refers to the boundaries that the researcher sets in terms of what would and would not be included in the study. It is important to delimit a study in order to make it manageable and focused. It also refers to the process of defining the scope and boundaries of a research project. It involves specifying the parameters that guide the research, helping to focus the study on a particular area of interest while excluding irrelevant or extraneous factors. Delimitation is a critical aspect of research planning as it ensures that the study remains manageable, feasible and relevant to the research objectives. In this study due to time factor, infrastructure factor, human resource and economical factor the delamination of the study are as the follows:

- This study was held in Kathmandu district of Nepal only.
- This study only focused on grade X students of all three community schools of Kathmandu district.
- The study was delimited on 92 students, 3 Mathematics teachers and 2 administrator of sampled school.

Operational Definition of the Key Terms

GeoGebra. GeoGebra is a dynamic mathematics software application that integrates geometry, algebra, spreadsheets, graphing, statistics and calculus. It is designed to help students and educators explore and visualize mathematical concepts in an interactive and dynamic way. GeoGebra is particularly useful in mathematics education and is widely used in classrooms and for self-study.

Stakeholders: Stakeholders in this study are defined any individuals or groups that have an interest in or are affected by an organization. In this study stakeholders refers to the students of grade 10, secondary level mathematics teacher and school administrator of Nepal.

School Administrator. In this study school administrator refers to the head teacher and school management team.

Perception. In this study perception refers to the view of stakeholders towards the practice of GeoGebra in Mathematics classroom.

Teacher. A teacher is a person who imparts knowledge, skills and education to students. They facilitate learning by providing instruction, guidance and support, often within a formal educational setting such as school and university. In this study teacher refers to secondary level mathematics teacher.

Student. A person formally engaged in learning, especially one enrolled in a school or college. In this study student of grade X are taken as student.

Secondary level. Though present education system takes 9-12 as secondary level, for this study, only 9 and 10 classes are related.

Community School. Those school which established and manage by public, non-profitable, funded by government are community school.

Chapter II

Review of Related Literature

A literature review is a critical survey of existing scholarly literature on a particular topic. It provides an overview of current knowledge, allowing you to identify relevant theories, methods and gaps in the existing research. It can help to identify the gaps in knowledge in the related field. These gaps are where own research can make a significant contribution. The literature review can help to develop a theoretical framework for research. This framework will help to find make sense of the findings of research and to draw conclusion.

Empirical Review

I reviewed some thesis, journal, article and research paper related to this study which is described in the following paragraphs.

Asare and Atteh (2022) looked at the impact of using GeoGebra to enhance the teaching and learning of transformation in senior high schools in Ghana. The difference in performance of students when taught using the traditional method and when taught with the help of this innovation was the main objective of the study. The total of- 119 students were selected from high school of Ghana by simple random sampling. They concludes that GeoGebra is one sure tool which can aid the improvement of performance in problems involving transformation and for that matter geometry concepts as it enhances understanding which is key to good mathematics learning at secondary school level. The findings of this study demonstrates that technology has a favorable impact on students' learning expectations and outcomes. In this study they suggest that Mathematics teachers should adopt and employ technology applications in teaching different Mathematics concepts as it facilitates students’ achievement in mathematics. There should be regular in-service training for

mathematics instructors to be up to date with contemporary teaching techniques and keep pace with the changing times.

Likewise, Shrestha et al. (2021) conducted a research entitled “Mixed-Methods Research: A Discussion on its Types, Challenges and Criticisms”. The article advocates for mixed-method research (MMR) as a complementary research method that complements traditional quantitative and qualitative approaches. By examining MMR within the context of various research paradigms, the article presents it as a natural choice for addressing the increasingly complex needs of contemporary researchers. It proposes MMR as a flexible and adaptable conceptual framework for designing and conducting mixed methods research in a simplified manner. By explaining the fundamental principles and major theoretical tenets of a mixed-methods approach, which involves collecting both quantitative and qualitative data in response to research questions, the article highlights the benefits of adopting MMR, as it integrates post-positivism and interpretivism frameworks. While there is extensive literature on this research design intended to provide researchers with an understanding of the approach, there is limited literature that offers illustrative guidance to novice researchers in comprehending mixed methods, understanding the reasons for choosing it and selecting an appropriate mixed methods design. Drawing upon an analysis of notable works in the field, this article provides an overview of mixed methods designs, discusses the main types and explains potential challenges that may arise when using them, with the aim of assisting early career researchers, in particular and other researchers in general.

Also, In an article publish by Chalaune and Subedi,(2020) entitled "Effectiveness of GeoGebra in teaching school mathematics " which is publish on Contemporary Research: An Interdisciplinary Academic Journal. They explore that

the effectiveness of using Information and Communication Technology (ICT) in teaching and learning school mathematics. They conduct this experimental study at two secondary schools and its grade ten students were selected by using convenience sampling techniques where experimental and control group were chosen by tossing coin. In this study the use of GeoGebra in teaching school mathematics increases students' performance in comparison to only use of traditional method of teaching. Use of GeoGebra plays very vital role to make clear concept about 2D and 3D shapes and increase students' curiosity towards mathematics contents. They state that the proper use of ICT does not only increase the students' marks but also motivate them to their study in mathematics. GeoGebra software enhances the creativity and visualization of concept about different shapes. There is no doubt that using Geogebra software enhances clear information about mathematics topic; especially about mensuration and geometry as well as other related concepts. They also find that there are many challenges in using GeoGebra software at secondary level and to make clear concept about various shapes. If Curriculum Development Centre (CDC) included the course related to GeoGebra software at school level curriculum, it gives more knowledge and ideas about teaching mathematics. This study conclude that the use of ICT, particularly GeoGebra is an effective tool to increase achievement; to promote curiosity and creativity; to make clear sense of concepts; and to encourage overall learning of students in mathematics. Finally, their study suggests that school mathematics teachers need to use ICT for effective teaching and learning.

In the same context, Nazihatulhasanah and Nurbiha (2014), conducted a study "The effects of GeoGebra on students achievement" published on Procedia - Social and Behavioral Sciences, they investigates the effectiveness of using GeoGebra software on Mathematics learning among 62 students in Malaysia. In This study

applied quasi-experimental research design involving 62 students. Students were divided into two groups of the experimental group and the control group. The challenge is more complex in teaching and learning of mathematics, where teachers have to balance the mental, stationery and digital tools for teaching and learning that involve abstract mathematical concepts that is difficult to be understood by students. In this study, GeoGebra is a computer program (software) for Mathematics, especially for learning geometry and algebra. They state that learning and teaching of Mathematics should not be focused on purely theoretical, but also a variety of learning approaches that involve the use of teaching aids proven to help stimulate students' interest in Mathematics. The Mathematics software available in the market or even online has facilitated the task of the teacher to impart knowledge beneficial to the students. However, it depends on the teacher to utilize existing materials without the need to allocate extra time to develop other teaching aids. This software should be introduced to Mathematics educators so that students can explore the world of Mathematics in a wider and make the students able to think critically and creatively.

In the same way, Mainali and B. Key (2013) conducted a study " A case study of impressions of mathematics teachers in Nepal" the purpose of the study is to alert mathematics teachers to the existence of open source software; then to train them to access and use a particular DGS package (GeoGebra). They studied on 15 participations and they started workshop. They find that the Information and Communication Technology (ICT) has a minimal to nonexistent role at secondary school level in Nepal. Lack of both resources and investment are among the reasons; however, a larger problem may be the low priority placed on building an education system which will enable Nepalese young people to function better in the modern world. And also the General agreement was reached by participants that the software

was very useful and helpful in providing conceptual knowledge for students because of the interactive capability of the GeoGebra platform. The data showed that all teachers were highly impressed by thesoftware and interested in using GeoGebra in their regular lessons. They indicated their belief that GeoGebra helps to provide conceptual as well as procedural knowledge. There was general consensus that GeoGebra is helpful for meaningful learning, gives actual mathematical concepts and enhances long term memory of the mathematical concepts.

Likewise, Doktoroglu (2013) investigated the effect of teaching Linear equation with Dynamic mathematic software. The purpose of the study was to investigate the effects of teaching linear equations with Dynamic Mathematics Software (GeoGebra) on seventh grade students' achievement compared to the regular instruction. The study utilized a randomized posttest-only control group design, involving 60 seventh-grade students (32 girls and 28 boys) from a public school in the Yenimahalle district of Ankara. Conducted over the 2011-2012 fall semester, the study lasted for 9 class hours spread across three weeks. Data was collected using three Mathematics Achievement Tests: the Cartesian Coordinate System Achievement Test (MAT1), the Linear Relation Achievement Test (MAT2), and the Graph of Linear Equation Achievement Test (MAT3). Quantitative analysis was performed using analysis of covariance (ANCOVA). The results indicated that teaching the Cartesian coordinate system and linear relations using Dynamic Mathematics Software did not significantly affect seventh-grade students' achievement compared to regular instruction. On the other hand, the results also indicated that teaching graph of linear equations by using Dynamic Mathematics Software had a significant effect on seventh grade students' achievement positively. The foregoing background information constitute the theoretical rationale for testing the effectiveness of

GeoGebra and demonstration method on students' academic performance in mathematic in Secondary School in Akwa Ibom North West Senatorial District.

Moreover, Zakaria and Lee (2012), conducted a study "Teachers' Perceptions toward the use of GeoGebra in the Teaching and Learning of Mathematics" which is Published on Journal of Mathematics and Statistics. The purpose of this study was to examine teachers' perceptions toward the features and tools in GeoGebra. In this study a GeoGebra workshop was conducted involving 30 secondary school teachers explore. This study employed a quantitative survey method that uses a questionnaire to collect data. Descriptive statistics were used to measure teachers' perceptions toward the software during a GeoGebra workshop. In the study "Teachers' Perceptions toward the use of GeoGebra in the Teaching and Learning of Mathematics" state that approximately 20% of Malaysian students failed to achieve the minimum benchmarks in mathematics. Furthermore, students struggle with understanding mathematical concepts and lack essential problem-solving skills. This study aimed to investigate teachers' perceptions of the features and tools in GeoGebra. A workshop on GeoGebra was held, involving 30 secondary school teachers. A quantitative survey method using a questionnaire was employed to gather data for this study. Descriptive statistics were used to measure teachers' perceptions toward the software during a GeoGebra workshop. The study revealed that mathematics teachers in secondary schools have a positive attitude toward the use of GeoGebra.

Through this discussion, they conclude that mathematics is a subject that is abstract and that requires the collective imagination of students and teachers, particularly in the areas of geometry and transformations. The use of technology exposes students to learning without boundaries and also promotes student-centered learning, where the teacher acts as an enabler or facilitator. GeoGebra software is

expected to help mathematics teachers diversify their teaching methods to facilitate students' understanding of mathematics concepts through effective teaching and learning. In addition , they also explore it is expected that GeoGebra will be used as an alternative to encourage teachers to employ technology as a means of harnessing student potential in the teaching and learning of mathematics.

In the same manner, Hutkemri and Zakaria (2012) conducted a study on the effect of GeoGebra on student's conceptual and procedural knowledge of function. The study aimed to identify the conceptual and procedural knowledge on the topic of functions based on group type and gender. This research involved 284 students from two upper secondary schools in Rokan Hulu, Riau, Indonesia. Of these students, 138 were placed in the experimental group (using GeoGebra software), while the remaining 146 were in the control group. Data were collected using conceptual and procedural tests on the topic of functions. Statistical analyses, including t-tests, one-way ANOVA, and two-way ANOVA, were conducted using SPSS 19.0. The study's findings revealed significant differences in students' conceptual and procedural knowledge based on the type of group. However, there was no significant difference in this knowledge based on gender. The study's results suggest implications for using GeoGebra in mathematics learning. Many studies have examined the effectiveness of technological tools like GeoGebra, which facilitate the visualization of linear equations.

In conclusion, I can see the studies have shown that GeoGebra is a useful tool for teaching and learning mathematics. It can help students to visualize concepts, make connections between different ideas and develop their problem-solving skills and GeoGebra can be used to improve students' achievement in mathematics.

Students who use GeoGebra tend to score higher on tests and have a better understanding of the concepts being taught. These studies have found that GeoGebra is particularly effective for teaching geometry and transformation. These are two areas of mathematics that can be difficult to understand for many students. GeoGebra helps to make these concepts more concrete and easier to grasp. GeoGebra can be used to promote creativity and problem-solving skills. Students who use GeoGebra are more likely to be engaged in their learning and to come up with their own solutions to problems. GeoGebra is a valuable tool for teaching and learning mathematics. It can be used to improve students' achievement, promote creativity and develop problem-solving skills. In those research only limited on specific sector of mathematical content. Some study are conducted in developed country. In the present situation of Nepal we have to find the perception of stakeholders towards the practice of GeoGebra to develop the quality of education in Nepal. Due to this reason this study is focused on the perception of stakeholders towards use of GeoGebra in mathematics classes and to find the challenges and opportunity on the practice of GeoGebra in secondary level mathematics classes.

Review of Theoretical Literature

Constructivism. The first theory I reviewed in this research is constructivism. Constructivism is a theory of learning that emphasizes the importance of learners actively constructing their own knowledge. It is based on the idea that learners do not simply passively receive information, but rather they actively engage with their environment and construct their own understanding of the world through their experiences.

Vygotsky's theory, known as a socio historical approach to learning, has contributed much to the constructivist movement. His well-known contribution to

teaching and learning is his idea of the zone of proximal development (ZPD). This refers to the relationship between the pupils' developmental level and their instructional level, that is, the distance between their developmental level when working on their own and their potential development as determined by problem solving under the guidance of adults or peers who know more. (Gatt & Vella, 2003)

Vygotsky (1978) describes the ZPD as the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.

Assistance in the ZPD is called scaffolding. It characterizes the social interaction among students and teachers that precedes internalization of the knowledge skills. Scaffolding developed to help students internalize information occurs best in learning situations where the learners have opportunities to communicate their thoughts (Roihler & Cantlen, 1997). Scaffolding refers to the supportive situations which adults create to help children extend current skills and knowledge to a higher level of competence. As the child grows in competence, there is a gradual withdrawal of support for completing the task (Gaskins et al., 1997).

In this study, GeoGebra can be used to implement constructivist learning in mathematics education in a number of ways. Teachers can use GeoGebra to create interactive activities that allow students to explore mathematical concepts and relationships at their own pace. Students can use GeoGebra to construct their own mathematical models and to test their hypotheses. Students can also use GeoGebra to collaborate with each other on mathematical projects. Using GeoGebra to create interactive activities that allow students to explore geometric concepts in teaching learning activities. GeoGebra allow students to construct their own mathematical

models. GeoGebra allow students to collaborate with each other on mathematical projects. GeoGebra is a powerful tool that can be used to implement constructivist learning in mathematics education. By using GeoGebra to create interactive activities, allow students to construct their own mathematical models and collaborate with each other on mathematical projects, teachers can help students to actively construct their own mathematical knowledge. And these activities can be observe in the classroom.

Connectivism. The Second theory I reviewed in this research is connectivism. Connectivism is a learning theory that emphasizes the importance of making connections between different sources of information in a digital age. It is based on the principles that knowledge is distributed across a network of connections that learning is the process of making connections and that technology plays a central role in learning. Connectivism has a number of implications for teaching and learning, such as a focus on helping students to develop the skills they need to learn effectively in a networked world.

Siemens (2008) suggested that modern day learning occurs through network connections as individuals share their interests, knowledge, perspectives, expertise and opinions in online or virtual learning environments (Dunaway, 2011). Internet technologies, comprised of databases and search engines, are capable of housing thousands of blogs, news articles, book excerpts, journal articles, video clips and podcasts. According to Siemens (2008), connectivism is a learning theory comprised of different series of nodes to connect hundreds of networks to facilitate synchronous and asynchronous learning (Dunaway, 2011). These connections provide individuals with direct access to reliable information from millions of sources to duplicate, reproduce and share within their social networks and to delete, critique and discard inaccurate, irrelevant and unreliable information.

Network connections contain streams of information constantly flowing with substantiated data including empirical findings from peer-reviewed journals as well subjective information from personal websites or blogs (Siemens, 2008). One of the principles of connectivism is how higher order thinking skills are activated when individuals can distinguish which of the abundant and diverse information available online are reliable or sustainable (Siemens, 2008). This connectivism principle is aligned with Center for Advancement of Learning and Assessment (CALA)'s definition of higher order thinking skills as skills achieved by individuals who work in environments that facilitate "persistence, self-monitoring, open-minded and flexible attitudes" (King, Goodson & Rohani, 2009)

Modern society, with its rapid scientific and technological advances, has seen an exponential rise in accessible knowledge and continuously changing and emerging technologies. The emergence of the internet, particularly Web 2.0, has provided access to the views and opinions of a wide range of individuals opening up opportunities for new forms of communication and knowledge formation inside and outside of formal educational institutions. Previous ways of navigating and filtering available information are likely to prove ineffective in these new contexts. The ability to access relevant information and harness the resources offered by the views and opinions of others have become important skills particularly as the need for lifelong learning, both formal and informal is increasingly recognized by individuals, organizations and institutions (Goldie, 2016).

In this study, I intends investigate how students are using GeoGebra to connect with mathematical concepts in new and meaningful ways. . I used connectivism to explore how students are using GeoGebra to make connections between different mathematical concepts. Student and teachers are using tutorials of

GeoGebra in online platform and they use to share, suggest and connected by various online media. GeoGebra allows students to visualize and interact with mathematical concepts in a dynamic way. So examine how students are using GeoGebra to make connections between different mathematical concepts and to develop a deeper understanding of mathematical concepts. So this theoretical framework is useful for this study.

Conceptual Framework of the Study

A conceptual framework in research is a synthesized structure of interrelated concepts, variables and their assumed relationships designed to guide and illuminate the investigation of a specific problem or phenomenon. It serves as a roadmap, drawing upon existing knowledge and theories to provide a foundation and context for the research inquiry.

In this study the conceptual framework we start with perception of stakeholders towards the practice of GeoGebra. And these stakeholders are students, teachers and school administration. I was collected quantitative data from students and qualitative data from teacher and school administrators by interview. I was collected information about perception, technological knowledge, familiarity with software, interest and access etc. from student. Then the information about perception, pedagogical barriers, curriculum alignment and teacher training was collected from teacher. In the same way following information collected by school administration. Then the received information were mixed and view by constructivism and connectivism approach. Then I was explored the targeted objective and I found the conclusion of the study. The overall conceptual framework is explained in the following figure:-

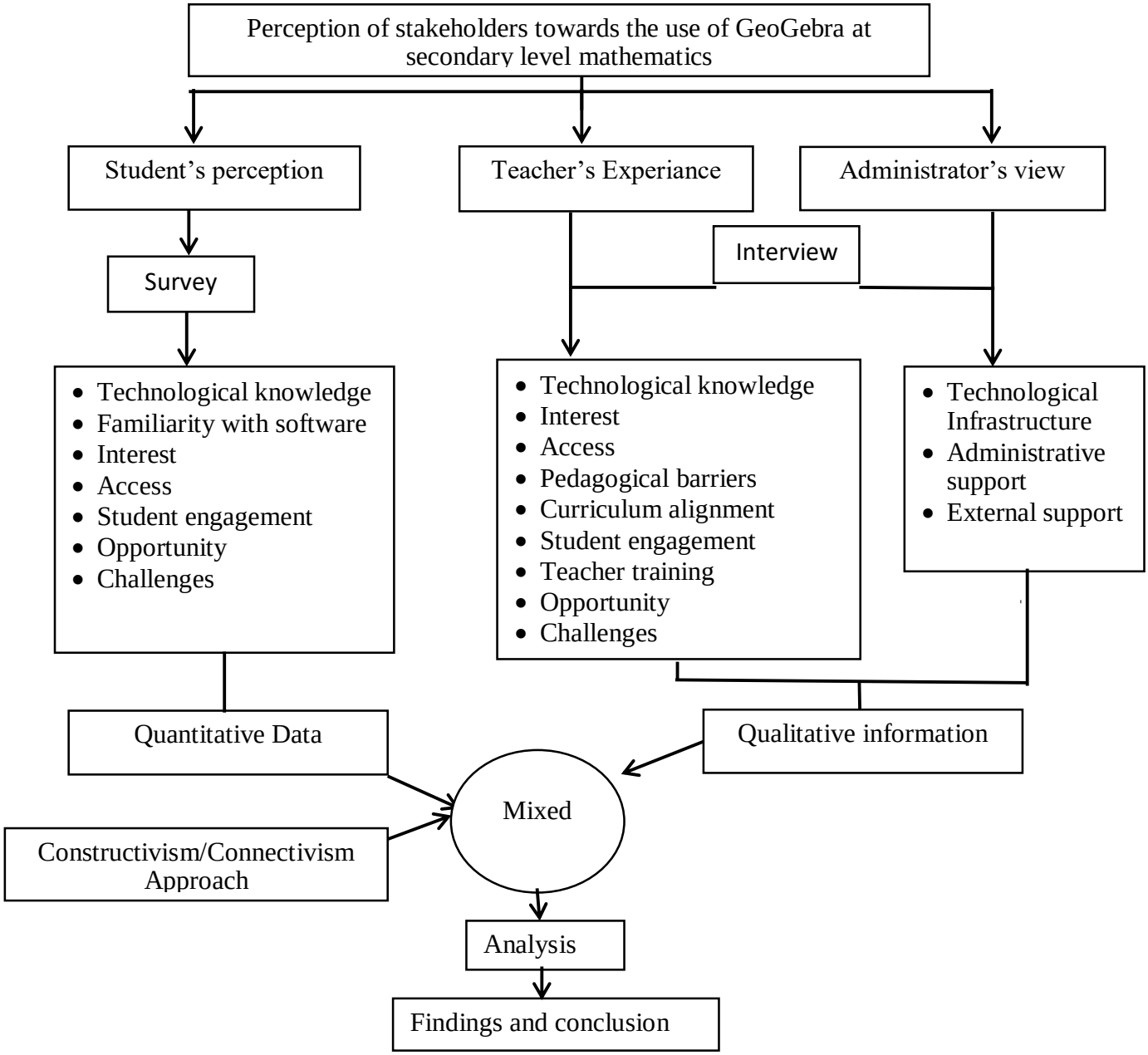


***Figure No.1*:** Conceptual framework of the study

Chapter III

Methods and Procedures

Research methodology provides a framework for the researcher to plan, conduct and analyze research in systematic and organized way. This helps to ensure that results of the research are accurate, reliable, they can be replicated and communicated to others. Research methodology provides a clear plan for the research; helps to define the research problem, develop the research questions and identify the appropriate methods for collecting and analyzing data also it helps to avoid bias.

Design of the Study

Research design refers to the overall plan, strategy, or structure devised to systematically investigate a research problem or question. It outlines the blueprint or framework that guides the collection, analysis and interpretation of data in a study. This design encompasses the methodological choices, procedures and techniques employed to address specific research objectives, including the selection of participants, data collection methods and the overall approach to analyzing and drawing conclusions from the gathered information. The research design acts as a roadmap, shaping the entire research process, ensuring that the study is conducted in a systematic and rigorous manner to achieve meaningful and reliable results.

Creswell and Plano Clark (2018) maintain that the convergent design, researchers combine the results of quantitative and qualitative data analysis to gain a more comprehensive understanding of a problem, validate findings from one set of data with the other, or assess whether participants' responses to quantitative predetermined scales align with their responses to open-ended qualitative questions. This approach essentially merges the two datasets.

This study was focused to find the perception of stakeholders towards the practices of GeoGebra in mathematics classes and explore the opportunity and challenges towards the practice of GeoGebra at secondary level. So this study based on the mixed method research design. The convergent parallel mixed method design was followed in this research. The detailed information were collected from the students, teachers and school administrators. To fulfill the objectives of the study the qualitative data were collected through interview with teachers, school administrations and quantitative data were collected using survey questions for students.

Population of the Study

All the students, Mathematics teachers and school administrations of secondary level of Kathmandu district in academic year 2080/81 who practice GeoGebra was be considered as the population of this study.

Sampling Techniques

Sampling techniques are essential for research, allowing researchers to draw meaningful inferences about a population by studying a representative subset. While most secondary schools in Nepal do not currently utilize GeoGebra, this study specifically focuses on those institutions that have already adopted it. Therefore, a purposive sampling technique was employed to select the sample in this study. Within these selected schools all students of grade X, all mathematics teachers and school administrators of the sample school was considered the target respondents for the study. This targeted approach ensures that the data collected reflects the experiences and perspectives of individuals directly involved with GeoGebra integration in their teaching mathematics.

Sample and Sample Size of the Study

A sample is a subset of a population that is selected for research purposes. The goal of sampling is to select a sample that is representative of the population as a whole, so that the findings of the study can be generalized to the population. In my research, I selected three schools of Nagarjun municipality of Kathmandu district. These schools are located in western region of the Kathmandu valley. Almost 50% students of these school are temporarily lives there and others are permanent citizens of this municipality. All students of these three schools was selected and the number of students limited to 92. From these school 3 Mathematics teachers were selected and only 2 Principal of these schools selected as sample of the study.

Data Collection Tools

Survey questionnaire. A survey method is a research field that utilizes structured questions and closed-ended formats to gather numerical data from a specific group of individuals. This method aims to quantify the participants' experiences, attitudes, or characteristics in a measurable way, allowing for statistical analysis and generalization of findings. In this study I used survey questionnaire for collecting data from student. I used questionnaire to collect quantitative data from student. The questionnaire includes technological knowledge, familiarity with software, interest, access, student engagement, opportunity and challenges. The details view of survey questionnaire is presented in Appendix:I.

Interview Guideline. An interview guideline is a document that outlines the topics and questions that will be covered in an interview. It is an essential tool for ensuring that the interview is focused and productive and that the interviewer collects all of the necessary data.

In this study I made interview guideline and I was collected the data/Information from the teachers and school administration. I took interview of 3 teachers and 2 school administrations. Also, I wrote some noticed key information while conducting interview. The interview guideline includes teachers' experience about technological knowledge, interest, access, pedagogical barriers, curriculum alignment, student engagement, teacher training, opportunity and challenges. Administrators view about technological infrastructure, administrative support and external support. The details view of interview guideline for teachers and school administrators is presented in Appendix: II and Appendix: III.

Validity and Reliability of the Tools

Validity indicates whether the tool is measuring the specific construct or concept it is intended to measure and Reliability refers to the consistency of a tool. Validity and reliability are important for all types of research. If the tool that is used to collect data is not valid or reliable, the results of the statistical analysis will be meaningless. In this study I insured the validity of interview guideline by using expert judgments method. I used Cronbach's alpha method for reliability of the tools. To insure the reliability of test I created a questionnaire using Google Forms and conducted a pilot survey with students from Halchowk Secondary school in Nagarjun municipality. From the data collected, I calculated a Cronbach's alpha value of 0.782. Cronbach's alpha is a number used to determine the reliability of a set of questions or items in a test. In simple terms, it tells us how consistently the test measures what it is supposed to measure. The value of Cronbach's alpha ranges from 0 to 1, with higher values indicating better reliability. The value of 0.782 is considered good, indicating that the test or survey is fairly dependable and provides consistent results.

Data Collection Procedures

This study employed a multifaceted approach to data collection, ensuring a comprehensive understanding of perceptions towards the practice of GeoGebra in secondary schools. Gaining access to selected schools and securing permission from the administration was the first step. Once approved, appropriate respondents were identified and selected, including secondary-level mathematics teachers and a representative sample of students from grade X. Data was gathered through various methods: questionnaires for students, interviews with teachers and administrators and detailed field notes capturing key observations, interactions and reflections. All collected data was securely stored and managed ethically, ensuring the integrity and confidentiality of the research process.

Data Analysis and Interpretation

Data analysis and interpretation in research is the process of making sense of the data collected through created tools. In this research, I collected the quantitative data using questionnaires from students. For analyzing the qualitative data in my study, I used SPSS software to perform weighted mean in 5 points likert scale. If there is mean value more than 3 then it will be positive perception and if weighted mean calculated less than 3 then it will be negative perception. Using SPSS made it easier to handle the calculations and ensure accurate results.

In my study, I employed a thematic analysis method to explore the data systematically. The process began with conducting interviews to gather in-depth information from participants. Following the interviews, I transcribed the audio recordings into written text to prepare the data for detailed examination. The next step involved coding the transcribed data, where I identified significant pieces of information and assigned theme codes. These codes were then organized into basic

themes that captured the core ideas present in the data. This structured approach allowed for a comprehensive analysis of the qualitative data, providing a clear understanding of the underlying themes. Those themes were compared and analyzed with reviewed literature and constructivism/connectivism approaches.

To make sure the research findings were accurate and reliable, I used a method called triangulation. This involved comparing both numerical (quantitative) and descriptive (qualitative) data, as well as getting perspectives from students, teachers and administrators. By looking at all these different sources, I could find where they agreed and where they didn't. This process made the research stronger and gave a complete understanding of how people feel about using GeoGebra in math classes. Using both types of data analysis and triangulation helped me draw solid and insightful conclusions about the benefits and challenges of using GeoGebra at secondary level.

Ethical Consideration

Ethical considerations in research are the moral and professional principles that guide responsible and ethical conduct. These considerations are crucial because they ensure that research is conducted responsibly and that the rights and well-being of participants are protected. While collecting data, I treated participants with dignity and respect. In this study, I ensured that participants were fully informed about the purpose of the study, the procedures involved and any potential risks and benefits before they agreed to participate. I protected the confidentiality of participants' data by using pseudonyms, removing identifying information and storing data securely. I was prepared to provide support to participants who experienced any harm as a result of their participation in the study.

Chapter IV

Analysis and Interpretation of Data

This chapter dives into the heart of the research by examining the data collected from students, teachers and stakeholders regarding their perceptions towards use of GeoGebra in secondary level mathematics classroom. The data analysis were presented using clear and concise methods, outlining the chosen statistical techniques and software employed. The data was gathered through two primary methods questionnaires administered to students and interview were conducted with teachers and stakeholders. Appropriate respondents were identified and selected, including secondary-level mathematics teachers and a representative sample of students from grade X. Data was gathered through various methods: questionnaires for students, interviews with teachers and administrators, classroom observations of grade X GeoGebra sessions and detailed field notes capturing key observations, interactions and reflections.

The data collected from student questionnaires was analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including frequencies and percentages, were employed to summarize student responses regarding their preferences, challenges and learning experiences with GeoGebra.

Perception of Stakeholders towards Practice of GeoGebra at Secondary Level Mathematics Classroom

To find the perception of student towards practice of GeoGebra I used five domain which are technological knowledge, familiarity with software, interest, access and student engagement in this domain there are four, four, ten, four and seven statement respectively. For the interview guideline there are seven domains which are

technological knowledge, interest, access, pedagogical barriers, curriculum alignment, student engagement and teacher training. To find the school administrators perception I used technological infrastructure, administrative support and external support. These domains are explained separately as follows:

Perceptions of Stakeholders about Technological Knowledge

In the search of understanding stakeholders' perceptions towards the integration of GeoGebra in secondary level mathematics classroom, a comprehensive analysis was undertaken. This involved the implementation of a mixed methodology surround both quantitative and qualitative research techniques. Specifically, students were surveyed using a five Likert scale questionnaire consisting of four statements aimed to measure their technological knowledge and utilization of GeoGebra. Additionally, interviews were conducted with mathematics teachers and the school administrator (principal) to gather insights into their perspectives and experiences regarding implementation of GeoGebra. The survey findings are exactly documented in Table-1, supplemented by the integrated viewpoints obtained from the interviews. This comprehensive serves to enrich the analysis of stakeholders' perceptions towards the practices of GeoGebra at the secondary level of mathematics classroom.

Table 1

Students' perceptions about the importance of technological knowledge

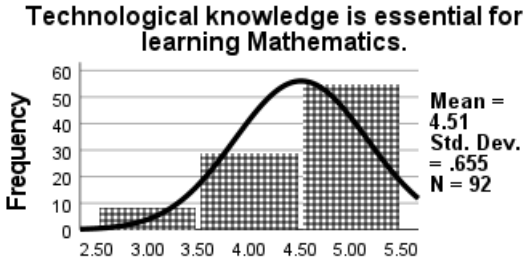
	Statement	SA	A	U	DA	SDA	Mean	Decision
1	Technological knowledge is essential for learning Mathematics.	55	29	8	0	0	4.5109	Positive
2	Search engines (Google search) are helpful to learn Mathematics.	52	23	15	2	0	4.3587	Positive
3	I create own Google account for better access of technology.	48	34	5	3	2	4.3370	Positive

4	I am familiar with mathematical software like Photomath, GeoGebra.	37	46	4	5	4.2500	Positive

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

Students' perception toward importance of technological get 4.36415 mean value which is positive. Which means Students think technological knowledge is very important. The separate interpretation of statements as follows:

Technological knowledge is essential for learning Mathematics. The data analysis indicates a strong consensus among surveyed secondary-level mathematics students on the importance of technological knowledge in learning mathematics. A significant majority, 55 students (59.78%), strongly agreed and an additional 29 students (31.52%) agreed with this statement, with no students expressing disagreement. The mean value of 4.5109 reflects the overall perception of technology as essential in their learning. This massive agreement highlights the necessity of integrating technological tools into mathematics teaching to enhance learning outcomes and student engagement.



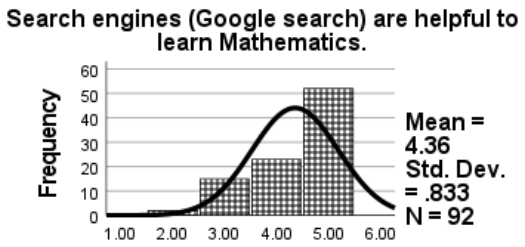
In the same context Teacher-A said that *"As a teacher, I think knowing about technology is really important for teaching and learning. It helps us to use different tools and resources to make lessons more interesting and easy to understand for students. With technology, students can work together and communicate better, which makes learning more fun. Also, being good with technology means we can keep up with new ways of teaching So, knowing about technology really helps us be better teachers and makes learning more exciting for students."* This view shows that

understanding technology is very important for effective teaching and learning. They say that technology allows teachers to use various tools and resources to make lessons more engaging and easier for students to understand. Technology also helps students collaborate and communicate better, making learning more enjoyable. Additionally, being skilled with technology enables teachers to stay updated with new teaching methods. Teachers think that knowing about technology helps teachers improve and makes learning more exciting for students.

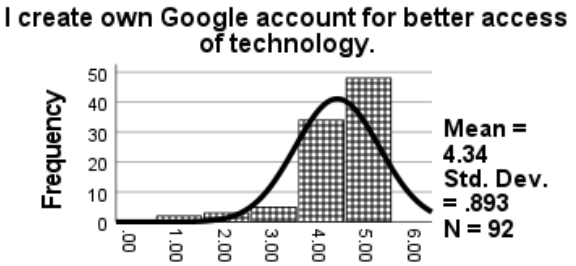
In the similar context, Principal-B told that *"Technology is very important in education today. As the principal, I believe students and teachers need to understand how to use it well. It's not just about gadgets like computers and smartphones; it's about improving learning, communication and problem-solving. We include technology in our lessons to prepare students for future careers, offering personalized learning and access to useful information. Ensuring students are comfortable with technology is a big focus for us."* School administrators talk about how important technology is in education today. They said that it's crucial for both students and teachers to know how to use technology, not just devices like computers and smartphones, but also software and online tools that can improve learning. The principal believes that technology helps students learn better, communicate more effectively and solve problems. They make sure to include technology in their lessons because it prepares students for the modern world and their future careers. This means that students learn valuable skills that they will need when they start working. By using technology, the school can also offer personalized learning experiences, which means teaching can be tailored to each student's needs and abilities. They believes technology gives students access to a lot of useful information that can help them learn more. They wants to ensure that all students are comfortable with using

technology because it is such a big part of everyday life and work now. Making sure students have these skills is a major focus for the school.

Search engines (Google search) are helpful to learn Mathematics. The data analysis reveals a widespread acknowledgment among secondary-level mathematics students of the utility of search engines, particularly Google, in supporting their learning. A substantial majority, 75 students (81.52%), either strongly agree or agree with this sentiment, with 52 students (56.52%) strongly agreeing and 23 students (25%) agreeing. However, 15 students (16.30%) are undecided, indicating some uncertainty and only 2 students (2.17%) disagree. The high mean value of 4.3587 reflects a general consensus on the beneficial role of search engines in mathematics learning. This shows that most of the secondary-level mathematics students find search engines, especially Google, very helpful for learning math.

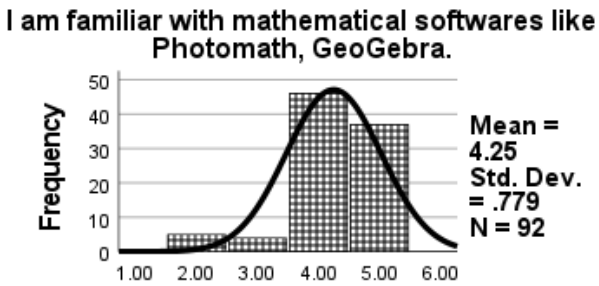


I create own Google account for better access of technology. The analysis reveals a notable trend among secondary-level mathematics students towards proactively creating their own Google accounts to enhance their access to technology. A significant majority, 82 students (89.13%), either strongly agree or agree with this initiative, with 48 students (52.17%) strongly agreeing and 34 students (36.96%) agreeing. In contrast, a smaller group of 5 students (5.43%) are uncertain, while 3 students (3.26%) disagree and 2 students (2.17%) strongly disagree. The high mean value of



4.3370 indicates a extensive acknowledgment of the benefits of owning Google accounts. The analysis shows that most secondary-level mathematics students create their own Google accounts to improve their access to technology, highlighting a broad recognition of its benefits.

I am familiar with mathematical software like Photomath, GeoGebra. The data highlights a strong consensus among secondary-level mathematics students regarding the value of technology in their education. 90.22% are familiar with mathematical software such as Photomath and GeoGebra. This data shows that most of the student are familiar with mathematical software like Photomath, GeoGeobra and others.



Technology is quickly changing how math is taught, with students recognizing its power to enhance their learning. Almost all students agree that understanding technology is key to learning math and teachers see it as a way to create more engaging and collaborative lessons. School leaders also stress that technology isn't just about gadgets but about improving learning, communication and problem-solving skills. Students are proactive, creating accounts and using search engines like Google to aid their studies, showing their readiness to use technology as a learning tool. This common agreement among students, teachers and leaders highlights technology's transformative potential in mathematics learning, preparing students for success in a tech-driven world.

Perceptions of Stakeholders about Familiarity with Software

When it comes to understanding how familiar people are with the software, there are differences among teachers, students and administrators. Some teachers are excited and use the software, but there are worries about fairness in access. Students also vary in how comfortable they are with GeoGebra tools. Administrators decide where to spend resources, which affects how much people know about the software. It's important to recognize these differences to make sure everyone has a fair chance to learn and use GeoGebra in secondary education.

Table 2

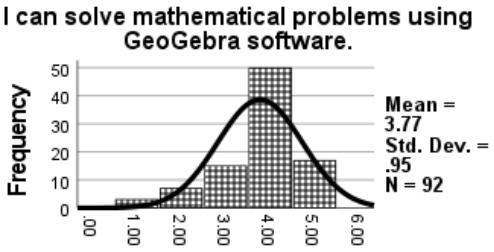
Students' perception about familiarity of software

	Statement	SA	A	U	DA	SDA	Mean	Decision
5	I can solve mathematical problems using GeoGebra software.	17	50	15	7	3	3.7717	Positive
6	I can use basic tools of GeoGebra.	11	28	23	19	11	3.0978	Positive
7	GeoGebra is useful for drawing geometric shapes.	25	37	22	4	4	3.8152	Positive
8	I believe GeoGebra can be used to explore mathematical relationships between shapes.	35	27	13	13	4	3.8261	Positive

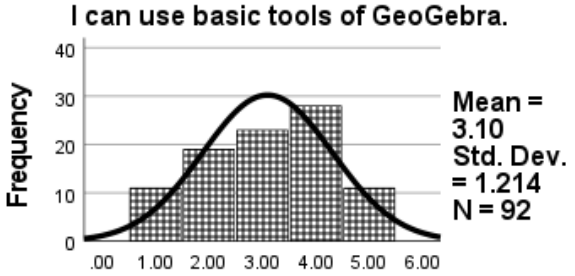
Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

From the table-2, students' perception of their familiarity with software received a mean score of 3.6277, which is positive score. This indicates that most students feel more comfortable and familiar with using software. Students generally have a good understanding and confidence in using software tools. The analysis of each statements is presented separately as below;

I can solve mathematical problems using GeoGebra software. The data indicates a range of proficiency levels among secondary-level mathematics students in using GeoGebra software for solving mathematical problems. While 72.83% of respondents (67 students) feel confident, with 54.35% agreeing and 18.48% strongly agreeing, a notable 27.17% (25 students) are either uncertain or disagree, including 16.30% undecided and 10.87% disagreeing. The mean value of 3.7717 reflects average confidence level in using GeoGebra. The data shows that most secondary-level math students feel confident using GeoGebra software to solve problems, though some are still uncertain or lack confidence. Overall, the average confidence level in using GeoGebra is average.



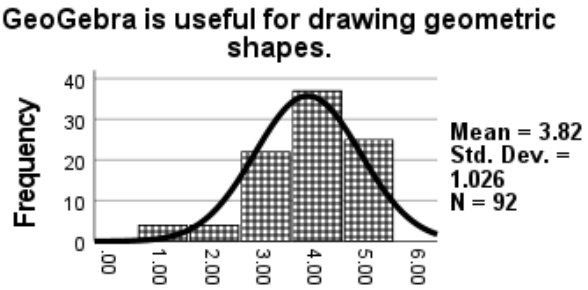
I can use basic tools of GeoGebra. The data reveals varied levels of comfort among secondary-level mathematics students in using basic GeoGebra tools. About 42.39% of students (39 students) agree or strongly agree with their ability to use these tools, with 30.43% agreeing and 11.96% strongly agreeing. Conversely, 45.65% (42 students) are either unsure or disagree, including 25% undecided and 20.65% disagreeing. The mean value of 3.0978 indicates average confidence in using GeoGebra. Data shows students demonstrate varying levels of comfort in using basic GeoGebra tools.



In the same way one of the teacher B said *"I decided to learn GeoGebra by myself after a short introduction. It's easy to use and I like how it works. I'm always*

finding new ways to use it in my lessons." This means many teachers learned GeoGebra on their own after a brief introduction because it is easy to use and effective. They continually find new ways to use it in their lessons, reflecting a broader trend among teachers who are integrating GeoGebra into their teaching methods. Teacher's positive experience with independent learning highlights the user-friendly nature of GeoGebra and its adaptability in lesson planning.

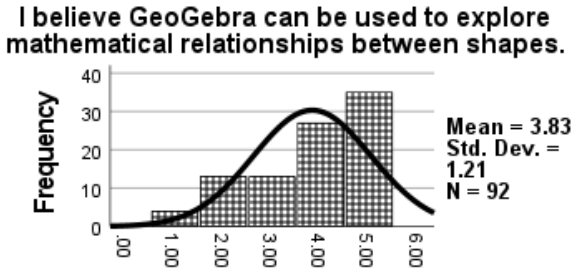
GeoGebra is useful for drawing geometric shapes. The data indicates that students have differing views on the usefulness of GeoGebra for drawing geometric shapes. A majority, approximately 67.39% (62 students), agree or strongly agree that GeoGebra is beneficial for this purpose, with 40.22% agreeing and 27.17% strongly agreeing. However, a significant portion, around 28.26% (26 students), feel uncertain or disagree, including 23.91% who are unsure and 4.35% who disagree. The average score of 3.8152 shows that people generally agree that GeoGebra is somewhat useful for drawing geometric shapes.



In the same context Teacher-C said that "*GeoGebra is a powerful tool for drawing geometric shapes. For example, you can easily construct triangles, circles and polygons and then explore their properties dynamically. It's especially helpful for demonstrating theorems and geometric transformations.*" This stamen shows that GeoGebra is a very effective tool for creating and working with geometric shapes. With GeoGebra, teachers can quickly draw shapes like triangles, circles and polygons. After drawing these shapes, teachers can interact with them to see how their

properties change, which helps in understanding their characteristics better. This is particularly useful for teaching and learning geometric concepts and theorems because student can see how shapes transform and behave in real-time, making the learning process more interactive and engaging.

I believe GeoGebra can be used to explore mathematical relationships between shapes. The data reveals that students have mixed opinions on GeoGebra's potential for exploring mathematical relationships between shapes. A majority, around 67.39% (62 students), agree or strongly agree with this capability, with 29.35% agreeing and 38.04% strongly agreeing. However, 32.61% (30 students) express uncertainty or disagreement, including 14.13% who are unsure and 18.48% who disagree. The mean value of 3.8261 indicates students believe that GeoGebra can be used to explore mathematical relationship between shapes.



In the same topic Teacher-A said that "*Beyond just drawing shapes, GeoGebra also offers tools for measuring angles, calculating areas and creating geometric proofs*." Which shows GeoGebra is not just a tool for drawing basic geometric shapes like circles and triangles. It also has advanced features that allow users to measure angles between lines, calculate the area of shapes and even create and verify geometric proofs. This means students and teachers can use GeoGebra for a deeper understanding of geometry by exploring and analyzing various properties and relationships within shapes, making it a comprehensive tool for learning and teaching mathematics. Findings of teachers view is similar to the Asare and Atteh (2022) that

states technology has a favorable impact on students' learning expectations and outcomes.

Interest of Stakeholders towards GeoGebra

Analyzing stakeholder interest in GeoGebra for teachers, students and administrators reveals varied perspectives with student survey data presented in table-3 and interview findings from mathematics teachers and the principal discussed below.

Table 3

Interest of students towards GeoGebra

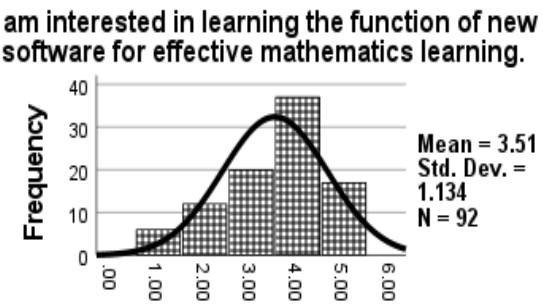
	Statement	SA	A	U	DA	SDA	Mean	Decision
9	I am interested in learning the function of new software for effective mathematics learning.	17	37	20	12	6	3.5109	Positive
10	I like to use internet to find the solution of mathematical problems.	9	19	23	28	13	2.8152	Negative
11	I enjoy learning from GeoGebra.	33	34	7	12	6	3.8261	Positive
12	Exploring how shapes relate to each other using GeoGebra seems like a more engaging way to learn math.	33	43	10	4	2	4.0978	Positive
13	GeoGebra is good to understand geometrical concept.	38	41	5	6	2	4.1630	Positive
14	GeoGebra turns math formulas into pictures, making it easier to understand.	36	32	13	8	3	3.9783	Positive
15	I believe that using GeoGebra could be a helpful addition to my current way of learning mathematics.	29	43	13	6	1	4.0109	Positive

16	GeoGebra is not useful for learning mathematics.	4	6	10	47	25	2.10	Negative
17	GeoGebra is time consuming software.	3	11	9	43	26	2.1522	Negative
18	I request teacher to use GeoGebra.	27	29	9	17	10	3.5000	Positive

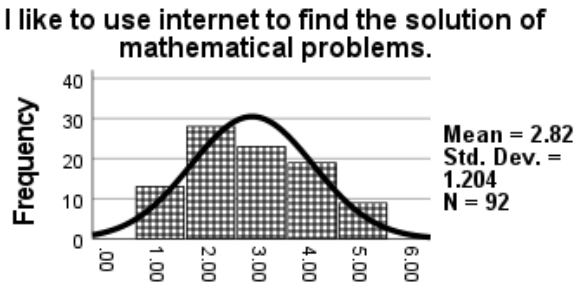
Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

From the table-3, Interest of students towards GeoGebra received a mean score of 3.59, which is higher than the average score. This score indicates that students generally have a positive interest in GeoGebra. The analysis of each statements is presented separately as below;

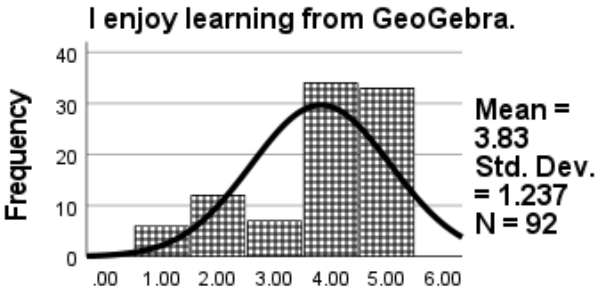
I am interested in learning the function of new software for effective mathematics learning. The data shows that students have varying levels of interest in learning the functionality of new software for effective mathematics learning. A majority, about 58.70% (54 students), agree or strongly agree with this interest, with 40.22% agreeing and 18.48% strongly agreeing. However, a significant portion, around 41.30% (38 students), express uncertainty or disagreement, including 21.74% who are unsure and 19.57% who disagree. The mean value of 3.5109 indicates that most students are very keen on exploring and understanding how new software can help them learn mathematics better. This means that they are excited about using technological tools to improve their math skills and find innovative ways to study the subject.



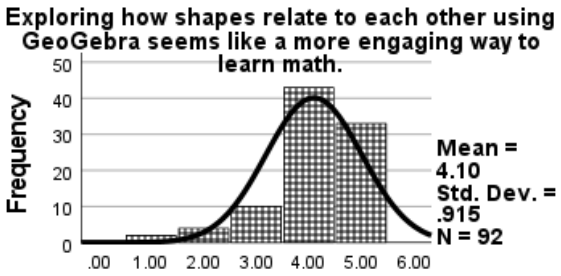
I like to use internet to find the solution of mathematical problems. The data indicates diverse opinions among students regarding the preference for using the internet to solve mathematical problems. About 45.65% (42 students) agree or strongly agree that they enjoy using the internet for this purpose, with 20.65% agreeing and 9.78% strongly agreeing. However, a larger portion, approximately 55.43% (51 students), express uncertainty or disagreement, including 30.43% who are unsure and 14.13% who disagree. The mean value of 2.8152 suggests that while some students find the internet helpful for solving math problems, overall, they are not particularly excited about it.



I enjoy learning from GeoGebra. The data reveals diverse sentiments among students regarding their enjoyment of learning from GeoGebra. A significant majority, approximately 72.83% (67 students), express agreement or strong agreement with this statement, indicating a positive perception of GeoGebra as a learning tool. Specifically, 36.96% (34 students) agree and 35.87% (33 students) strongly agree. Conversely, 27.17% (25 students) express uncertainty or disagreement, with 13.04% (12 students) feeling unsure and 14.13% (13 students) disagreeing. The average value of 3.8261 reflects a positive attitude towards GeoGebra among most students.

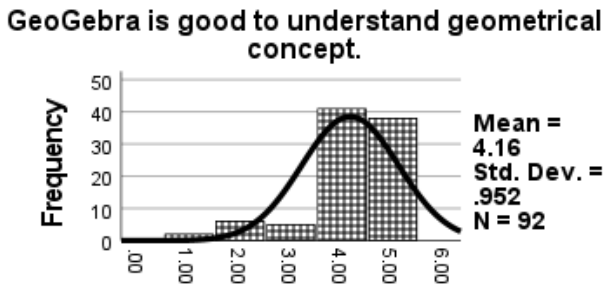


Exploring how shapes relate to each other using GeoGebra seems like a more engaging way to learn math. The data underscores a strong belief among students that using GeoGebra to explore relationships between shapes makes learning mathematics more engaging. A substantial majority, about 82.61% (76 students), agree or strongly agree with this sentiment, with 46.74% (43 students) agreeing and 35.87% (33 students) strongly agreeing. Conversely, a minority, approximately 17.39% (16 students), express uncertainty or disagreement, including 10.87% (10 students) who are unsure and 4.35% (4 students) who disagree. The high mean value of 4.0978 reflects a strong overall agreement on the engaging way to learn mathematics.



In the same context Teacher-A said *"I've been teaching math for many years, but I believe there's always something new to learn. Technology offers exciting possibilities for enhancing student understanding. I recently participated in a GeoGebra workshop and found it very informative. I'm eager to start using GeoGebra in my classroom to supplement traditional methods. I believe it can be a valuable tool for students to explore geometric relationships in a more interactive way."* From the teacher's experience, teachers believes that learning never stops and technology can make learning math more interesting. Teachers are excited to use GeoGebra in their classes alongside regular teaching methods. They think it will help students understand geometry better because they can interact with shapes and explore how they relate to each other.

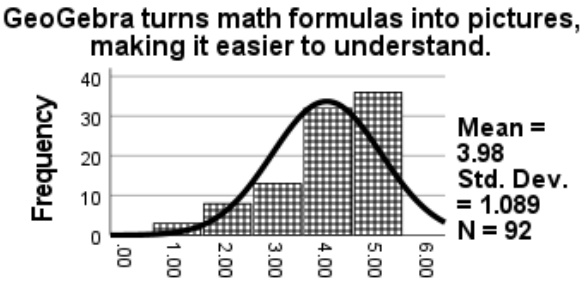
GeoGebra is good to understand geometrical concept. The data indicates a strong consensus among students on the effectiveness of GeoGebra in understanding geometrical concepts.



Approximately 85.87% (79 students) agree or strongly agree with this, with 44.57% strongly agreeing and 41.30% agreeing. Only 14.13% (13 students) express uncertainty or disagreement. The mean value of 4.1630 reflects students get better understanding geometrical concept by using GeoGebra.

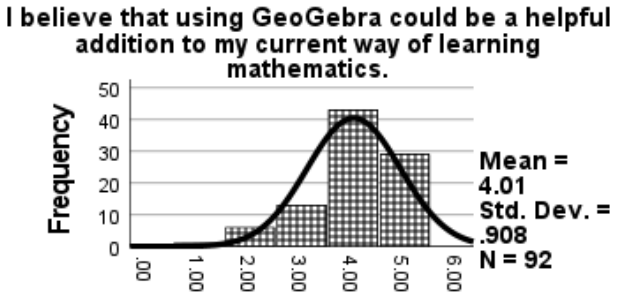
In the same topic Teacher-B said that "*GeoGebra's feature allows students to experiment with various geometric constructions and dynamically observe how changes affect different properties, promoting a more intuitive grasp of geometry.*" From this view I conclude students can see how making changes in figures affects things like the size, angles and relationships between different parts of the shapes. By doing this, students can understand geometry better because they can see how things change visually, making it easier for them to grasp the concepts.

GeoGebra turns math formulas into pictures, making it easier to understand. The data suggests a prevailing belief among students that GeoGebra effectively translates mathematical formulas into visual representations, aiding comprehension. Approximately 73.91% agree or strongly agree, while 26.09% express uncertainty or disagreement. Specifically, 34.78% agree and 39.13% strongly agree, while 14.13%

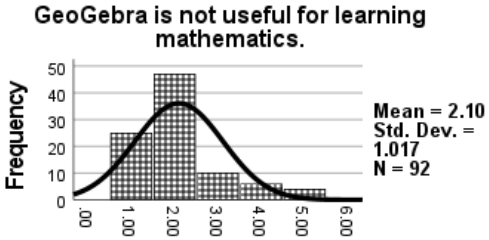


are unsure and 8.70% disagree. The mean value of 3.9783 reflects positive perception towards GeoGebra makes mathematics easier to understand.

I believe that using GeoGebra could be a helpful addition to my current way of learning mathematics. The data suggests that most students believe incorporating GeoGebra into their mathematics learning methods could be beneficial. Approximately 78.26% agree or strongly agree, with 46.74% strongly agreeing and 31.52% agreeing. Conversely, 21.74% express uncertainty or disagreement, including 14.13% unsure and 6.52% disagreeing. The mean value of 4.0109 indicates positive perception it means students believe that GeoGebra will be helpful for learning mathematics.

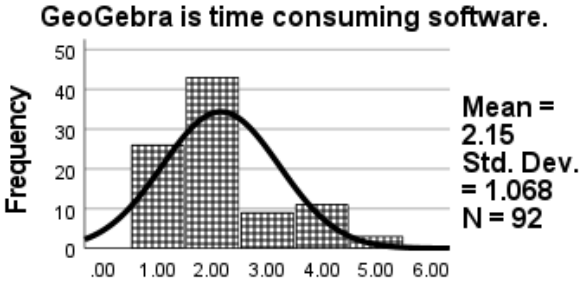


GeoGebra is not useful for learning mathematics. The data strongly suggests that the majority of students disagree with the statement that GeoGebra is not useful for learning mathematics. A substantial majority of students, comprising approximately 72 (78.26%), either disagree or strongly disagree with this statement. Specifically, 47 students (around 51.09%) disagree and 25 students (approximately 27.17%) strongly disagree, indicating that most students find GeoGebra to be useful for learning mathematics. On the other hand, a smaller portion, around 20 (21.74%) students, express uncertainty or agreement with the statement, with 10 students (10.87%) feeling undecided, 6 students (6.52%) agreeing, and 4 students (4.35%) strongly agreeing. The average



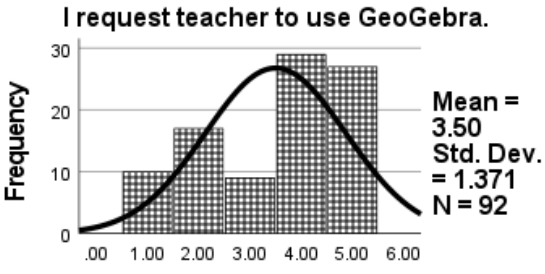
value of 2.10 reflects negative perception of students that means students think GeoGebra is useful for learning mathematics.

GeoGebra is time consuming software. The data indicates a diverse range of opinions among students regarding the perceived time consumption associated with GeoGebra. Approximately 75% express uncertainty or disagreement, suggesting they don't see GeoGebra as excessively time-consuming. Conversely, 25% agree, with 12% agreeing and 3% strongly agreeing. Conversely, 28% either feel unsure or disagree, with 10% uncertain and 47% disagreeing. The mean value of 2.1522 reflects most of the student think that GeoGebra is not time consuming software.



In the topic of time consumption of GeoGebra Teacher-B said "*GeoGebra might take more time as everyone learns how to use it, but once you're used to it, it can actually save time by making it easier to create and understand geometric shapes quickly*." This experience of teacher shows GeoGebra might take some time initially, it becomes a time-saver once everyone is familiar with it. The software makes it easier and faster to create and understand geometric shapes. So, despite the initial investment in learning how to use GeoGebra, it ultimately helps streamline the process of teaching and learning geometry, making it more efficient in the long run.

I request teacher to use GeoGebra. The data shows a mixed sentiment among students regarding their willingness to request GeoGebra's use in the classroom. Around 60.87%



agree or strongly agree, indicating a willingness to advocate for its integration. Conversely, 39.13% express uncertainty or disagreement. Specifically, 31.52% agree and 29.35% strongly agree. Conversely, 39.13% feel unsure or disagree, with 9.78% uncertain and 29.35% disagreeing. The mean value of 3.5000 suggests most of the students likes to use GeoGebra so they use to request teacher to use GeoGebra in teaching learning.

In the same topic Teacher-C said "*many students ask to use GeoGebra because they find it helpful for understanding geometry better."* GeoGebra has features that make learning geometry easier and more interesting. This interactive experience helps students grasp difficult concepts better than just reading about them or looking at static pictures. So, GeoGebra makes learning more effective and engaging, students often request to use it. Mainali and B. Key (2013) state that all teachers were highly impressed by the software and interested in using GeoGebra in their regular lessons. They indicated their belief that GeoGebra helps to provide conceptual as well as procedural knowledge.

Perception of Stakeholders towards Analysis of Access

Analyzing access to GeoGebra reveals disparities among stakeholders. Teachers, students and administrators may face different challenges in accessing the software and its resources. While some teachers may have easy access and actively incorporate GeoGebra into their teaching, others may encounter barriers such as limited technology or training opportunities. Such data of student is in the table-4 and other information explained below.

Table 4

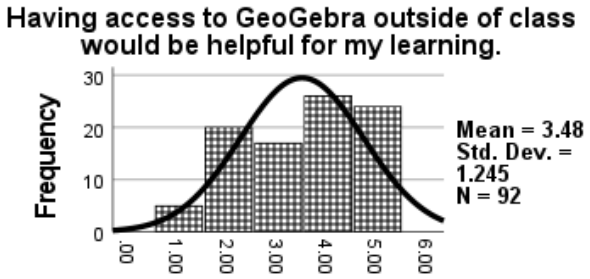
Students' perception towards access

	Statement	SA	A	U	DA	SDA	Mean	Decision
19	Having access to GeoGebra outside of class would be helpful for my learning.	24	26	17	20	5	3.4783	Positive
20	We have access to a computer with GeoGebra installed or can access it online.	7	10	17	40	18	2.4348	Negative
21	School must provide student computer lab with GeoGebra installed computer.	41	44	4	2	1	4.3261	Positive
22	It is helpful if we install Geogebra in our mobile phone.	25	39	17	5	6	3.7826	Positive

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

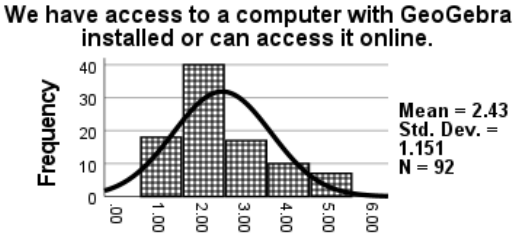
From the table-4, students' perception towards access received a mean score of 3.5**,** which is higher than the average score. This score indicates that students generally have a positive perception towards access of GeoGebra. The analysis of each statements is presented separately as below;

Having access to GeoGebra outside of class would be helpful for my learning. The data reveals a mixed sentiment among students regarding the perceived helpfulness of having access to GeoGebra outside of class for their learning. Approximately 54.35% express uncertainty or disagreement, indicating a lack of consensus on its benefits. Conversely, 45.65% agree, with 28.26% agreeing and 26.09% strongly agreeing. Conversely, 54.35% feel unsure or disagree, with 18.48% uncertain and 35.87% disagreeing. The mean value



of 3.4783 suggests that if student get access GeoGebra outside of class it will beneficial for them to learn mathematics.

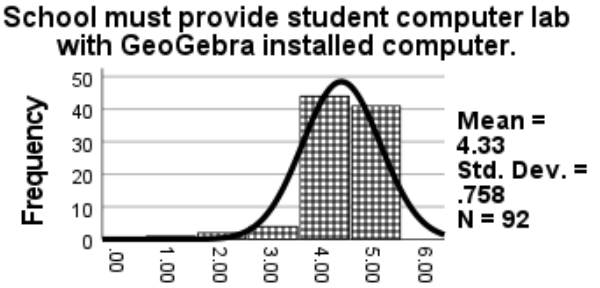
We have access to a computer with GeoGebra installed or can access it online.



The data suggests a varied perception among students regarding the accessibility of GeoGebra among their peers. Approximately 52.17% express uncertainty or disagreement, indicating a lack of consensus on its widespread availability. Conversely, 47.83% agree, with 10.87% agreeing and 7.61% strongly agreeing. Conversely, 52.17% feel unsure or disagree, with 18.48% uncertain and 33.70% disagreeing. The mean value of 2.4348 suggests that most of the students do not have computer with GeoGebra.

Principal-B said *"Our school got some grant to buy new computers, which is great news. Now, both teachers and students will have better access to technology in class, so we can use it more often."* This indicates that the access of computer is going to be better schools are getting grants from many social organization and also from local government. This makes access of GeoGebra better.

School must provide student computer lab with GeoGebra installed computer.



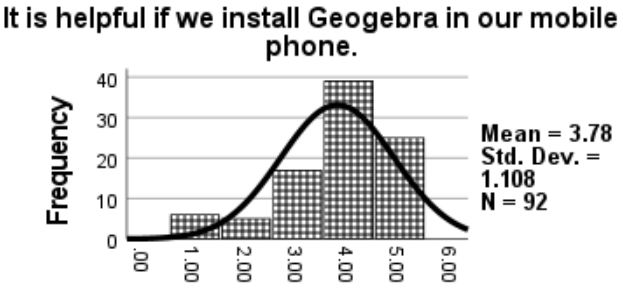
The data suggests a strong consensus among students regarding the necessity for schools to provide computer labs equipped with GeoGebra installed

computers. Approximately 92.39% agree or strongly agree, indicating widespread belief in integrating GeoGebra into school computer resources. Conversely, only 7.61% express uncertainty or disagreement. Specifically, 47.83% strongly agree and 44.57% agree. Conversely, 7.61% feel unsure or disagree, with 4.35% uncertain and 2.17% disagreeing. The mean value of 4.3261 indicates almost all student think that school should provide them a computer with GeoGebra for better learning of mathematical concept.

In the topic of access teacher-A said *"Unfortunately, our school has limited access to computers in the classroom. This can be a barrier to integrating technology like GeoGebra into our lessons more extensively."* It shows that school doesn't have enough computers available for students to use during class. Because of this, it's hard for them to use technology tools like GeoGebra as much as they would like in their lessons. This lack of computers makes it difficult to incorporate these helpful tools into teaching geometry.

Teacher-B said *"Many students come from homes with limited access to computers and internet. This creates an equity issue, as not everyone has the opportunity to practice with GeoGebra outside of school."* This experience indicates that some students don't have the same resources available to them as others. In this case, it's about access to computers and the internet. Because many students don't have these resources at home, they're unable to use GeoGebra, a tool that could help them practice and understand geometry better. This lack of access creates a gap or inequality among students. Some have the opportunity to use technology to enhance their learning, while others do not. This inequity can affect students' ability to succeed in their studies and can widen the gap between those who have access to resources and those who don't.

It is helpful if we install Geogebra in our mobile phone. The data suggests a mixed perception among students regarding the helpfulness of installing GeoGebra on their mobile phones. Approximately 69.57% agree or strongly agree, recognizing the potential benefits.



Conversely, 30.43% express uncertainty or disagreement. Specifically, 42.39% agree and 27.17% strongly agree. Conversely, 30.43% feel unsure or disagree, with 18.48% uncertain and 11.96% disagreeing. The mean value of 3.7826 suggests

Teachers have different opinions about using GeoGebra in community school, mostly because of technology and resources. Some worry about fairness because not all students have computers or internet at home. But others think having better technology in class, like new computers, could be really helpful. Also, GeoGebra can be used without internet, which is good for students who don't have it at home. These ideas show how important it is to think about different views and make sure everyone has what they need to use GeoGebra in secondary level.

Perception of stakeholders towards student engagement

Student engagement is essential for learning and student engagement should be center of the entire process. So while using GeoGebra we have to improve the appropriate engagement of student. So the perception of stakeholders on this topic most be evaluate. Student’s perception is in table-5 and others was in the bellow.

Table 5

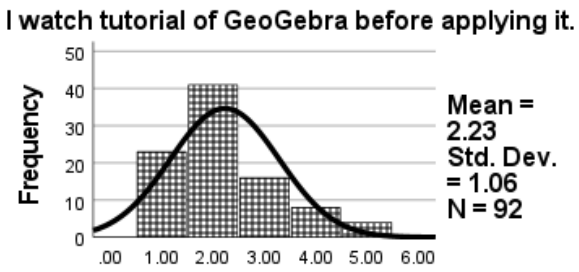
Students' perceptions about student engagement

S.N.	Statement	SA	A	U	DA	SDA	Mean	Decision
23	I watch tutorial of GeoGebra before applying it.	4	8	16	41	23	2.2283	Negative
24	Using GeoGebra, I feel more engaging than traditional methods of learning Mathematics (textbooks, lectures).	29	44	11	7	1	4.0109	Positive
25	Using GeoGebra helps me to visualize and understand math concepts better.	37	36	9	7	3	4.0543	Positive
26	GeoGebra allows me to explore math in a more interactive and hands-on way.	31	37	15	6	3	3.9457	Positive
27	I feel more confident in my ability to solve math problems after using GeoGebra.	26	47	8	8	3	3.9239	Positive
28	I don't like to use GeoGebra it is time wasting for me.	6	22	11	36	17	2.61	Negative
29	I would be more likely to practice math problems outside of class if I could use GeoGebra.	18	38	18	13	5	3.5543	Positive

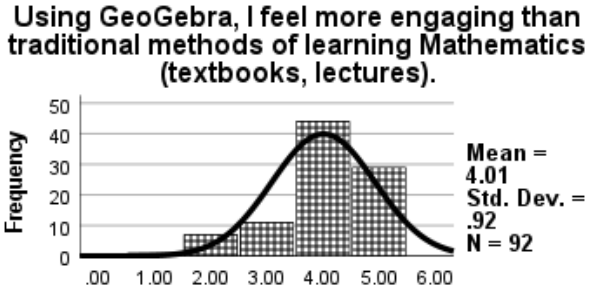
Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

Table-5 shows students' perception towards engagement in learning. It has a mean score of 3.48**,** which is higher than the average score. This score indicates that students generally have a positive perception towards engagement in learning through GeoGebra. The analysis of each statements is presented separately as below;

I watch tutorial of GeoGebra before applying it. The data suggests varied practices among students regarding the utilization of tutorials before using GeoGebra. Approximately 69.57% express uncertainty or disagreement, indicating a lack of consensus on the necessity of watching tutorials. Conversely, 30.43% agree or strongly agree. Specifically, 8.70% agree and 4.35% strongly agree. Conversely, 69.57% feel unsure or disagree, with 17.39% uncertain and 44.57% disagreeing. The weighted mean value of 2.2283 which is negative and shows that most of the students are not used to watch tutorial of GeoGebra. Most of them are totally depend on teachers.

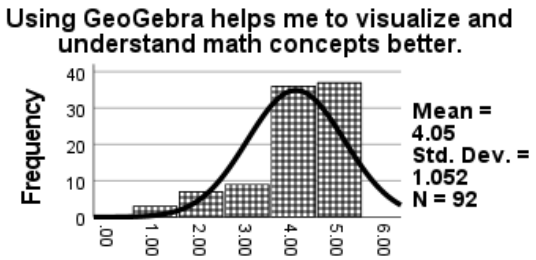


Using GeoGebra, I feel more engaging than traditional methods of learning Mathematics (textbooks, lectures). The data reveals a prevalent sentiment among students regarding the engagement experienced through the use of GeoGebra compared to traditional methods of learning mathematics. Approximately 79.35% agree or strongly agree, indicating a widespread perception that GeoGebra enhances engagement. Conversely, 20.65% express uncertainty or disagreement. Specifically, 47.83% strongly agree and 31.52% agree. Conversely, 20.65% feel unsure or disagree, with 11.96% uncertain and 7.61% disagreeing. The mean value of 4.0109 indicates that almost students feels teaching through GeoGebra is more engaging than traditional methods.



Also Teacher-B's perception is *"I've noticed that students become more curious and interested in experimenting with different shapes and functions within the GeoGebra environment. They seem excited to explore and try out new things."* This indicates that when students use GeoGebra, they become more curious and engaged. GeoGebra allows students to interact with mathematical concepts in a dynamic and visual way, which sparks their interest and encourages them to explore further. When students use GeoGebra, they're not just passively learning from a textbook or lecture. They are actively experimenting with shapes and functions, trying out different ideas and discovering how things work on their own.

Using GeoGebra helps me to visualize and understand math concepts better.

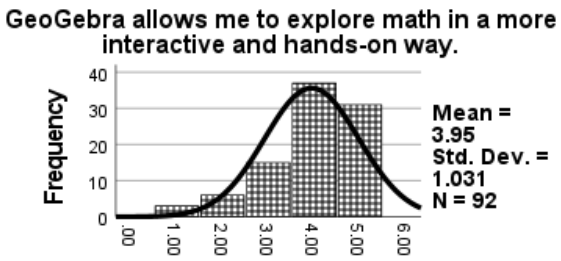


The data indicates a strong consensus among students regarding the effectiveness of GeoGebra in enhancing visualization and understanding of mathematical concepts. Approximately 79.35% agree or strongly agree, demonstrating widespread recognition of GeoGebra's efficacy in facilitating visual understanding. Conversely, 20.65% express uncertainty or disagreement. Specifically, 39.13% agree and 40.22% strongly agree. Conversely, 20.65% feel unsure or disagree, with 9.78% uncertain and 7.61% disagreeing. The mean value of 4.0543 suggests almost students can understand and visualize mathematical concept by using GeoGebra.

In the other hand on the topic of student engagement Teacher-C said *"Students seem genuinely excited and engaged when using GeoGebra. The visual representation of concepts makes learning more interactive and enjoyable."* This shows that when

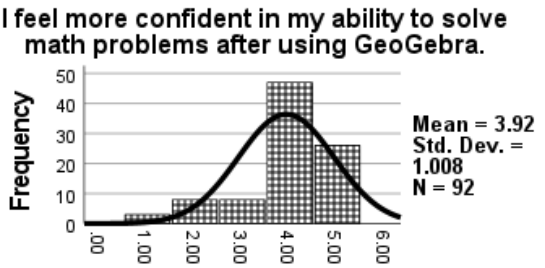
students use GeoGebra, they get really excited and interested. This is because GeoGebra shows concepts using pictures and diagrams, which makes learning feel like playing a game. So, instead of just reading or listening, students can see things visually, which makes learning more fun and easier to understand.

GeoGebra allows me to explore math in a more interactive and hands-on way.



The data indicates a prevalent belief among students regarding the interactive and hands-on nature of exploring mathematics through GeoGebra. Approximately 73.91% agree or strongly agree, showing widespread recognition of GeoGebra's capacity for interactive exploration. Conversely, 26.09% express uncertainty or disagreement. Specifically, 40.22% agree and 33.70% strongly agree. Conversely, 26.09% feel unsure or disagree, with 16.30% uncertain and 6.52% disagreeing. The mean value of 3.9457 shows that GeoGebra allows them to explore in a more interactive and hands-on way.

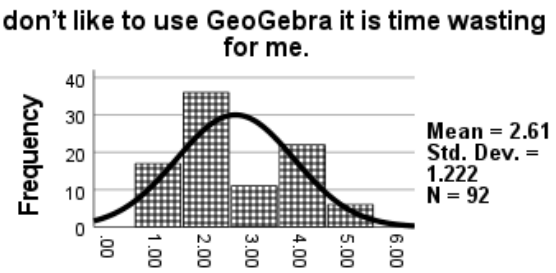
I feel more confident in my ability to solve math problems after using GeoGebra.



The data reveals a significant agreement among students regarding the confidence boost they experience in mathematical problem-solving after using GeoGebra. Approximately 79.35% agree or strongly agree, indicating widespread recognition of GeoGebra's

positive impact on confidence levels. Conversely, 20.65% express uncertainty or disagreement. Specifically, 51.09% strongly agree and 28.26% agree. Conversely, 20.65% feel unsure or disagree, with 8.70% uncertain and 8.70% disagreeing. The mean value of 3.9239 highlights that students feels more confident in ability to solving mathematical problem after using GeoGebra.

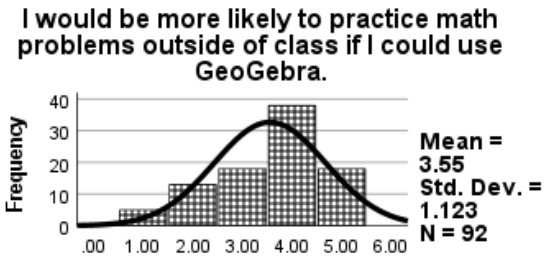
I don't like to use GeoGebra it is time wasting for me. The data from the statement "I don't like to use GeoGebra; it is time-wasting for me" reveals mixed perceptions among respondents. A notable portion, 17 respondents (18.5%), strongly disagreed with the statement, indicating they do not find GeoGebra time-wasting. However, the largest group, comprising 36 respondents (39.1%), disagreed, showing a considerable number of stakeholders also do not view GeoGebra as time-wasting. On the other hand, 11 respondents (12%) were undecided. Meanwhile, 22 respondents (23.9%) agreed that GeoGebra is time-wasting and a smaller group of 6 respondents (6.5%) strongly agreed. This distribution shows that while a significant portion of respondents do not consider GeoGebra to be a waste of time, a substantial minority still hold the opposite view, reflecting varied attitudes towards the use of GeoGebra in mathematics teaching.



In the other hand Teacher-A believe that not student feel comfortable to use technology and such software like GeoGebra and he said *"Some students might not feel okay with technology at first. Giving clear directions and chances to try it out can help them feel better."* This experience indicates some students might not feel very comfortable using technology or software like GeoGebra, especially at first. However,

they believe that if teachers give clear instructions and opportunities for students to practice using it, those students will start feeling more confident and comfortable with the technology.

I would be more likely to practice math problems outside of class if I could use GeoGebra. The data suggests a mixed sentiment among students regarding their inclination to practice math problems outside of class with GeoGebra's availability.



Approximately 60.87% express uncertainty or disagreement, while 39.13% agree. Specifically, 41.30% agree and 19.57% strongly agree that GeoGebra would increase their likelihood of practicing math problems outside of class. Conversely, 60.87% feel unsure or disagree, with 19.57% uncertain and 41.30% disagreeing. The average value of 3.5543 indicates a moderate level of agreement The principal-A said *"As a principal of this school, I firmly believe in the importance of integrating computer subjects into our basic level classes. By making it compulsory, we ensure that students are exposed to essential technological skills from an early age, preparing them for the digital world ahead. Moreover, I have full confidence in our highly qualified teachers to effectively utilize such technology in their teaching methods. With their expertise, I am certain that they can engage students positively and enhance their learning experiences through interactive and innovative approaches."*

The view of principal shows there is important to have computer classes mixed in with our regular subjects in school. They believe that by making it a must-do thing, students will learn all the important computer skills they need right from the

start. This will help them out a lot when they're older and using computers for all kinds of matter, like jobs or just everyday things. The principal is confident that their teachers, who know a lot about teaching, can use computers in a really good way to help students learn better.

They're sure that by using computers in teaching, the teachers can make learning more fun and interesting for students. This means using computer to teach lessons, which can make learning feel more like playing. The principal thinks this will help students get excited about learning and understand things better. They believe that with the teachers' skills, students can have a really great time while they're learning important things for the future. Chalaune and Subedi,(2020) state that that the proper use of ICT does not only increase the students' marks but also motivate them to their study in mathematics which findings is similar to teachers experience and school administrators' view.

Opportunities and Challenges towards Practice of GeoGebra at Secondary Level Mathematics Classroom

To find the opportunities and challenge for student towards practice of GeoGebra I used two domain which are opportunity and challenges in this domain there are seven and six statement respectively. For the interview guideline there are seven domains which are access, pedagogical barriers, curriculum alignment, student engagement and teacher training. To find the school administrators perception I used technological infrastructure, administrative support and external support. These domains are explained separately as follows:

Perception of Stakeholders about Opportunity

Analyzing opportunities for GeoGebra usage, student perceptions are detailed in Table-6, while insights from teachers and the principal offer additional perspective.

Teachers and the principal express optimism about leveraging GeoGebra's potential to enhance mathematical understanding and engagement.

Table 6

Students' perceptions about opportunity

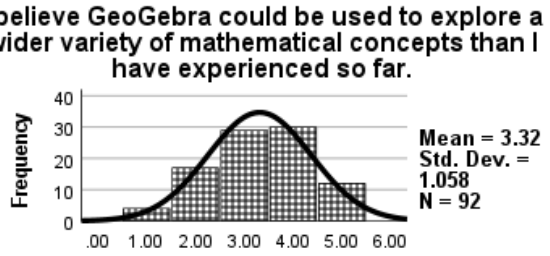
	Statement	SA	A	U	D	SD	Mean	Decision
30	I believe GeoGebra could be used to explore a wider variety of mathematical concepts than I have experienced so far.	12	30	29	17	4	3.3152	Positive
31	GeoGebra could be helpful for learning math concepts that are traditionally difficult to understand.	30	27	17	12	6	3.6848	Positive
32	Using GeoGebra could help me connect math concepts to real-world applications.	22	35	21	9	5	3.6522	Positive
33	I would be more likely to use GeoGebra outside of class if it had more tutorials or learning resources.	7	28	26	22	9	3.0217	Positive
34	GeoGebra could be a more valuable learning tool if it offered opportunities for collaboration with classmates.	10	24	29	21	8	3.0761	Positive
35	GeoGebra would be better if it had more fun things to do, like games or puzzles, to learn math.	25	29	21	16	1	3.6630	Positive
36	I can learn many mathematical concept which is not included in our textbook/curriculum using GeoGebra.	5	14	2	35	16	2.5326	Negative

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

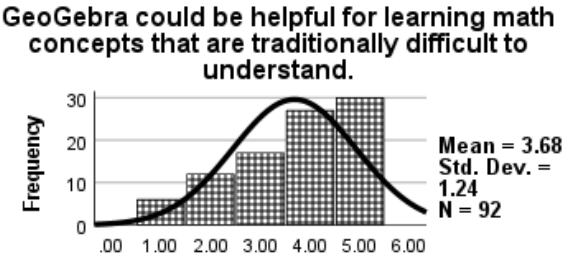
Table-6 shows Students perceptions about opportunity. It has a mean score of 3.32**,** which is higher than the average score. This score indicates that students

generally have a positive perception towards opportunity of learning through GeoGebra. The analysis of each statements is presented separately as below;

I believe GeoGebra could be used to explore a wider variety of mathematical concepts than I have experienced so far. The data presents a diverse perspective among students regarding GeoGebra's potential to explore a broader range of mathematical concepts. Approximately 64.13% express uncertainty or disagreement, while 35.87% agree. Specifically, 32.61% agree and 13.04% strongly agree that GeoGebra could explore a wider variety of mathematical concepts. Conversely, 64.13% feel unsure or disagree, with 31.52% uncertain and 18.48% disagreeing. The average value of 3.3152 suggests that most of the student believe GeoGebra could be used to explore a wider variety of mathematical concepts than they have experienced.



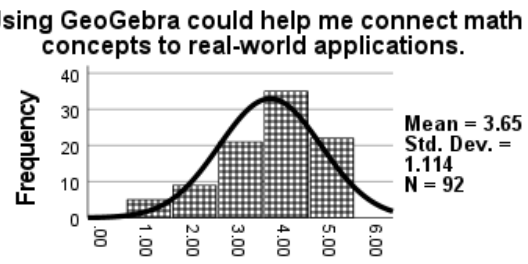
GeoGebra could be helpful for learning math concepts that are traditionally difficult to understand. The data reveals a prevalent belief among students regarding GeoGebra's potential to aid in understanding traditionally challenging math concepts. Approximately 61.96% agree or strongly agree, while 38.04% express uncertainty or disagreement. Specifically, 29.35% agree and 32.61% strongly agree that GeoGebra could assist in learning difficult math concepts. Conversely, 38.04% feel unsure or disagree, with 18.48% uncertain and 19.57% disagreeing. The average value of 3.6848 suggests most of the student understood



mathematical concept which they did not get from traditional method of teaching and learning.

In the view of teacher-A, said *"GeoGebra offers great opportunities in secondary mathematics. Firstly, it personalizes learning by allowing students to explore at their own pace. Secondly, it promotes creativity and problem-solving skills through visualization and manipulation of geometric figures."* This view emphasized the significant benefits that GeoGebra offers in secondary mathematics. It highlighted two key advantages. Firstly, GeoGebra enables personalized learning by allowing students to engage with mathematical concepts at their own pace. This means students can explore and understand topics according to their individual learning styles and preferences. Secondly, Teacher-A pointed out that GeoGebra encourages creativity and problem-solving skills. By providing tools for visualizing and manipulating geometric figures, GeoGebra allows students to approach problems in a more dynamic and interactive way, fostering deeper understanding and enhancing their ability to tackle mathematical challenges effectively. GeoGebra's potential to transform the learning experience in secondary mathematics classrooms.

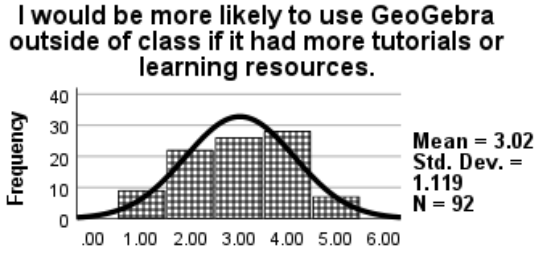
Using GeoGebra could help me connect math concepts to real-world applications. The data shows mixed opinions among students about GeoGebra's ability to link math concepts to real-world applications. About 61.96% express uncertainty or disagreement, while 38.04% agree. Specifically, 38.04% agree and 23.91% strongly agree that GeoGebra can aid in making these connections. Conversely, 61.96% are unsure or disagree, with 22.83% feeling uncertain and 39.13% disagreeing. The



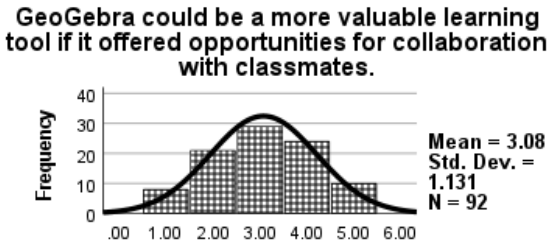
average value of 3.6522 indicates most of the students can relate mathematical concepts to the real world applications by the help of GeoGebra.

In the same way teacher-C said *"In my view, GeoGebra enhances accessibility, inquiry-based learning and authentic assessment. It simplifies complex concepts, encourages curiosity and provides insight into students' skills through interactive assessments."* The view express GeoGebra helps students learn in different ways. They believe that GeoGebra makes it easier for all students to learn, encourages them to ask questions and helps teachers understand what students are good at through interactive tests. They think GeoGebra makes hard things easier to understand, makes students curious about learning and helps teachers see how well students are doing.

I would be more likely to use GeoGebra outside of class if it had more tutorials or learning resources. The data indicates a divided perspective among students on using GeoGebra outside of class if more tutorials or learning resources were available. Approximately 56 students (60.87%) express uncertainty or disagreement, while 36 students (39.13%) express agreement. Specifically, 28 students (30.43%) agree and 7 students (7.61%) strongly agree, whereas 26 students (28.26%) feel uncertain and 30 students (32.61%) disagree. The average value of 3.0217 suggests some of the student don't like to use GeoGebra outside of the class if they had more tutorials or learning resources but 36 students like to use GeoGebra outside the class if they get learning resources.

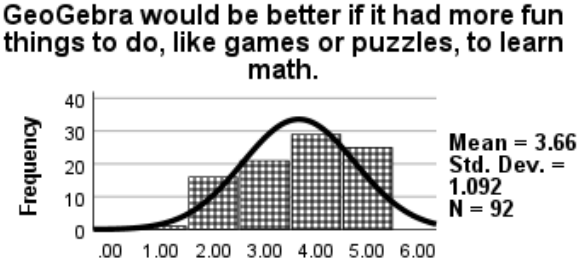


GeoGebra could be a more valuable learning tool if it offered opportunities for collaboration with classmates. The data shows mixed student views on GeoGebra's collaborative potential. About 54.35% are uncertain or disagree, while 45.65% agree. Specifically, 26.09% agree and 10.87% strongly agree. Conversely, 31.52% are uncertain and 22.83% disagree. The average value is 3.0761, indicating only less than 50% student believe that a GeoGebra could be a more valuable learning tool if they get opportunity for collaborative learning.



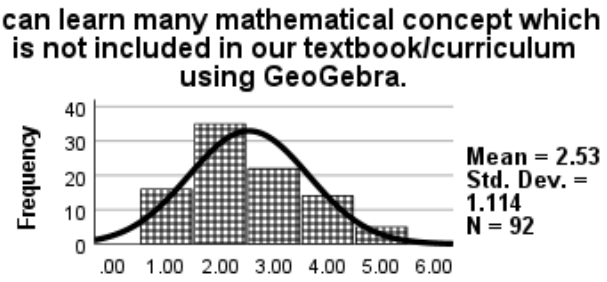
In the same way Teacher-B said *"As a mathematics teacher, I see GeoGebra as a tool for active learning, differentiation and collaboration. It encourages students to engage with concepts, supports varied learning styles and promotes a sense of community in the classroom."* This view agreed that GeoGebra serves as a valuable asset for mathematics instruction. They perceive GeoGebra not just as a software tool, but as a facilitator of active learning, catering to diverse learning styles and promoting collaboration among students. GeoGebra encourages students to actively engage with mathematical concepts, accommodates different ways of learning and try to develop a sense of community within the classroom environment.

GeoGebra would be better if it had more fun things to do, like games or puzzles, to learn math. The data reveals varied student opinions on enhancing GeoGebra with interactive elements like games or puzzles. About 54.35% are uncertain or disagree, while 45.65% agree. Specifically,



31.52% agree and 27.17% strongly agree that adding fun activities would improve GeoGebra. Conversely, 22.83% are uncertain and 31.52% disagree. The average value of 3.6630 indicates GeoGebra would be better if it had more fun things to do like games or puzzles to learn mathematics for most of the students' perspective.

I can learn many mathematical concept which is not included in our textbook/curriculum using GeoGebra. The data reveals a significant divergence in students' perceptions regarding GeoGebra's capacity to facilitate learning of mathematical concepts not covered in the textbook or curriculum. A substantial majority of students, approximately 55.43%, express uncertainty or disagreement with this statement, indicating a lack of consensus on GeoGebra's ability to supplement the curriculum. Conversely, around 44.57% of students express agreement. Specifically, 15.22% agree and 5.43% strongly agree that GeoGebra helps them learn additional mathematical concepts. In contrast, 55.43% either feel unsure or disagree, with 2.17% feeling uncertain and 38.04% disagreeing. The average value of 2.5326 suggests most of the students can learn many mathematical concept which is not included in the curriculum by using GeoGebra.



In analyzing opportunities with GeoGebra, students' perceptions align positively with teachers' viewpoints. Teacher-A highlights GeoGebra's potential to personalize learning, fostering creativity and problem-solving skills through interactive exploration of geometric concepts. Similarly, Teacher-B emphasizes its role as a tool for active learning, differentiation and collaboration, supporting diverse

learning styles and building classroom community. Another teacher echoes these sentiments, noting GeoGebra's ability to enhance accessibility, inquiry-based learning and authentic assessment, simplifying complex concepts and encouraging curiosity. The research of Doktoroglu (2013) finds that teaching graph of linear equations by using GeoGebra had a significant effect on seventh grade students' achievement positively. Together, these perspectives and research review underscore GeoGebra's multifaceted opportunities for enriching secondary mathematics teaching, promoting engagement and facilitating meaningful learning experiences for students.

Perceptions of Stakeholders about Challenges

In understanding the challenges surrounding GeoGebra, data from student surveys is detailed in Table-7, while insights from other mathematics teachers and the principal offer additional perspectives. Teachers and the principal acknowledge various hurdles, such as limited access to technology or initial discomfort with using new software.

Table 7

Students' perceptions towards challenges

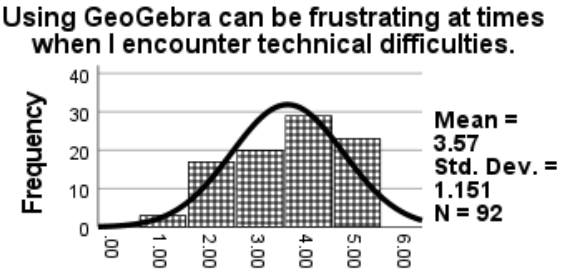
	Statement	SA	A	U	D	SD	Mean	Decision
37	Using GeoGebra can be frustrating at times when I encounter technical difficulties.	23	29	20	17	3	3.5652	Positive
38	I get discouraged if I can't figure out how to use GeoGebra to complete a task.	24	37	15	11	5	3.6957	Positive
39	I found the GeoGebra interface (menus, tools) to be difficult to learn at the first time.	29	36	7	17	3	3.7717	Positive
40	We don't get to much time to spend on computer/mobile to use	24	51	14	3	0	4.0435	Positive

	Geogebra.							
41	GeoGebra is an expensive software. So, all the students cannot afford such software.	5	10	16	41	20	2.3370	Negative
42	There is lack of proper training of GeoGebra for learner.	25	36	20	8	3	3.7826	Positive

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA)

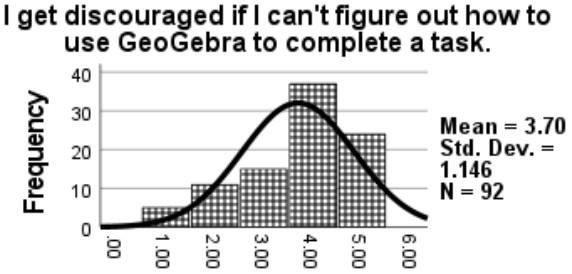
Table-7 shows Students perceptions towards challenges. It has a mean score of 3.62**,** which is higher than the average score. This score indicates that students generally have a positive perception towards challenges of learning mathematics through GeoGebra. The analysis of each statements is presented separately as below;

Using GeoGebra can be frustrating at times when I encounter technical difficulties. The data shows that a significant majority of students, about 75%, find GeoGebra frustrating when facing technical difficulties. Specifically, 31.52% agree and 25% strongly agree with this statement. In contrast, 25% of students are either unsure or disagree, with 21.74% feeling uncertain and 18.48% disagreeing. The average value of 3.5652 reflects most of the students think using GeoGebra can be frustrating at times when they encounter technical difficulties.

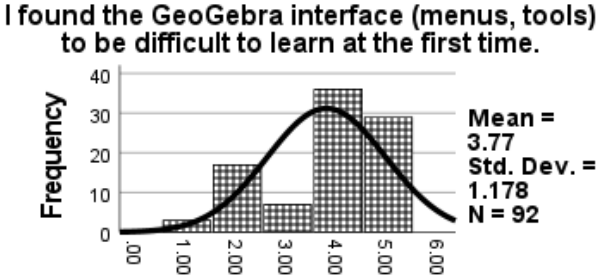


I get discouraged if I can't figure out how to use GeoGebra to complete a task.

The data indicates a significant sentiment among students about the discouragement they feel when facing challenges using GeoGebra. Approximately 66.3% of students either agree or strongly agree with this statement, highlighting the impact of difficulties on their motivation. Specifically, 40.2% agree and 26.1% strongly agree that they get discouraged when they can't figure out how to use GeoGebra for a task. In contrast, 33.7% of students express uncertainty or disagreement, with 16.3% feeling uncertain and 17.4% disagreeing. The average value of 3.6957 reflects most of the students get discouraged if they cannot figure out how to use GeoGebra to complete a task.



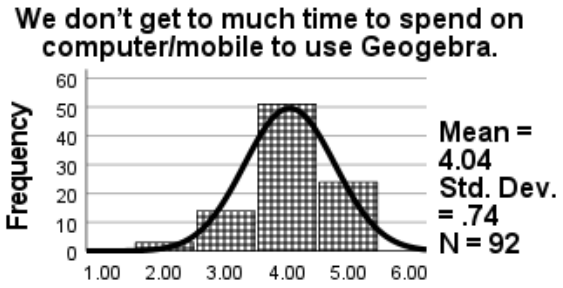
I found the GeoGebra interface (menus, tools) to be difficult to learn at the first time. The data indicates a significant consensus among students about the initial difficulty in learning the GeoGebra interface, including menus and tools. Approximately 70.65% of students either agree or strongly agree with this statement, highlighting widespread recognition of the challenges in navigating GeoGebra initially. Specifically, 39.13% agree and 31.52% strongly agree on the difficulty. Conversely, 29.35% of students express uncertainty or disagreement, with 7.61% feeling uncertain and 21.74% disagreeing. The average value of 3.7717 suggests most



of the student found that the GeoGebra interface like menus tools to be difficult to learn at the first time.

In the other hands in the topic of challenge, Teacher-A said *"I am fortunate to have participated in a comprehensive GeoGebra training program provided by our local government. This training has equipped me with the necessary skills and knowledge to effectively utilize GeoGebra in my teaching practices. With the support and resources provided through this program, I am confident in my ability to integrate GeoGebra seamlessly into my lessons, enhancing student engagement and understanding in geometry and mathematics."* This experience shows that teachers got training provided by the local government, specifically focusing on GeoGebra. This training has equipped them with the necessary skills to effectively incorporate GeoGebra into their teaching methods. With the support received and the resources provided through this program, teachers are feeling confident in seamlessly integrating GeoGebra into their lessons. They believe that this integration will enhance student engagement and understanding in geometry and mathematics.

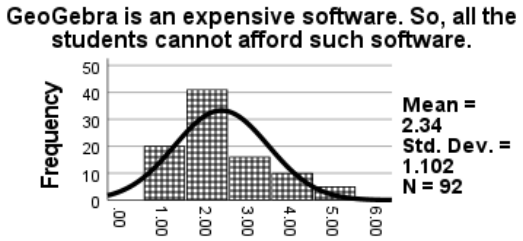
We don't get to much time to spend on computer/mobile to use Geogebra.



The data indicates a prevalent sentiment among students regarding the limited time available for using GeoGebra on computers or mobile devices. A significant majority, approximately 75 students (81.52%), either agree or strongly agree with this statement, reflecting a widespread acknowledgment of time constraints. Specifically, 51 students (55.43%) agree, while 24 students (26.09%) strongly agree. Conversely,

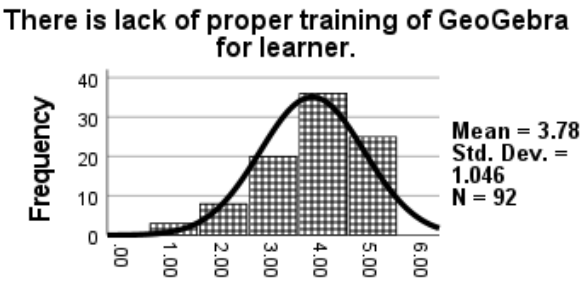
around 17 students (18.48%) express uncertainty or disagreement. The average value of 4.0435 suggests that all most students don't get much time to spend on computer or mobile to use GeoGebra.

GeoGebra is an expensive software. So, all the students cannot afford such software. The data suggests a predominant belief among students regarding the perceived affordability of GeoGebra. Approximately 61 students (66.3%) either agree or strongly agree that GeoGebra may be unaffordable for all students due to its perceived expense. Conversely, around 31 students (33.7%) express uncertainty or disagreement. The average value of 2.3370 indicates most of the student think GeoGebra is not on expensive software and they knew they can afford it.



In the question of challenges faced by school administrator, the principal-A said *"As a school administrator, implementing technology like GeoGebra in secondary level education poses several challenges that we need to address. Ensuring equitable access to technology for all students is a significant hurdle. We must consider factors like internet connectivity and device availability to ensure no student is left behind."* School administrators express that using technology such as GeoGebra in school education comes with its challenges. One big problem is making sure that all students have equal access to this technology. This means making sure that everyone has the internet and devices they need to use GeoGebra. The principal wants to make sure that no student misses out on using this technology because they don't have the sufficient resources.

There is lack of proper training of GeoGebra for learner. The data suggests a prevailing sentiment among students regarding the adequacy of training provided for GeoGebra users. Approximately 61 students (66.3%) either agree or strongly agree that there is a lack of proper training for GeoGebra learners. Conversely, around 31 students (33.7%) express uncertainty or disagreement. The average value of 3.7826 indicates most of the student still believe that there is lack of preper training of GeoGebra for learner.



Also principal-A said "*We need to manage our budget and handle the practical problems of getting and taking care of our technology. To overcome these challenges, we need to plan carefully, work together and stay dedicated to giving our students the best learning opportunities."* School administrators believe that they understand the importance of managing the school's budget and dealing with the practical issues involved in obtaining and maintaining technology for education. To solve these challenges, they emphasize the need for careful planning, teamwork and a strong commitment to providing students with the best possible learning experiences. Essentially, they believe that by working together and staying dedicated, they can overcome these obstacles and ensure students have access to quality education resources.

Principal-B said that "*There's the challenge of providing adequate training and support for teachers. Many educators may feel intimidated by new technology and require guidance to effectively integrate it into their teaching practices."* In some school principal figured out that one of the difficulties is making sure teachers know

how to use new technology like GeoGebra. Some teachers might feel a bit scared or unsure about using it, so they need help to learn how to use it well in their teaching. This way, they can make the most of the technology and help students learn better.

Additionally the study Zakaria and Lee (2012) revealed that similar result as this study that finds that mathematics teachers in secondary schools have a positive attitude toward the use of GeoGebra. Both teachers and principals face common challenges when trying to use technology like GeoGebra in high school. Teacher-B says that many teachers don't have enough training to use the software effectively in their lessons. Principals are worried about making sure all students can use the technology fairly, especially if some students don't have good internet or enough devices. They also know that teachers might need extra help to feel confident using new technology. Everyone agrees that dealing with money and practical issues like buying and keeping up with technology is tough. To fix these problems, everyone needs to work together, plan carefully and make sure students always have good chances to learn.

Chapter-V

Summary, Finding, Conclusion, Implication and Recommendation

In this section, you'll find an overview of the entire study along with its findings and conclusions drawn from the analysis and interpretation of both quantitative and qualitative data. Additionally, recommendations on how these findings can be applied in academic and administrative domains are provided. This chapter covers the following sections:

- Summary of the study
- Finding of the study
- Conclusion of the study
- Implications of the study
- Recommendation for the further study

Summary of the Study

The study aimed to explore the perceptions of stakeholders towards the use of GeoGebra software in secondary level mathematics classes and to identify the opportunities and challenges associated with its use. The research seek to understand how students, teachers and school administrators view toward practice of GeoGebra, focusing on its potential benefits for student engagement and learning, as well as any difficulties in implementing the software. Specifically, the study addressed the stakeholders' perceptions and the practical issues related to practice of GeoGebra at secondary level mathematics classroom.

Using a mixed-methods research design, the study combined quantitative and qualitative approaches to gather comprehensive data. The researchers employed a convergent parallel mixed-method design, collecting detailed information from students, teachers and school administrators. A purposive sampling technique was

used to select a sample comprising 92 students from three schools, along with three mathematics teachers and two school principals. Data collection tools included survey questionnaires for students, which covered topics such as technological knowledge, software familiarity, interest, access, engagement and challenges. Additionally, interviews were conducted with teachers and administrators to gather qualitative perception.

To ensure the study's validity and reliability, expert judgment was used to validate the interview guidelines and Cronbach's alpha method was applied to verify the reliability of the tools. Data collection involved questionnaires for students and conducting interviews for teachers and administrators. The data were analyzed using SPSS software for quantitative analysis, including weighted mean, while thematic analysis was employed for qualitative data. This comprehensive approach provided a well-rounded understanding of the perceptions of stakeholders towards practice of GeoGebra in secondary mathematics classroom.

The study found that stakeholders have a strong positive perception of GeoGebra in secondary mathematics education. Students rated their experience highly, enjoying its interactive features and finding it beneficial for understanding concepts. Teachers felt comfortable and supported in using GeoGebra, with school administrators and local government providing necessary training and resources. While some teachers and students initially faced challenges with technology, overall, GeoGebra boosted student engagement, creativity, problem-solving skills and made complex concepts easier to grasp. The findings emphasize the need for ongoing training and reliable infrastructure to fully leverage GeoGebra's benefits in enhancing mathematical learning and real-world application.

Finding of the Study

We discovered a range of perspectives of stakeholders towards the practice of GeoGebra at the secondary level mathematics teaching. Teachers expressed for GeoGebra's potential to enhance student engagement and understanding of mathematics, students' perception towards use of GeoGebra and administrators view on practice of GeoGebra in teaching learning. However, challenges were noted, particularly concerning access to technology and the need for teacher training. Students exhibited positive attitudes towards GeoGebra, finding its interactive features beneficial for learning. Administrators acknowledged implementation challenges but expressed commitment to addressing them to ensure student success with GeoGebra. The major findings of this study were as follows:

- The average mean of 42 statement which is surveyed by student is 3.6 so the perception of students towards the practice of GeoGebra at secondary level mathematics is strongly positive.
- Perception of teacher towards the practice of GeoGebra at secondary level is positive and they feel comfortable and encouraged to use it in classroom.
- Perception of school administrators towards the use of GeoGebra at secondary level is positive they encourage teachers to use ICT like GeoGebra in teaching learning.
- The local government is supporting school and teacher both to use ICT and it provided training of GeoGebra, local government and other social organization provided fond, computers and smart board for school.
- Some of teachers are confident to use GeoGebra in teaching of mathematics but some teachers need some help of tutorials, help from expert.

- Students feels GeoGebra as a more engaging and conceptual learning method of mathematics.
- Students were more excited and engaged when using GeoGebra due to its visual and interactive features.
- Students became more curious and willing to experiment with math concepts in GeoGebra.
- Some students initially struggled with technology, highlighting the need for clear instructions and practice.
- The principal supported adding GeoGebra to the teaching and learning believing it prepares students for the digital world.
- Students and teachers agreed that technological knowledge is crucial for learning math.
- GeoGebra boosts creativity and problem-solving skill of students through visualizing and manipulating shapes.
- GeoGebra encourages active learning and collaboration among students.
- GeoGebra makes complex concepts easier to understand and promotes student curiosity through different features of GeoGebra.
- Technical issues with GeoGebra frustrated students and sometimes discouraged its use.
- Some students found GeoGebra challenging at first, indicating a need for better training.
- Limited access to computers or devices restricted the use of GeoGebra.
- Both students and teachers need better training to use GeoGebra effectively.
- Students felt GeoGebra helps connect math to real-world applications, making learning more practical.

- Adding games and puzzles to GeoGebra could make math more fun and engaging.
- Teachers felt confident using GeoGebra to enhance their teaching and improve student engagement and learning outcomes.

Conclusion of the Study

The comprehensive analysis of data reveals exact understanding of the perceptions of students, teachers and administrators towards the practice of GeoGebra in secondary-level mathematics classrooms. The study found that GeoGebra significantly enhances students' understanding and engagement with mathematical concepts. This tool aids in visualizing complex mathematical problems, making abstract concepts more visible and comprehensible for students. Teachers observed that GeoGebra promotes more interactive and engaging learning environment, which in turn motivates students to participate actively in their learning process. Administrators highlighted the importance of incorporating technological tools like GeoGebra to prepare students for a technologically advanced future, emphasizing its role in promoting critical thinking and problem-solving skills.

Despite the positive reception, the study also identified several challenges associated with the implementation of GeoGebra. Students reported difficulties in learning the software, which sometimes distracted from their overall learning experience. Both students and teachers pointed out the need for extensive training and ongoing support to effectively integrate GeoGebra into the classroom. Teachers expressed concerns about the alignment of GeoGebra with the existing teaching learning methods and the additional time required to prepare lessons incorporating this tool. Administrators acknowledged these challenges, emphasizing the necessity

for structured professional development programs and adequate resources to support the effective use of GeoGebra in classrooms.

Overall, the findings shows the potential of GeoGebra to transform mathematics education at the secondary level. The positive impact on student engagement and understanding is significant, the study also highlights the practical challenges that need to be addressed for successful implementation. By providing comprehensive training for teachers, ensuring curriculum alignment and offering continuous support, schools can hold the benefits of GeoGebra to enhance the quality of mathematics education.

Implications of the Study

After analyzing the data and deriving the findings and conclusions of this research, the major implications of the study are outlined below:

- This study would be useful to the different schools and institutions.
- GeoGebra significantly increases student engagement by making learning more interactive and enjoyable.
- Using GeoGebra helps students connect mathematical concepts to real-world applications, making the subject more relevant and interesting.
- Students like GeoGebra's features, making math learning more engaging and interesting
- Supportive school leaders and local government can help overcome challenges like limited access to computers for GeoGebra use.
- GeoGebra's visual and interactive features can boost student curiosity and encourage experimentation with math concepts.
- GeoGebra helps students develop problem-solving skills and creativity through manipulating shapes.

- GeoGebra promotes active learning and collaboration among students in the classroom.
- Both teachers and students need access to high-quality training to maximize the benefits of GeoGebra.
- GeoGebra can make complex math concepts easier to understand and connect them to real-world applications.
- It can be used for the education policy maker.

Recommendations for the Further Study

Due to the lack of infrastructure and time, this thesis could not cover all sectors comprehensively. This study focused on the perceptions of stakeholders towards the practices of GeoGebra in secondary level mathematics. Therefore, it is recommended that future studies explore additional sectors. By examining these areas in more detail, researchers can gain a better understanding and provide more comprehensive insights into the subject.

- A similar study can be conduct on the effectiveness of various training programs for teaching GeoGebra.
- A similar study can be conduct on the long-term impact of GeoGebra on students' mathematical skills and academic performance over time.
- A similar study can be conduct on examine how enhanced collaborative features in GeoGebra affect student learning outcomes and engagement.

Reference

Abera Wassie, Y. & Awgichew Zergaw, G. (2019).Some of the Potential Affordances, Challenges and Limitations of Using GeoGebra in Mathematics Education, *EURASIA Journal of Mathematics, Science and Technology Education*, 2019, 15(8), em1734 ISSN:1305-8223. https://doi.org/10.29333/ejmste/108436

Abera Wassie, Y. and Awgichew Zergaw, G.(2021). Capabilities and Contributions of the Dynamic Math Software, GeoGebra—a Review. *North American GeoGebra Journal* Volume 7, Number 1, ISSN 2162-3856

Abramovich, S. (2013). Computers in Mathematics Education: An Introduction. *Computers in the Schools* 30(1-2): 4-11.

Acarli, D. S., & Ozel, S. (2020). The effects of dynamic geometry software on students' achievement and retention in geometry. Journal of Educational Computing Research, 58(5), 1217-1237.

Asare T. Asare and Atteh Evans (2022). The Impact of Using GeoGebra Software in Teaching and Learning Transformation (Rigid Motion) on Senior High School Students' Achievement , *Asian Journal of Education and Social Studies 33(1): 36-46, 2022; Article no.AJESS.90855ISSN: 2581-6268*

Bozkurt, E., & Dönmez, N. O. (2019). Prospective mathematics teachers' views about using dynamic mathematics software in constructivist learning environments. Educational Technology & Society, 22(3), 135-147.

Burt, J. K., Denard, H., Howard, T. C., & Thompson, D. R. (2019). Exploring teachers' use of GeoGebra to support mathematical modeling in secondary mathematics classrooms. *Journal of Computers in Mathematics and Science Teaching*, 38(2), 149-168.

Chalaune Bir B. and Subedi Abatar. (2020). Effectiveness of GeoGebra in teaching school mathematics ,Contemporary Research: An Interdisciplinary Academic Journal, 2020, vol. 4 (1): 46-58

Cheng, L., & Qian, X. (2019). A study of dynamic geometry software's pedagogical affordances in teaching and learning mathematics. *Educational Technology Research and Development*, 67(2), 355-373.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and Conducting Mixed Methods Research (3rd ed.). SAGE Publications Ltd. United Kingdom.

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges and Criticisms. Journal of Practical Studies in Education, 2(2), 25-36 DOI: https://doi.org/10.46809/jpse.v2i2.20

Doktoroglu, R. (2013). The Effect of Teaching Linear Equation with Dynamic Mathematics Software on seventh grade student's Achievement thesis in mathematics Education Faculty of Social Science Middle East Technical University.

Dunaway, M.K. (2011). Connectivism: Learning theory and pedagogical practice for networked information landscapes. In *Reference Services Review. 39(4)*, (pp. 675-685). doi:http://dx.doi.org/10.1108/00907321111186686.

Gaskins, T., Raunch, S., Gensmore, E., Cunicelli, E., Ohara, C., Six, L., & Scott, T., (1997) Scaffolding, The Development of Intelligence among Children who are delayed in Learning to Read, in Hogan, K., & Pressley M., (eds.), Scaffolding Student Learning, Massachusetts: Brookline Bks.

Gatt, S. & Vella, Y. (eds.), (2003), Constructivist Teaching in Primary School: Examples in Social Studies, Science, Mathematics, Design and Technology

and ICT, Malta: Agenda Publishers https://www.researchgate.net/publication/284722693.

Goldie, J. G. S. (2016) Connectivism: a knowledge learning theory for the digital age? *Medical Teacher*, 38(10), pp. 1064-1069.; doi:10.3109/0142159X.2016.1173661

Hohenwarter, M., Hohenwarter, W., & Lavicza, P. (2010). The impact of dynamic geometry software on students' learning of mathematics: A meta-analysis. *Educational Studies in Mathematics*, 74(3), 257-283.

Mainali B. Raj and B. Key Mary (2013). Using dynamic geometry software GeoGebra in developing countries:A case study of impressions of mathematics teachers in Nepal , Nepal.

Majerek , Dariusz.(2014). Application Of Geogebra For Teaching Mathematics. Advances in Science and Technology Research Journal Volume 8, No. 24, Dec. 2014, pages 51–54 DOI: 10.12913/22998624/567

Nazihatulhasanah A. and Nurbiha A.(2014). The effects of GeoGebra on students achievement Procedia - Social and Behavioral Sciences 172 (2015) 208 – 214. Siemens, G. (2008, January 27). *Learning and knowing in networks: Changing roles for educators and designers.* Article presented to ITFORUM. Retrieved from http://itforum.coe.uga.edu/Paper105/Siemens.pdf

Osman, M. (2006). The use of dynamic geometry software in secondary mathematics education: A case study. Malaysian Journal of Education, 34(1), 1-13.

Preiner, G. (2008). Using dynamic geometry software in mathematics education: A review of recent research. Educational Research Review, 3(3), 156-178.

Roihler, L., & Cantlen, D., (1997), Scaffolding: A Powerful tool in Social Constrcutivism, in Hogan, K., K., & Pressley M., (eds.), Scaffolding Student Learning, Massachusetts: Brookline Bks.

Tamam B. & Dasari D. (2021). The use of Geogebra software in teaching mathematics. *Journal of Physics: Conference Series*; doi:10.1088/1742-6596/1882/1/012042

Vygotsky, L.S., (1978), Mind in Society : The Development of Higher Psychological Processes, Cambridge, Massachusetts: Harvard University Press.

Zainal, Z.(2007). Case study as a research method. *Jurnal Kemanusiaan.* bil.9, Jun 2007, Universiti Teknologi Malaysia.

Zakaria E. and Lee S. (2012).Teachers' Perceptions toward the use of GeoGebra in the Teaching and Learning of Mathematics, Journal of Mathematics and Statistics 8 (2): 253-257, 2012 , ISSN 1549-3644

Zulnaidi, H. and Zakaria, E. (2012). The Effect of Using GeoGebra on Conceptual and Procedural Knowledge of High School Mathematics Students, Asian Social Science, 8(11), 101-106.

APPENDICES

Appendix: I

Questionnaire for Students

School Name: ……

Student's Name: ……

Roll No.: ……..

Please study the statement carefully and tick the best one of the following:-

Strongly Agree (**SA**) Agree (**A**) Undecided (**U**)

Disagree (**DA**) Strongly Disagree (**SDA**)

Areas	**S.N.**	**Statement**	**SA**	**A**	**U**	**DA**	**SDA**
Technological knowledge	1	Technological knowledge is essential for learning Mathematics.					
	2	Search engines (Google search) are helpful to learn Mathematics.					
	3	I create own Google account for better access of technology.					
	4	I am familiar with mathematical softwares like Photomath, GeoGebra.					
Familiarity with software	5	I can solve mathematical problems using GeoGebra software.					
	6	I can use basic tools of GeoGebra.					
	7	GeoGebra is useful for drawing geometric shapes.					
	8	I believe GeoGebra can be used to					

		explore mathematical relationships between shapes.					
Interest	9	I am interested in learning the function of new software for effective mathematics learning.					
	10	I like to use internet to find the solution of mathematical problems.					
	11	I enjoy learning from GeoGebra.					
	12	Exploring how shapes relate to each other using GeoGebra seems like a more engaging way to learn math.					
	13	GeoGebra is good to understand geometrical concept.					
	14	GeoGebra turns math formulas into pictures, making it easier to understand.					
	15	I believe that using GeoGebra could be a helpful addition to my current way of learning mathematics.					
	16	GeoGebra is not useful for learning mathematics.					
	17	GeoGebra is time consuming software.					
	18	I request teacher to use GeoGebra.					
Access	19	Having access to GeoGebra outside of					

		class would be helpful for my learning.					
	20	I believe most students in my class have access to a computer with GeoGebra installed or can access it online.					
	21	School must provide student computer lab with GeoGebra installed computer.					
	22	It is helpful if we install Geogebra in our mobile phone.					
Student engagement	23	I watch tutorial of GeoGebra before applying it.					
	24	Using GeoGebra, I feel more engaging than traditional methods of learning Mathematics (textbooks, lectures).					
	25	Using GeoGebra helps me to visualize and understand math concepts better.					
	26	GeoGebra allows me to explore math in a more interactive and hands-on way.					
	27	I feel more confident in my ability to solve math problems after using GeoGebra.					

	28	I don't like to use GeoGebra it is time wasting for me.					
	29	I would be more likely to practice math problems outside of class if I could use GeoGebra.					
Opportunity	30	I believe GeoGebra could be used to explore a wider variety of mathematical concepts than I have experienced so far.					
	31	GeoGebra could be helpful for learning math concepts that are traditionally difficult to understand.					
	32	Using GeoGebra could help me connect math concepts to real-world applications.					
	33	I would be more likely to use GeoGebra outside of class if it had more tutorials or learning resources.					
	34	GeoGebra could be a more valuable learning tool if it offered opportunities for collaboration with classmates.					
	35	GeoGebra would be better if it had more fun things to do, like games or puzzles, to learn math.					

	36	I can learn many mathematical concept which is not included in our textbook/curriculum using GeoGebra.					
Challenges	37	Using GeoGebra can be frustrating at times when I encounter technical difficulties.					
	38	I get discouraged if I can't figure out how to use GeoGebra to complete a task.					
	39	I found the GeoGebra interface (menus, tools) to be difficult to learn at the first time.					
	40	We don’t get to much time to spend on computer/mobile to use Geogebra.					
	41	GeoGebra is an expensive software. So, all the students cannot afford such software.					
	42	There is lack of proper training of GeoGebra for learner.					

Appendix: II

Interview Guideline for Teacher

Personal and professional information

School Name: … … … … … … … ….

Teacher's Name:… … … … … … … … … … ..

Experience:… … … … … … .. ..

- **Technological knowledge**

  -Knowledge about technology.

  -Knowledge about to use GeoGebra.

- **Interest**

  -Interest to use technology in teaching learning.

  -Interest to use GeoGebra in classroom.

- **Access**

  -Access of ICT tools in classroom, school and home.

  -Access of GeoGebra for students in school and home also.

  -Access of internet facility in school as well as home.

- **Pedagogical barriers**

  -Classroom management while using GeoGebra.

  -Barrier related to assessment

  -Time management while using GeoGebra.

- **Curriculum alignment**

  -Fulfilment of the objectives of curriculum.

  -Content related to GeoGebra.

  -Necessity of GeoGebra to teach mathematics in secondary level.

  -Relevancy of content, materials and methodology.

- **Student engagement**

  -Reaction of student while using GeoGebra.

  -Participation of students while using GeoGebra.

  -Progress of students after using GeoGebra.

- **Teacher training**

  -GeoGebra learning platform for teacher in your school and locality.

  -Teacher training from Local government, school or any other organization.

- **Opportunity**

  -Improvement in quality of teaching.

  -Better understanding of mathematical concept.

  -Easy to teaching Geometrical concept as compare to traditional method.

- **Challenges**

  -Availability of ICT tools.

  -Support from school, student and parents.

  -Time management.

  -Engagement of students.

Appendix: III

Interview Guideline for Administrator

Personal and professional information

School Name: … … …… …… … ….

Respondent's Name:… … … … … … … … … … … ..

Experience: … … … … … ….. .. ..

- **Technological Infrastructure**

  -Availability of ICT tools.

  -Feedback from students and parents.

- **Administrative support**

  -Managing extra time for mathematics teacher.

  -Providing laptop, computer for teacher.

- **External support**

  -Support from SMC.

  -Support from Local government.

  -Support from parents and other organization.

Appendix: IV

Table 8

Questionnaire, students' response, mean value and decision.

	Statement	SA	A	U	DA	SDA	Mean	*Decision*
1	Technological knowledge is essential for learning Mathematics.	55	29	8	0	0	4.5109	Positive
2	Search engines (Google search) are helpful to learn Mathematics.	52	23	15	2	0	4.3587	Positive
3	I create own Google account for better access of technology.	48	34	5	3	2	4.3370	Positive
4	I am familiar with mathematical software like Photomath, GeoGebra.	37	46	4	5	0	4.2500	Positive
5	I can solve mathematical problems using GeoGebra software.	17	50	15	7	3	3.7717	Positive
6	I can use basic tools of GeoGebra.	11	28	23	19	11	3.0978	Positive
7	GeoGebra is useful for drawing geometric shapes.	25	37	22	4	4	3.8152	Positive
8	I believe GeoGebra can be used to explore mathematical relationships between shapes.	35	27	13	13	4	3.8261	Positive
9	I am interested in learning the	17	37	20	12	6	3.5109	Positive

	function of new software for effective mathematics learning.							
10	I like to use internet to find the solution of mathematical problems.	9	19	23	28	13	2.8152	Negative
11	I enjoy learning from GeoGebra.	33	34	7	12	6	3.8261	Positive
12	Exploring how shapes relate to each other using GeoGebra seems like a more engaging way to learn math.	33	43	10	4	2	4.0978	Positive
13	GeoGebra is good to understand geometrical concept.	38	41	5	6	2	4.1630	Positive
14	GeoGebra turns math formulas into pictures, making it easier to understand.	36	32	13	8	3	3.9783	Positive
15	I believe that using GeoGebra could be a helpful addition to my current way of learning mathematics.	29	43	13	6	1	4.0109	Positive
16	GeoGebra is not useful for learning mathematics.	4	6	10	47	25	2.10	Negative
17	GeoGebra is time consuming software.	3	11	9	43	26	2.1522	Negative

18	I request teacher to use GeoGebra.	27	29	9	17	10	3.5000	Positive
19	Having access to GeoGebra outside of class would be helpful for my learning.	24	26	17	20	5	3.4783	Positive
20	We have access to a computer with GeoGebra installed or can access it online.	7	10	17	40	18	2.4348	Negative
21	School must provide student computer lab with GeoGebra installed computer.	41	44	4	2	1	4.3261	Positive
22	It is helpful if we install GeoGebra in our mobile phone.	25	39	17	5	6	3.7826	Positive
23	I watch tutorial of GeoGebra before applying it.	4	8	16	41	23	2.2283	Negative
24	Using GeoGebra, I feel more engaging than traditional methods of learning Mathematics (textbooks, lectures).	29	44	11	7	1	4.0109	Positive
25	Using GeoGebra helps me to visualize and understand math concepts better.	37	36	9	7	3	4.0543	Positive
26	GeoGebra allows me to explore math in a more interactive and	31	37	15	6	3	3.9457	Positive

	hands-on way.							
27	I feel more confident in my ability to solve math problems after using GeoGebra.	26	47	8	8	3	3.9239	Positive
28	I don't like to use GeoGebra it is time wasting for me.	17	36	11	22	6	3.3913	Positive
29	I would be more likely to practice math problems outside of class if I could use GeoGebra.	18	38	18	13	5	3.5543	Positive
30	I believe GeoGebra could be used to explore a wider variety of mathematical concepts than I have experienced so far.	12	30	29	17	4	3.3152	Positive
31	GeoGebra could be helpful for learning math concepts that are traditionally difficult to understand.	30	27	17	12	6	3.6848	Positive
32	Using GeoGebra could help me connect math concepts to real-world applications.	22	35	21	9	5	3.6522	Positive
33	I would be more likely to use GeoGebra outside of class if it had more tutorials or learning resources.	7	28	26	22	9	3.0217	Positive

34	GeoGebra could be a more valuable learning tool if it offered opportunities for collaboration with classmates.	10	24	29	21	8	3.0761	Positive
35	GeoGebra would be better if it had more fun things to do, like games or puzzles, to learn math.	25	29	21	16	1	3.6630	Positive
36	I can learn many mathematical concept which is not included in our textbook/curriculum using GeoGebra.	5	14	2	35	16	2.5326	Negative
37	Using GeoGebra can be frustrating at times when I encounter technical difficulties.	23	29	20	17	3	3.5652	Positive
38	I get discouraged if I can't figure out how to use GeoGebra to complete a task.	24	37	15	11	5	3.6957	Positive
39	I found the GeoGebra interface (menus, tools) to be difficult to learn at the first time.	29	36	7	17	3	3.7717	Positive
40	We don’t get to much time to spend on computer/mobile to use Geogebra.	24	51	14	3	0	4.0435	Positive
41	GeoGebra is an expensive	5	10	16	41	20	2.3370	Negative

	software. So, all the students cannot afford such software.							
42	There is lack of proper training of GeoGebra for learner.	25	36	20	8	3	3.7826	Positive

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (DA), Strongly Disagree (SDA