DETERMINANTS OF STUDENTS' SCHOLASTIC ACHIEVEMENT IN LEARNING CALCULUS IN DEGEM PREPARATORY SCHOOL, NORTH SHOA, OROMIA REGIONAL STATE, ETHIOPIA

MSc THESIS

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POSTGRADUATE PROGRAM DIRECTORATE

I hereby certify that I have read and evaluated this thesis entitled "Determinants of Students' Scholastic Achievement in learning calculus in Degem Preparatory School, North Shoa, Oromia Regional State" prepared under my guidance, by Lemi Tolossa. I recommended that it be submitted as fulfilling the thesis requirement.

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DEDICATION

This thesis manuscript is dedicated to my wife Fanose Regasa without whose prayers, support and relentless encouragement during my class and research work I would not have come this far.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. Any scholarly matter that is included in the thesis has been given recognition through citation.

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BIOGRAPHICAL SKETCH

The author was born on April 12, 1981 in Kuyu Woreda, North Shoa Zone and attended his Primary Education at Suyyum Demissew Elementary School and he attended his Secondary education at Gebre Guracha Senior Secondary School. After completing his secondary school education in September 2001 he joined Addis Ababa University and graduated with BSc Degree in Mathematics in June 2003. As his education leads him to teaching, he was employed and teaching Mathematics at Mendida secondary school in Abbichuna Gnea Woreda in 2004. He joined the Postgraduate Program Directorate at Haramaya University in June 2007 to pursue further studies.

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ABBREVIATIONS AND ACRONYMS

APOS	Action Process Object Schema
DPS	Degem Preparatory School
IEPA	Institute for Educational Planning and Administration
MoE	Ministry of Education
SPSS	Statistical Package for Social Science
UNESCO	United Nations Education Science and Cultural Organization

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ABSTRACT

The purpose of this study was to identify the determinants of students' scholastic achievement in learning calculus in DPS. The research was designed in a descriptive survey method. Participants of the study were 72 grade 12 students and 3 mathematics teachers in DPS. Simple random sampling techniques were employed in order to select sample participants. Three instruments were used for data collection from sample students and teachers. Primary data were used to assess achievements in calculus. Data were analyzed by using SPSS version 20 for questionnaires and achievement test and narrative words for teachers' interviews. The results of the data analysis were presented using mean and percentage. According to the key finding of this study: Items related to Library, teachers' competency and training, school facilities and parent involvement, Items related to students background knowledge on pre-calculus and items related to students knowledge on calculus were found to be a contributing determinants for these patterns as well as low achievement levels in DPS. Finally, it was recommended that: calculus curriculum designers regularly evaluate, revise and design by identifying the problems to work on improving the status of students learning calculus from the lower level of the country's educational system. Mathematics teachers would revise the concepts of pre-calculus for students before he/she starts the lesson calculus portions. Teachers and key stakeholders would work hand in hand to improve students pre-calculus and calculus achievement and provide supplementary materials such as reference books which help students on pre-calculus and calculus portions.

Key words: *Achievement, Preparatory School, Calculus, Determinant*

1. INTRODUCTION

1.1. Background of the Study

Mathematics is a necessity that was born out of problems created by human interactions, from the time humans saw the need to quantify their possessions and compare their wealth with others, to the time of performing great scientific and technological feats (Adeyefa, 2012).

Mathematics was evolving and becoming more complicated as human endeavors and interactions were becoming more complex. It enhances development and the achievement of sophistication in Science and Technology; the construction of high rise building, the manufacturing of supercomputers, exotic cars, the landing of spacecraft's on the Moon and the planet Mars, the launching of satellites, the use of internet banking, to mention but a few; hence the slogan mathematics is the Queen of Science and the mother of technology (Adeyefa, 2012).

Calculus is a branch of mathematics that focused on limits, continuity, functions, derivatives and integrals. Isaac Newton and Gottfried Leibniz independently discovered calculus in the mid-17^{th} century. Before Newton and Leibniz, the word "Calculus" referred to anybody of mathematics, but became a popular term for a field of mathematics based upon their insights. By the middle of the 17^{th} century, European mathematics had changed its primary repository of knowledge. In comparison to the last century which maintained Hellenistic mathematics as the starting point for research. Newton, Leibniz and their contemporaries increasingly looked towards the works of more modern thinkers. Europe had become home to a burgeoning mathematical community and with the advent of enhanced institutional and organizational bases a new level of organization and scholastic integration was being achieved (Pekrun, Goetz, Tiz and Perry, 2002).

Dreyfus and Eisenberg (2007) showed that; most students completing a topic in calculus have a pre-rigorous achievement of calculus and very few ever achieve full achievement of the rigorous definition. They confirmed students' difficulties when they say that most students have little success in achievement this important mathematical idea.

A limit is a number, that the function values are "Tending to or heading toward" as x gets closer or nearer to a particular value $x = a$, or as x gets larger either in the positive or negative sense. Limit at a point refers to the behavior of the function values for x's nearer and nearer to $x = a$. Limit at infinity refers to the behavior of the function values for larger and larger values of x in the positive or negative direction (Salas & Hille, 2010).

The notation for limit $\lim_{x\to\infty} f(x)$ is confusing; however, it is important in order for students to make connections between function values and limit. As a result, difficulty occurs when starting the problem solving process since it is unlike any notation seen in prior mathematical experiences. Students have vague interpretations of "lim" if the referents did not represent the mathematical meaning well enough or if the connection between the referent and written notation was not appropriate. An achievement of the notation is built gradually in order to make connections necessary to achievement its meaning and so there must be an achievement of this notion of "Nearness", what happens to the function values on the y-axis when x-values get close or near a given point on the x-axis. Also for large x, as x is tending toward infinity, the focus is on what number the function values are getting near (Tall, 2006).

Limit is a basic idea in calculus. Without limit calculus simply does not exist. Every single notion of calculus is a limit in one sense or another Salas and Hille (2010). Instantaneous velocity is the limit of average velocities; the slope of a tangent line to a curve is the limit of the slope of secant lines; an infinite series is the limit of a finite sum; the area of a circle is the limit of areas of inscribed polygon as the number of sides increase infinitely. In the formal teaching of calculus the stated limits are obtained by methods of differentiation and integration, which the fundamental theorem of calculus refers to as reverse processes.

Integral calculus is generally concerned with the determination, properties and applications of the integrals of functions. It is used in the calculation of area bounded by curves, volume of a solid of revolution, moment of inertia, fluid pressure and work etc. (Stewart, 2010). An increasing numbers of investigations have shown that students have difficulties in achievement the concept of integration. Many students cannot achieve a deeper achievement they find calculus very hard and abstract (Salazar, 2014).

The gap between this research and the related study was:

- ✓ This study seeks/tries to identify the determinants of students' scholastic achievement in learning calculus.
- ✓ There is no specific study related with this topic in the place where the researcher is working.
- ✓ This study took place in Degem preparatory school.

1.2. Statement of the Problem

Problems related to learning calculus were common phenomena among students around the world. This holds true in DPS context too; a number of determinants influence students' calculus achievement positively or negatively.

It is true that in every discipline concepts are basis for further learning and development of a portion. This is particularly true for calculus for its highly sequenced by its own nature. The achievement of subsequent concepts was hardly possible if and only if the pre- requisite concepts are not clearly established. For instance, a student cannot achievement the concept of derivatives before he/she clearly achieve the concept of limit (Andualem, 2006).

Lack of achievement in calculus often can make students lose interest in the portion and affect their calculus achievement. The ability to use procedures and achievement concepts in calculus are two things necessary in learning calculus Hiebert and Carpenter (2011). Achievement in calculus learning generally involves actions to know concepts and principles related to the procedures and relating or creating meaningful relationships between existing concepts and newly-learnt concepts.

Without proper grasp of the limit concept, a very important branch of mathematics known as analysis would also not exist. At an elementary level, analysis deals with the notions of real number, function, limits of numerical sequences and continuity. At an advanced level these extend to analysis of several variables, complex analysis and functional analysis Artigue (2008). The implication of this description is that the concepts of infinitely large and infinitely small are also important in analysis courses.

Despite the importance of the idea of calculus, students continue to hold incomplete and alternative conceptions of it even after careful instruction. However, “This does not prevent them from working out exercises, solving problems and succeeding in their examinations” (Cornu, 2008).

As a calculus teacher, I expect students to come to me with conceptual achievement of functions. For example, students should be able to solve equations, graph, evaluate functions, transfer between forms of functions and compute basic sums, differences, products and quotients of functions. However, this is far from the truth. As I introduced topics for students in calculus, I find myself reviewing topics from previous portions. For this reason, there is often much frustration for the teacher as well as the student. My frustration stems from having to find time to review topics that are not necessarily part of the curriculum. The students become frustrated due to their struggles in trying to learn new topics without having complete achievement of foundational material. Identifying the area in which a student struggles and correcting the way a student achievements a topic should be a goal at each level of mathematics (Dreyfus & Eisenberg, 2007).

The researcher became aware of students’ problems with the idea of a limit from his experience of teaching calculus portion in DPS. Under the limit there are subtopics about the limit of a function at a point, a limit as x approaches infinity, one side limit, the relationship between limit and continuity (Bezuidenhout, 2001).

As the objective of the portion outline dictates that at the end of the unit, the students could calculate limit in a variety of problems, but in most cases they found it very difficult to explain the idea of a limit in their own words. So that I became curious and wanted to investigate the idea of limit further. I wanted to determine why students find this idea so complicated; whether the complexity is inherent to the nature of the idea itself; whether it is due to the way in which it is taught or whether it is due to any other reasons. A possible explanation for the identified problem is that the idea of a limit is often taught in isolation. Students see the idea as a concept on its own without any relationship to other calculus ideas. Students do not realize the important role that limits play in the study of calculus at higher institution level in Differential Calculus, Integral Calculus and continuity. They cannot explain why the idea of a limit is fundamental to calculus. They are unable to relate limit to the broader field of calculus.

The motivation for this investigation thus was to determine the conceptions that students have the idea of a limit, to try and reveal the specific determinants of students' scholastic achievement in learning calculus (Bezuidenhout, 2001).

The scholastic achievements of students were affected by a number of determinants. These determinants could be grouped into two broad categories as: in-school and out school determinants. In this regard, Philip (2000) indicated that determinants such as qualified teachers, facilities like adequate text books and learning process (monitoring and evaluation) have great influence on the successful achievement of the educational objective and enhancing students' scholastic achievement in learning calculus.

1.3. Research Questions

This study was attempted to answer the following research questions:

1. What are the major determinants that significantly obstruct the students' scholastic achievement in learning calculus in DPS?
2. How do students achieve the idea of calculus in DPS?
3. What are their difficulties to achieve calculus concept in DPS?

1.4. Objectives of the Study

1.4.1. General objective

The general objective of the study was to identify determinants of students' scholastic achievement in learning calculus in DPS.

1.4.2. Specific objectives

The specific objectives of this study were to:

1. Identify the major determinants that significantly affect the students' scholastic achievement in learning calculus.
2. Investigate how students perceive and achieve the calculus concept.
3. Investigate their difficulties on pre-calculus and calculus.

1.5. Significance of the Study

This study is particularly used to address determinants of students' scholastic achievement in learning calculus in DPS. This study helped the society (students' parent), students and teachers in DPS. This research study is designed to show ways how to overcome students' problem toward calculus education in some specific area. This study adds the knowledge we have about the barriers, possibilities in teaching-learning calculus in DPS. It indicates possibilities to explore and overcome the barriers encountered. In addition, the study is expected to indicate some general problems and needs of DPS students' scholastic achievement in learning calculus. Furthermore, a finding of this research will lay out the foundation for further study on this area in the future.

1.6. Scope of the Study

This study is delimited in searching for the determinants of students' scholastic achievement in learning calculus in DPS. The study emphasized on only grade 12 students in DPS. This study is also delimited to the specific topic: limits, continuity, derivatives and integration.

1.7. Limitation of the Study

Due to time and financial constraints, the school involved in this study was only one preparatory school in Degem Woreda. The study would have been more comprehensive if more preparatory schools from this area were included; however, such kind of study needs abundant resources in terms of budget, time and man power. Moreover, absence of relevant reference materials related to this study was the other determinants through study and the researcher has been forced to rely on internet. In spite of this, the researcher has attempted to make the study as complete as possible.

1.8. Organization of the Study

This thesis has five major chapters. Chapter one constituted the introduction, which focuses mainly on the background of the study, statement of the problem, research questions, objectives of the study, significance of the study, scope of the study, limitation of the study, organization of the study and operational definition of key terms. Unit two deals with reviews of different literatures about determinants of students' scholastic achievement in learning calculus. Unit three contains research design and methodology which includes description of the study area, design of the study, source of data, description of population and sample, data collection instruments, validity and reliability test, procedures for data collection, methods of data analysis and ethical considerations. Unit four contains results and discussion. Finally, unit five presents summary, conclusion and recommendations. References and appendices are also attached at the end.

1.9. Operational Definition of Key Terms

Achievement: After a lot of study and exercise, students' success and performance in calculus.

Calculus: is a portion in mathematics that deals with functions, limits, continuity, derivatives and integrals.

Determinants: are facts, circumstance or situation which identifies or aids diagnosis or determines the nature or conditions an outcome or issue of low achievement in calculus.

Preparatory school: the Ethiopian school structure of education that constitute grade 11-12.

Scholastic: one who advocates or practices traditional methods in solving calculus problems.

2. REVIEW OF RELATED LITERATURE

2.1. Determinants of Students Scholastic Achievement in Learning Calculus

2.1.1. Teachers competency and training

Darling (2014) indicated teacher quality characteristics such as certification status and degree in the field to be taught are very significantly and positively correlated with student outcomes. Characteristics such as education level show positive but less strong relationships with education outcomes. In all cases, the proportion of well-qualified teachers is by far the most important determinant of student achievement: it is highly significant in all equations for both subject areas in all years and at all grade levels.

According to UNESCO (2008) Ethiopia has certified educational standard for the preparatory schools, i.e., the minimum required qualification to teach at preparatory level requires at least a 2^{nd} degree. Teachers must master the subjects they are teaching to get diligent, hard work, skilled and competent students. This shows that teachers must be well trained before they join teaching profession and to be fruitful or successful in all aspects.

Darling (2014) defines well qualified teacher as one who was fully certified and held the equivalent of a major in the field being taught. Although the formal qualification of teachers is an important indicator for their knowledge and competence in teaching, it has only calculus utility in analyzing how well prepared teachers are for what they have to teach in schools. More detailed knowledge of the portions they have taken during their training needs to be compared to the actual content and skills required to teach the preparatory school's curriculum.

Ruthland and Bremer (2002) refer to teacher qualification in two ways - traditional and alternative qualification routes. Traditional certification is when an individual completes an undergraduate degree or post graduate program in education. Alternative routes of certification are based on coursework in pedagogy and subject area without a degree in education. Hardy and Smith (2006) short term activities such as mentoring, peer evaluations and workshops as ways other than formal qualifications for improving teaching. More often graduates teachers

with second degree content go into teaching if they cannot find another job right away. Although they often get somewhat lower salary than a fully qualified teacher; they choose not to enroll in the one year post- graduate professional training and therefore lack a foundation for teaching.

The good performance was attributed to excellent instructions given by qualified teachers in addition to other inputs. It has been evidenced that in many countries, teacher qualifications that are considered to be related to student learning have become desirable targets of teacher education reform. Some of these reforms call for the professionalization of teacher education by making it longer, upgrading it to graduate programs, and regulating it through mechanisms of licensure, certification and promotion aligned with standards (Darling, 2014).

2.1.2. Parent involvement

Parental involvement may be different from culture to culture and society to society. Parental involvement may have different types, which might have differential influence on scholastic achievement of their students'. Parental expectations have a greater impact on student's educational outcomes. Parental involvement may include activities like helping students' in reading, encouraging them to do their homework independently, monitoring their activities inside the house and outside the four walls of their house and providing coaching services for improving their learning in different subjects. Parents play a crucial role in both the home and school environments. In general, parental involvement is associated with students' higher achievements in calculus, enrolment in more challenging programs, greater scholastic persistence, better behavior, better social skills and adaptation to school, better attendance and lower drop-out rates (Henderson & Mapp, 2002).

Parental involvement categorized into four broad strands. These are: Parental involvements in students' school-based activities, Parental involvement in students' at home-based activities, direct parental involvement in scholastic activities of students' and indirect parental involvement in scholastic activities of students'. It is true that parental involvement level vary among parents. For example mother parent of young students', educated or uneducated parents, father's involvement, their economic status, family background, social environment. It is observed that parental involvement with students' from early age has been found to

equate with better outcomes specially in building their personalities parents are primary guides to them, students' try to copy them and considered them that they are always write so parents can shape their life as they can. Their involvement has positive impact on students' scholastic achievement even when the background determinant of such as social class, family size has been taken into account (Desforges & Abouchar, 2003).

The Ethiopian Education and Training Policy MoE(2005) and the guideline for National Teachers Education stress the need for teacher commitment in involving parents and community in the educational process. The required guidelines, strategies and programs are available to promote the involvement of parents in their students' education. The guideline on Organization of Educational Management Community Participation and Education Finance MoE(2005) emphasis on the school boards and parent-teacher association which are expected to handle managerial, administrative and scholastic matters in the education of students' in Ethiopia.

2.1.3. The school facilities

Poor and inadequate facilities affect the overall scholastic achievement of schools. Sufficient facilities promote scholastic achievement and ensure to strengthen the overall scholastic achievement of schools. While unattractive and old school buildings; cracked classroom walls and floors; lack of toilets; lack of desks and benches; lack of transport facility; lack of proper security system; lack of drinking water; lack of power supply; lack of playgrounds; lack of teaching staff; lack of sufficient classrooms; overcrowded classrooms; lack of educational technology; lack of first aids facility etc negatively affect scholastic achievement of the schools. Therefore, it is right to say that scholastic achievement has a close link with the availability of educational facilities (Hussain et al., 2012).

There are several determinants of classroom physical environment i.e. visual determinant, acoustic determinant, thermal determinant, spatial determinant and time determinant. Visual determinant refers to the quality of lighting in different parts of the classroom. It is determined by the level of natural and artificial light available in the classroom. It also refers to the way by which the classroom environment is arranged i.e. visually interesting, creating a favorable atmosphere and any unwanted disruptions e.g. windows overlooking playgrounds etc.

Acoustic determinant is an important determinant as we mostly depend upon verbal communication in our classroom. Noise level mainly depends upon school design, classroom organization and teaching methodologies applied during a lesson (Basit, 2005).

Poor classroom acoustics can adversely affect learning environment for many students. Constant noise exposure can damage cognitive performance and functioning (Higgins et al, 2004). Thermal determinant refers to the heating and ventilation of the classroom and are generally out of the teachers' control as they are climate variables. It plays a fundamental role in making classroom atmosphere favorable and comfortable and hence affects the behavior and performance. Spatial determinant relates to the space management and has a great impact on behavior particularly on communication. Time determinant refers to the amount of time a student is participating in learning process i.e., the number of minutes the student is actively participating in teacher directed lessons and activities Basit(2005). Therefore, it is concluded that physical environment of classroom comprises of classroom size and structure, furniture, seating arrangement, instructional technologies, room heater, ceiling fans, curtains, cupboard, equipments, lighting and ventilation.

Proper arrangement of classroom environment plays a remarkable role in making instructional process more effective and establishes an atmosphere favorable and encouraging to learning. The quality of the physical classroom setting significantly affects scholastic achievement of the students. Physical facilities in classrooms ensure effective and successful teaching learning process. Without these facilities, effective and fruitful teaching learning process is not possible. Students get more information from their teachers in well facilitated classrooms and consequently they show good performance. On the other hand, if students feel uncomfortable in classroom then they will fail to get more information from their teachers. Lyons (2001) stated that poor school facilities adversely impact teachers' effectiveness and also their performance. Consequently it negatively affects student achievement. They further concluded that achievement in cognitive and affective learning outcomes were repeatedly associated with classrooms environment, which were perceived as having greater cohesiveness, satisfaction, goal direction, organization and less friction.

The classroom climate should be cautiously managed not only to provide physical comfort but also to serve as a positive determinant in the learning process by stimulating attentiveness and

concentration. To maintain such a climate, the atmosphere must be treated to simultaneously controlled temperature, humidity, cleanliness and circulation. Duncan son (2005) established that temperature, heating and air quality are the fundamental elements for the educational attainment of students.

2.1.4. Students attitude towards calculus

According to Ademe and Gebre (2000), significant gender differences find in several areas and attitude variables are found to be useful in predicting grades. In addition to this many research studies have been done on comparison between female and male students attitude towards calculus and suggested that there is no significant difference between attitude towards calculus among male and female students.

From previous studies, students' achievement in calculus has affected by several determinants such as the environment of the school where it must be favorable teaching and learning process. Teaching methodology has direct effect on achievements of calculus and on the student, etc (Tadesse, 2006).

Attitude is a central part of human identity. Every day people love, like, favor, oppose, agree, disagree, argue, persuade, etc. All these are evaluative response to an object. Hence, attitude is defining as "A summary of evaluation of an object of thought" Rosetta (2007). In addition, attitude has seen as cognitive and effective orientations towards an object, idea, person, situation, etc. Attitudes are frequently measured using self-report.

Students who are benefited more from high quality instruction are self- regulated, have strong calculus backgrounds and calculus self-concept is one of the determinants that influence students achievement in calculus and this determinants related to their motivation to learn calculus Andualem(2006). In addition, he notes that students' intellectual-mathematical motivations and social-personal motivations also influence the students' attitudes in learning calculus.

2.2. Prerequisites for the Achievement of Calculus

Functions in Calculus

Prior to calculus, students are introduced to procedures for evaluating functions and solving equations. Therefore, they are seeing functions as a static entity. In other words, although they are able to view functions in the way best suited for the problem, they are primarily instructed on functions at the action view of the APOS framework Carlson et al (2010). If students have developed a deep achievement of functions prior to attending a high school calculus portion or even college, they will be better prepared for these portions Akkus et al (2008). In calculus, functions play a vital role. Some of the problems that students are faced with include slope of a function and the equation of tangent lines. Because of this, development of the function concept in earlier mathematics courses is vital for student success. Further, the ability to apply the definition of function is a vital part of the background of any student hoping to achievement calculus Breindenbach et al (2008). Much of the success that students achieve in calculus classes appears to stem from their achievement of functions.

Finding limits of functions forces students to interpret behavior of a function near a particular x-coordinate. Students must possess a dynamic view of function and they must view functions at least at the process level Carlson (2010). Carlson (2010) suggests that a deep achievement of the concept of function is a vital part of the background of any student hoping to comprehend calculus. Being able to visualize, make the connection between the equation form and the graphical form of a function, plays a key role in achievement limits of functions. Habre and Abboud (2006) also state that one fundamental change that calculus witnessed in recent years is an increased emphasis on visualization. Once students begin exploring the concept of derivative, they then explore deeper into their achievement of function. Here they are calculating rates of change, slopes of tangent lines, looking at related rates and use the derivative concept to describe the graphical representation of a function. Achievement functions and being able to connect their different representations as well as being able to analyze and make use of particular parts of functions is necessary for success with derivatives.

The concept of function is central to a student's ability to describe relationships of change between variables, explain parameter changes and interpret and analyze graphs Clement

(2001). The final topic of a typical first-year calculus course is the integral. Here students use integration to calculate areas of regions between two functions, find volumes of solids created by revolving a region around an axis and apply integration to solve physics problems. Creating the connection of what role functions play in each of these topics is a struggle for many students. With a strong mathematical background and achievement of function, students are typically successful achievement these concepts. Students with weak achievement of function struggle to make sense of much of what happens in calculus (Oehrtman et al., 2008).

2.3. Limits and Other Concepts in Calculus

2.3.1. Limits of function

Definition: If the values of a function f(x) approach the value L as x approaches c we say that f has limit L as x approaches c and write,

$$\lim_{x \to c} f(x) = L.$$

In order to achievement limits and other calculus concepts, students ought to have a global interpretation of the behavior of functions and their graphs Lauten, Graham & Ferrni (2010). This includes the idea of the continuity of functions. Students also need to be familiar with graphs i.e. the interpretation of given graphs as well as the sketching of a graph when its algebraic formula is given. Another important related aspect is the idea of infinity.

Epistemological Obstacles in Limit

Cornu (2008) defines an epistemological obstacle as knowledge which functions in a certain domain of activity and becomes well-established. Then it fails to work satisfactorily in another context where it malfunctions and leads to contradictions. It then becomes necessary to destroy the original insufficient knowledge and to replace it with a new concept that operates satisfactorily in the new domain.

Epistemological obstacles occur both in the historical development of scientific thought and in educational practice. They have two essential characteristics:

- They are unavoidable and essential constituents of knowledge to be acquired,

- They are found, at least in part, in the historical development of the concept Cornu(2008).

There are four major epistemological obstacles in the history of the limit concept according to Cornu (2008) these are:

i. The failure to link geometry to numbers,
ii. The idea of the infinitely large and infinitely small,
iii. The metaphysical aspect of the idea of limit and
iv. Is the limit attained or not?

The idea of a limit is difficult to introduce in mathematics because it seems to have more to do with metaphysics or philosophy. This metaphysical aspect of limit is one of the principal obstacles for today's students. This obstacle makes the comprehension of the limit extremely difficult, particularly because it cannot be calculated directly using familiar methods of algebra and arithmetic. The question whether the limit is actually reached or not, is still alive in the minds of today's students. This is another obstacle to the idea of a limit (Cornu, 2008).

2.3.2. The continuity of functions

The issue of continuity has become one of practical as well as theoretical importance. Continuous functions are the functions we normally use in the equations that describe numerical relations in the world around us. They are the functions we use to describe how a body moves through space or how the speed of a chemical reaction changes with time. It is important to know when continuity is called for, what it entails and how to test for it Finney & Thomas (2008). A function $y = f(x)$ that can be graphed throughout its domain with one continuous motion of the pen (that is without lifting the pen) is an example of a continuous function. A function is continuous if it is continuous at each point of its domain. The continuity test can be used to test for continuity at a point.

The continuity test

A function y = f(x) is continues at x = c if and only if it meets all the following three conditions:

i. f(c) exists (f is defined at c)
ii. $\lim_{x\to c} f(x)$ exists (f has a limit as $x \to c$)
iii. $\lim_{x\to c} f(x) = f(c)$ (the limit equals to the function value)

To test for continuity at endpoints, the appropriate one-sided limit is used Finney & Thomas (2008). For any function y = f(x) it is important to distinguish between continuity at $x = c$ and having a limit as $x \to c$. The limit is wherethe function is headed as $x \to c$. Continuity is the property of arriving at the point where f(x) has been heading when x actually gets to c (Finney & Thomas, 2008).

2.3.3. Derivative of functions

To improve students' learning about the derivative of function concept, more and more research has focused on alternative methods of teaching the concept that may aid students' conceptual achievement. A majority of the studies that focus on enhancing students' achievement of the derivative concept emphasize the use of technology for the teaching and learning process. This may involve using computers, the graphing calculators (Serhan, 2006).

2.4. Achievement in Calculus

Achievement in Calculus has been for the past several decades a topic of investigation for researchers around the world concerned with improving the quality of calculus education. Calculus achievement of students in the preparatory school years has been found to be significant to success in tertiary calculus and performance in other science portions, as well as contributing to better career options and quality of life. There is, however, increasing concern about levels of students' calculus achievement and quality of calculus education globally Martin (2000). Students' calculus achievements in preparatory school have an influential effect on their performance in college and their future careers.

In almost all Ethiopian schools considering calculus as a challenging portion which cannot be understood is a common phenomenon among students, teachers and parents. But, this is true in many countries too. Calculus is considered by many individuals as a difficult portion to learn. This kind of outlook has a direct relation with achievement. The importance of calculus learning has repeatedly been emphasized by educators and politicians. Both teachers and parents have paid attention to students' performance in calculus and their progress every year. Achieving well in calculus, according to Martin(2000), has to do with how students deal with their studies in calculus and how they cope with or accomplish different tasks given to them by their teachers, bearing in mind the expected standard of performance.

According to Education (2008), students' commitment in calculus refers to students' motivation to learn calculus, their confidence in their ability to succeed in calculus and their feelings about calculus. Students' commitment in calculus plays a key role in the acquisition of calculus skills and knowledge Education (2008). Therefore, confidence towards problem solving is believed to play a significant role in calculus achievement and might be one of the determinants that influence students in calculus achievement. For the purpose of this study, calculus achievement means the performance of pupils in calculus as determined by the magnitude of scores gained in calculus test and examinations.

2.5. Conceptual Framework

This chapter outlines four determinants of students' scholastic achievement in learning calculus. These are: teachers' competency and training, parents' involvement, school facilities and students attitude towards calculus. As students move onto a higher level of mathematics classes, the role of functions, limits, continuity, derivatives and integral achievement becomes more important. Achievement of functions, limits, continuity, derivatives and integral in the researcher study was determined, in part, by a student's ability to work with these topics as measured by the APOS framework. The ability to apply the definition of functions, limits, continuity, derivatives and integral were used to determine another aspect of that students' achievement of these topics.

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Description of the Study Area

The study was conducted in DPS. Degem is in Ethiopia, Oromia administrative North Shoa zone and located on 125km in the West of Addis Ababa. It is bordered with Girar Jarso, Meta, Yaya Gulele and Kuyu Woredas in the North, South, East and West directions respectively. The climatic condition of the town is favorable and moderate temperature. DPS is found in Degem town which is the center of Woreda. This school was selected for this study deliberately on the basis of familiarity, the existence of several novice teachers who have been under mentoring program and required assistance from the experienced teachers.

3.2. Design of the Study

Survey research was preferred in this study, since in survey research the investigator selects a sample of respondents and administers a questionnaire and conduct interview to collect information on the variables of interest. The populations of the study were all students of grade 12 at the time of data collection. Even though the selections design of the study would depend on the nature of the study, the research problems had addressed and the resources available for the study. There is an increasing attention of using both quantitative and qualitative methods as a research strategy. Quantitative research methods are characterized by the collection of information which can be analyzed numerically, the results of which are typically presented using statistics, tables and graphs. Qualitative research is primarily exploratory research. It is used to gain an achievement of underlying reasons, opinions and motivations (Creswell, 2008).

According to Creswell (2008) for mixed research, the overall strength of the study is greater than either qualitative or quantitative methods. Also, Abdisa (2013) recommended that employing both qualitative and quantitative methods are preferable, because using both enable the researcher to verify, substantiate the data and discover something that would have been missed. Therefore, both quantitative and qualitative techniques would have employed to meet the stated objectives of the study. Quantitative techniques had used to analyze the data gathered through questionnaire and achievement test. The data that obtained through interview

had analyzed, organized and summarized by qualitative methods. The result of quantitative analysis had confirmed by qualitative results for effective achievement of this study.

3.3. Source of Data

Primary data were used for this study. The primary data was collected from mathematics teachers engaged in teaching mathematics through interview and from students of DPS through questionnaire and achievement test. The primary sources were used for the researcher to get firsthand information about the issue under study.

3.4. Description of Population and Sample

The study was conducted on grade 12 students of DPS. There are 600 grade 12 students in DPS (320 male and 280 female). To complete the study on the allocated time determining an appropriate sample size would have been very vital issues in research because, large sample size would affect the researcher to complete on time and brings economical problem to the researcher to get accurate data. On the other hand, small sample size would lead to inaccurate results.

The total population size of grade 12 students in DPS is 600 (320 (53.33%) male and 280 (46.67%) female). Descriptive research typically uses larger samples; it is sometimes suggested that one should select 10-20% of the accessible population for the sample Singh (2014). As suggested by Singh(2014), the researcher selected 12% from the total population or 72 (36 male and 36 female)students' out of 600 students' of the total population and 3(2 male and 1 female) mathematics teachers by lottery methods to select students and all mathematics teachers.

Simple random sampling (lottery) technique was employed in selecting sample respondents from DPS to achieve the objectives of the study. The reason why simple random sampling is employed in this study is since it is the type of probability sampling in which each population has an equal chance of being selected. After writing 0 and 1 on a piece of properly folded paper, they are told to pick one. Which means those who pick 1 they are selected as element of a sample and those who pick 0 are out of the research. This sampling technique continues until

all classes and elements of the sample were identified. From 10 sections of grade 12 students all sections were selected and 7 students were taken from each 9 sections and 9 students from one section were selected for the study. In addition, all mathematics teachers (2 male and 1 female) were taken as a sample from this school.

Table 1: Description of population, sample students and mathematics teachers of DPS

	DPS					
Grade 12 Students	Population			Sample		
	Male	Female	Total	Male	Female	Total
	320	280	600	36	36	72
Mathematics teachers	2	1	3	2	1	3

Source: DPS record office

From Table 1 above 72 sample respondent students are taken from DPS. Out of student respondents, 36 are male whereas 36 are female. Since it was usually not possible to deal with the whole population, the researcher is identified the above sample population for this study. Finally, conclusions are drawn to the whole population of students under discussion.

3.5. Data Collection Instruments

The plan of the study was to collect data during at the end of calculus portion on mathematics of grade 12 students. Both quantitative and qualitative data were collected using different data collecting instruments. The tools were used for primary data collection include achievement test, questionnaire and interview.

3.5.1. Questionnaires

Close-ended question items were constructed to collect information from students in DPS. The question items were prepared in English and developed using Likert-type five point rating

scales. The five points were weighed according to the degree of agreements: 5 for strongly agree, 4 for agree, 3 for neutral, 2 for disagree and 1 for strongly disagree.

Based on the literature, the questionnaire (Appendix- I) was considered as a common instrument. The purpose of questionnaire was to identify students' scholastic achievement in learning calculus, achievement of the classroom teaching process and the knowledge they have on calculus Abdisa (2013). The questionnaire was developed from other researcher's instruments and personal experience.

For this study, one separate questionnaire was prepared for students. The questionnaires for students were structured and used to collect data about the entire status of the issue under investigation. It was also supposed to supplement all other instruments in the study. Since the instrument was adapted from different context, a pilot test was conducted to ascertain its clarity and check the accuracy with which it measures and what it was intended to measure in the study area. Twelve copies of questionnaires were distributed for 12 students and 3 were distributed for 3 teachers in DPS for pilot test. Based on the pilot test scores and comments were given, some amendments were made on the questionnaires. Then the questionnaire papers were distributed and filled by all the sample students and were returned.

3.5.2. Interview guide

The second instrument for this study was interview (Appendix-II) that was prepared for mathematics teachers of DPS to get some additional investigation on students' scholastic achievement and determinants of students learning calculus. The contents of the interview have similar idea with the contents of the questionnaire. For this purpose interview guides were prepared for 3 mathematics teachers.

3.5.3. Achievement test

Achievement test (Appendix-III) was the other basic instrument, which shows students calculus achievement. Students' achievement test was prepared for grade 12 students selected from DPS. Thus, the researcher prepared achievement test for 72 students of grade 12. Next the collection process was started by distributing questionnaire to sample students and

achievement test would be given for the selected students to get enough information on quantitative data.

3.6. Validity and Reliability Test

The validity of the test was determined by students 'performance measurement, which were unanimous about it being appropriate for the intended purpose.

The formula used to determine the reliability (or consistency) of the full test for this study was Rulon's formula given by:

$$\rho^2 X = 2\left[1 - \left(\frac{\sigma^2 Y_1 + \sigma^2 Y_2}{\sigma^2 X}\right)\right]$$

Where $\rho^2 X -$ is the reliability of the full test

$\sigma^2 Y_1 -$is the variance of the correct odd numbers test

$\sigma^2 Y_2 -$is the variance of the incorrect odd numbers test

$\sigma^2 X -$is the variance of the whole correct test

$$\sigma^2 Y_1 = 99.91, \quad \sigma^2 Y_2 = 17.82, \quad \sigma^2 X = 200.18$$

Therefore $\rho^2 X = 2\left[1 - \left(\frac{99.91+17.82}{200.18}\right)\right]$

$$= 2\left(1 - \frac{117.73}{200.18}\right) = 2(1 - 0.588) = 2(0.412) = 0.824$$

The formula used to determine the reliability of the half test was Rulon's formula correlation. The reliability coefficient of the full test was found to be 0.824 which is acceptable level because it was close to 1. Hence it can be used for the purpose of the intended.

3.7. Procedures for Data Collection

After correcting the result of pilot test, the questionnaire was reconstructed on the basis of item analysis and permission was requested from the school principals to collect data from the respondents. Orientation was given on one part, upon the process of distribution and collection of questionnaires to the assistance data collectors or mathematics teachers how to handle questions raised from the respondents. In addition, clear explanation was provided to the respondents about the questionnaire. At the beginning students were asked to fill in the personal data such as name of school, grade, age and sex. Then, they were also well informed to follow the instruction carefully, to answer all questions and give their authentic responses.

3.8. Methods of Data Analysis

This section presents the statistical methods used to treat the data that was obtained from sample students in DPS. These data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20 and the qualitative data were narrated in words. The data analysis part was done by using both qualitative and quantitative data analysis techniques. The quantitative data obtained through questionnaires and achievement test were analyzed by using tables. Qualitative data obtained through interviews were analyzed by using words. The questionnaires and interviews were prepared based on the basic research questions and review of related literature. To maximize the quality of the responses and the rate of return the time convenient for the respondents were arranged. A brief orientation about the whole purposes of the study was given for the respondents. A close follow-up was also made to correct problems that arose during the distribution, the filling of the questionnaire and collection of questionnaires were done in collaboration with the researcher and directors of DPS. The data collected from the sample students through questionnaire was tallied, organized and tabulated to facilitate analysis. The information gathered using teachers' interview was also organized qualitatively. In analyzing and reporting the data, mostly, the descriptive method was used to analyze the information collected using different instruments from different sources. Information obtained from questionnaires and achievement test from students of DPS of the sample respondents were analyzed quantitatively from the students' response to calculus achievement test, then percentage was computed for achievement test on learning calculus. To

determine students' achievement of calculus an item-by-item analysis was done on questionnaires. To make it more specific, if the mean falls between 1 and 1.49 below average, between 1.5 and 2.49 moderate and between 2.5 and 5 above average.

3.9. Ethical Considerations

Before starting to conduct the study, permission was assured from Haramaya University Postgraduate Program Directorate to conduct this research. In line with this, Haramaya University Postgraduate Program Directorate discussed with other management members and gave a positive feedback for conduction of this research. Moreover, Haramaya University Postgraduate Program Directorate was assigned head of mathematics department to facilitate an issue of this study. In collaboration with head of mathematics department the researcher informed the objective of this study and requested permission from the students to participate in the study. In this process the researcher was informed duration, time and research method used in the study. The researcher also explained that participating in the study would depend on willing of individual and the students could withdraw at any time. Ethical consideration was seriously taken into account i.e., interview was done with mathematics teachers, questionnaires were filled by students, achievement test was given for students in secret with respondents. Without permission of individual no one interfere the response of other so that the concern, integrity, consents and other human elements of the participants, interviewees were well protected. Students were asked to participate in the research voluntarily without physical or psychological coercion. Anonymity was guaranteed as their name would not be exposed in any of reports signed letters of consent to participate in the study.

4. RESULTS AND DISCUSSION

The purpose of this chapter is to present the results of the analysis of the data obtained. The study had mainly based on the quantitative data gathered through questionnaire and achievement test whereas qualitative data gathered through interview. The data collected by using different data collecting instruments are tabulated, presented and analyzed with reference to stated objective of the study.

4.1. Response on Determinants that Affect Students' Scholastic Achievement in Learning Calculus

4.1.1. Response related to Library, teachers' competency and training, school facilities and parent involvement

In this study, respondents were given questionnaire to indicate how much Library, teachers' competence and training, school facilities and parents were involved in students' learning at home and at school. The table below presents and summarizes the results. In addition to this, interview was conducted with mathematics teachers to mention some points regarding to teachers' competence and training, school facilities and parents' involvement in school.

Table 2: Response related to Library, teachers' competency and training, school facilities and parent involvement

No	Items	SA		A		N		D		SD		Mean
		No	%	No	%	No	%	No	%	No	%	
1	The library is open for me during the day time	6	8.3	31	43.1	13	18.1	5	6.9	17	23.6	3.06
2	I use the library during the day time	4	5.6	13	18.1	24	33.3	17	23.6	14	19.4	2.67
3	Your school library has enough number of reference books on calculus	7	9.8	19	26.4	15	20.8	14	19.4	17	23.6	2.79

4	Your teacher is knowledgeable on calculus portions	9	12.4	22	30.6	11	15.3	20	27.8	10	13.9	3.00
5	My parents help me in order to achieve calculus portions	9	12.4	18	25.1	17	23.6	11	15.3	17	23.6	2.88
6	My parents encourage me when I do homework on calculus	7	9.7	13	18.1	21	29.2	19	26.4	12	16.6	2.78

SA- Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD- Strongly Disagree

Item 1 of table 2 indicates the majority of students 31(43.1%) responded that they agree that the library was open for me during the day time. The mean score was 3.06. This indicates that above the average the library was open for me during the day time. Item 2 of table 2 indicates the majority of students 24 (33.3%) mentioned, students were neutral that they use the library during the day time. The mean score was 2.67. This indicates that above the average students use the library during the day time.

In the same table item 3 indicates the majority of students 19 (26.4%) agree that their school library has enough number of reference books on calculus. The mean score was 2.79. This indicates that above the average school library has enough number of reference books on calculus. In the same table item 4 indicates the majority of students 22 (30.6%) agree that their teacher is knowledgeable on calculus portions. The mean score was 3.00. This indicates that above the average teacher was knowledgeable on calculus portions.

In the same table item 5 indicates the majority of students 18 (25.1%) agree that their parents help them in order to achieve calculus portions. The mean score was 2.88. This indicates that above the average parents help their students in order to achieve calculus portions. In the same table item 6 indicates the majority of students 21(29.2%) are neutral that their parents encourage them when they do homework on calculus. The mean score was 2.78. This indicates that above the average parents encourage them when they do homework on calculus.

This reveals that the majority of students' responses indicated that items related to library, teachers' competency and training, school facilities and parent involvement could affect students' scholastic achievement in learning calculus.

During the interview sessions, all of mathematics teachers said that "It is difficult to get parents to be involved in the school matters due to different reasons. For example, time constraints, lack of interest and lack of motivational activities from the school. If we tried to ask parents to apply the school advice and participate in their students' education they were not volunteer to come to school by mentioning lack of time as a reason." "In fact stakeholders participate in different decision making activities; their participation during implementation was very low. What is true is, during implementation the big burden towards managerial personnel, that means especially principals the lion share."

According to Henderson and Mapp (2002), the role of parental involvement in students' education has become a central issue in educational policy and research. Research findings support the existence of a positive relationship between parental involvement and educational success, especially in the preparatory school years. Parents play a crucial role in both the home and school environments. In general, parental involvement is associated with students' higher achievements in calculus; enrolment is more challenging programs, greater scholastic persistence, better behavior, better social skills and adaptation to school, better attendance and lower drop-out rates.

During the interview sessions, all of mathematics teachers said that "The school facilities of the schools as much not attractive due to lack of calculus learning materials (text books) and inadequate facilities such as reference books on calculus." According to Lyons (2001), stated that poor school facilities adversely impact students' effectiveness and also their performance on calculus portions.

During the interview sessions, all of mathematics teachers said that "Experienced teachers have a richer background of experience to draw from and can contribute insight and ideas to the calculus portions on teaching and learning, were open to correction and were less dictatorial in classroom. Teachers' experience and student achievement was that students

taught by more experienced teachers achieve at a higher level, because their teachers have mastered the content and acquired classroom management skills to deal with different types of classroom problems." "Furthermore, more experienced teachers were considered to be more able to concentrate on the most appropriate way to teach particular topics to students who differ in their abilities, prior knowledge and backgrounds."

According to Ankomah, Koomson, Busn and Oduro (2005), teacher determinants that have an effect on scholastic achievement include the number of teachers on post, teacher pupil ratio; teacher qualifications and the personal characteristics of the individual teacher. The personal characteristics include scholastic qualifications, pedagogical training, content training, aptitude and years of service/experience. A teacher brings these characteristics to class to facilitate the teaching- learning process.

According to Yana and Wanjohi (2011) and Adeyemi (2010), found that teachers' experience was the prime predictors of determinants that affect students' scholastic achievement in learning calculus.

4.1.2. Response related to students background knowledge on pre-calculus class

In this study, respondents were given questionnaire to indicate how much students have background knowledge in learning pre-calculus class.

Table 3: Response related to students background knowledge on pre-calculus class

No	Items	SA		A		N		D		SD		Mean
		No	%	No	%	No	%	No	%	No	%	
7	You have enough knowledge about evaluating the function at a given point	12	16.7	9	12.5	17	23.6	26	36.1	8	11.1	2.88
8	You achieve about how to sketch the graphs of a given function	13	18.1	16	22.2	16	22.2	20	27.8	7	9.7	3.11

9	You achieve about the properties of exponential functions	14	19.4	13	18.1	24	33.3	12	16.7	9	12.5	3.15
10	You have enough knowledge about trigonometric identities	8	11.1	10	13.9	19	26.4	20	27.8	15	20.8	2.67
11	You achieve about the concept of absolute value	8	11.1	12	16.7	10	13.9	23	31.9	19	26.4	2.54
12	You have enough knowledge about power function	11	15.3	17	23.6	12	16.7	18	25	14	19.4	2.90
13	You achieve about the method of simplifying rational functions	13	18.1	16	22.2	20	27.8	14	19.4	9	12.5	3.14
14	You achieve about the properties of logarithmic functions	13	18.1	14	19.4	21	29.1	13	18.1	11	15.3	3.07

SA- Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD- Strongly Disagree

Item 7 of table 3 indicates the majority of students 26(36.1%) responded they disagree that they have enough knowledge about evaluating the function at a given point. The mean score was 2.88. This indicates that above the average they have no enough knowledge about evaluating the function at a given point. Item 8 of table 3 indicates the majority of students 20 (27.8%) mentioned, they disagree that they achieve about how to sketch the graphs of a given function. The mean score was 3.11. This indicates that above the average students did not achieve about how to sketch the graphs of a given function.

Item 9 of the same table indicates the majority of students 24(33.3%) responded they were neutral that they achieve about the properties of exponential functions. The mean score was 3.15. This indicates that above the average they achieve about the properties of exponential functions. Item 10 of table 3 indicates the majority of students 20(27.8%) mentioned, they disagree that they have enough knowledge about trigonometric identities. The mean score was 2.67. This indicates that above the average students has no enough knowledge about trigonometric identities.

Item 11 of the same table indicates the majority of students 23(31.9%) responded they disagree that they achieve about the concept of absolute value. The mean score was 2.54. This indicates that above the average they did not achieve about the concept of absolute value. Item 12 of same table indicates the majority of students 18 (25%) mentioned, they disagree that they have enough knowledge about power function. The mean score was 2.90. This indicates that above the average students has no enough knowledge about power functions.

Item 13 of the same table indicates the majority of students 20(27.8%) responded they were neutral that they achieve about the method of simplifying rational functions. The mean score was 3.14. This indicates that above the average they achieve about the method of simplifying rational functions. Item 14 of same table indicates the majority of students 21 (29.1%) mentioned, they were neutral that they achieve about the properties of logarithmic functions. The mean score was 3.07. This indicates that above the average students' achieve about the properties of logarithmic functions.

This reveals that the majority of students' responses indicate that students' have no enough background knowledge on pre-calculus class. Therefore this could affect students' scholastic achievement in learning calculus.

4.1.3. Response related to students knowledge on calculus

In this study, respondents were given questionnaire to indicate how much students have knowledge in learning calculus. The table below presents and summarizes the results.

Table 4: Response related to students background knowledge on pre-calculus class

No	Items	SA		A		N		D		SD		Mean
		No	%	No	%	No	%	No	%	No	%	
15	You have enough knowledge about finding limit of a sequence at infinity	14	19.4	12	16.7	15	20.8	19	26.6	12	16.7	2.96
16	You achieve how to find limits of function	12	16.7	16	22.2	20	27.8	11	15.3	13	18	3.04

	at a given point											
17	You achieve about basic limit theorems	12	16.7	11	15.3	18	25	22	30.5	9	12.5	2.93
18	You know how to find limits of function at infinity	12	16.7	13	18.1	14	19.4	23	31.9	10	13.9	2.92
19	You have enough knowledge about the two sided limits	11	15.3	9	12.5	21	29.1	19	26.4	12	16.7	2.83
20	You have enough knowledge about continuity of a function at a point	8	11.1	10	13.9	15	20.8	25	34.7	14	19.5	2.63
21	You achieve how to check continuity of a function on an interval	7	9.7	9	12.5	12	16.7	24	33.3	20	27.8	2.43
22	You achieve about applications of limits	5	7	9	12.5	16	22.2	27	37.5	15	20.8	2.47
23	You have enough knowledge about differentiation of a function at a point	9	12.5	6	8.3	22	30.6	30	41.7	5	6.9	2.78
24	You achieve how to check differentiability of a function on an interval	13	18.1	16	22.2	14	19.4	21	29.2	8	11.1	3.07
25	You achieve about how to find the derivative of power, simple trigonometric, exponential and logarithmic functions	11	15.3	10	13.9	17	23.6	20	27.8	14	19.4	2.78
26	You have enough knowledge about how to find the derivative of combination and composition of functions	11	15.3	7	9.7	13	18.1	17	23.6	24	33.3	2.5

27	You achieve about how to find the derivative of a function by chain rule	3	4.2	10	13.9	24	33.3	16	22.2	19	26.4	2.47
28	You achieve about how to find higher order derivatives of a functions	10	13.9	9	12.5	30	41.6	12	16.7	11	15.3	2.93
29	You achieve about applications of differential calculus	9	12.5	13	18.1	5	6.9	25	34.5	20	27.8	2.53
30	You achieve that integration is the reverse process of differentiation	8	11.1	9	12.5	10	13.9	29	40.3	16	22.2	2.5
31	You achieve about how to find the integral of power, simple trigonometric, exponential and logarithmic functions	2	2.8	5	6.9	14	19.4	30	41.7	21	29.2	2.13
32	You have enough knowledge about finding the given integrals by applying techniques of integration	7	9.7	16	22.2	15	20.8	25	34.7	9	12.5	2.82
33	You achieve about applications of integral calculus	11	15.3	7	9.7	19	26.4	28	38.9	7	9.7	2.82

SA- Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD- Strongly Disagree

Item 15 of table 4 indicates the majority of students 19(26.6%) responded they disagree that they have enough knowledge about differentiation of a function at a point. The mean score was 2.96. This indicates that above the average they have no enough knowledge about differentiation of a function at a point. Item 16 of the same table indicates the majority of students 20 (27.8%) mentioned, they were neutral that they achieve how to find limits of function at a given point. The mean score was 3.04. This indicates that above the average students' achieve how to find limits of function at a given point.

Item 17 of table 4 indicates the majority of students 22(30.5%) responded they disagree that they achieve about basic limit theorems. The mean score was 2.93. This indicates that above the average they did not achieve about basic limit theorems. Item 18 of the same table indicates the majority of students 23(31.9%) mentioned, they disagree that they know how to find limits of function at infinity. The mean score was 2.92. This indicates that above the average students did not know how to find limits of function at infinity.

Item 19 of table 4 indicates the majority of students 21(29.1%) responded they were neutral that they have enough knowledge about the two sided limits. The mean score was 2.83. This indicates that above the average they have enough knowledge about the two sided limits. Item 20 of the same table indicates the majority of students 25(34.7%) mentioned, they disagree that they have enough knowledge about continuity of a function at a point. The mean score was 2.63. This indicates that above the average students has no enough knowledge about continuity of a function at a point.

Item 21 of table 4 indicates the majority of students 24(33.3%) responded they disagree that they achieve how to check continuity of a function on an interval. The mean score was 2.43. This indicates that moderate students did not achieve how to check continuity of a function on an interval. Item 22 of the same table indicates the majority of students 27(37.5%) mentioned, they disagree that they achieve about applications of limits. The mean score was 2.47. This indicates that moderate students did not achieve about applications of limits.

Item 23 of table 4 indicates the majority of students 30(41.7%) responded they disagree that they have enough knowledge about differentiation of a function at a point. The mean score was 2.78. This indicates that above the average they have no enough knowledge about differentiation of a function at a point. Item 24 of the same table indicates the majority of students 21(29.2%) mentioned, they disagree that they achieve how to check differentiability of a function on an interval. The mean score was 3.07. This indicates that above the average students did not achieve how to check differentiability of a function on an interval.

Item 25 of table 4 indicates the majority of students 20(27.8%) responded they disagree that they achieve about how to find the derivative of power, simple trigonometric, exponential and logarithmic functions. The mean score was 2.78. This indicates that above the average students did not achieve about how to find the derivative of power, simple trigonometric, exponential and logarithmic functions. Item 26 of the same table indicates the majority of students 24(33.3%) mentioned, they strongly disagree that they have enough knowledge about how to find the derivative of combination and composition of functions. The mean score was 2.5. This indicates that above the average students has no enough knowledge about how to find the derivative of combination and composition of functions.

Item 27 of table 4 indicates the majority of students 24(33.3%) responded they were neutral that they achieve about how to find the derivative of a function by chain rule. The mean score was 2.47. This indicates that moderate students' achieve about how to find the derivative of a function by chain rule. Item 28 of the same table indicates the majority of students 30(41.6%) mentioned, they were neutral that they achieve about how to find higher order derivatives of a functions. The mean score was 2.93. This indicates that above the average students' achieve about how to find higher order derivatives of a function.

Item 29 of table 4 indicates the majority of students 25(34.7%) responded they disagree that they achieve about applications of differential calculus. The mean score was 2.53. This indicates that above the average they did not achieve about applications of differential calculus. Item 30 of the same table indicates the majority of students 29(40.3%) mentioned, they disagree that they achieve that integration is the reverse process of differentiation. The mean score was 2.5. This indicates that above the average students did not achieve that integration is the reverse process of differentiation.

Item 31 of table 4 indicates the majority of students 30(41.7%) responded they disagree that they achieve about how to find the integral of power, simple trigonometric, exponential and logarithmic functions. The mean score was 2.13. This indicates that moderate students did not achieve about how to find the integral of power, simple trigonometric, exponential and logarithmic functions. Item 32 of the same table indicates the majority of students 25(34.7%)

mentioned, they disagree that they have enough knowledge about finding the given integrals by applying techniques of integration. The mean score was 2.82. This indicates that above the average students has no enough knowledge about finding the given integrals by applying techniques of integration.

Item 33 of the same table indicates the majority of students 28(38.9%) mentioned, they disagree that they achieve about applications of integral calculus. The mean score was 2.82. This indicates that above the average students did not achieve about applications of integral calculus. This reveals that the majority of students' responses indicate that students' have no knowledge on calculus. Therefore this could affect students' scholastic achievement in learning calculus.

In general from the above results and discussion the major determinants that obstruct students' scholastic achievement in learning calculus in DPS were the following:

- Items related to library, teachers' competency and training, school facilities and parent involvement
- Students' background knowledge on pre-calculus class
- Students' knowledge on calculus

4.2. Students' achievement Concepts in Pre-Calculus

In this study, the focus of the test was to determine how students achievement concepts in pre-calculus through their answer to each question in the test.

4.2.1. Students achievement function

Table 5: Summary of respondents to question 1.1, 1.2 (part 1 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
1	No	%	No	%	No	%
1.1	30	41.7	37	51.4	5	6.9
1.2	34	47.2	28	38.9	10	13.9

From Table 5 above 30(41.7%) of the students got the correct solution, while 37(51.4%) of the students have arrived at incorrect answer and 5(6.9%) of the students did not give response for question 1.1.

From Table above 34(47.2%) of the students got the correct solution, while 28(38.9%) of the students have arrived at incorrect answer and 10(13.9%) of the students did not give response for question 1.2.

1.1.The correct solution was as follows:

$f(2) = 3(2)^2 + 2(2) - 4 = 12 + 4 - 4 = 12$

Some of the incorrect solution was as follows:

- $f(2) = 3(2)^2 + 2(2) - 4 = 6 + 4 - 4 = 6$
- $f(2) = 3(2)^2 + 2(2) - 4 = 12 + 4 - 4 = 20$

1.2.The correct solution was as follows

$f(x) = -3\ when\ x = -4$

Some of the incorrect solution was as follows:

- $f(x) = -3\ when\ x = -3$
- $f(x) = -3\ when\ x = -2$

From 1.1-1.2 the following difficulties of achievement are observed:

- ✓ Students did not substitute the given value into the variable correctly
- ✓ Students did not differentiate about the value of the x-axis and y-axis

4.2.2. Students achievement absolute value

Table 6: Summary of respondents to question 1.3 (part 1 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
1	No	%	No	%	No	%
1.3	23	31.9	41	57	8	11.1

From Table 6 above 23(31.9%) of the students got the correct solution, while 41(57%) of the students have arrived at incorrect answer and 8(11.1%) of the students did not give response for question 1.3.

The correct solution was as follows

$$f(x) = |x+1| = \begin{cases} x+1, & if\ x \geq -1 \\ -(x+1), & if\ x < -1 \end{cases} = \begin{cases} x+1\ , & if\ x > -1 \\ 1\ , & if\ x = 0 \\ -(x+1), & if\ x < -1 \end{cases}$$

Some of the incorrect solution was as follows:

- $f(x) = x + 1$
- $f(x) = x + 1\ for\ x \in \mathbb{R}$

From question 1.3 the following difficulties of achievement is observed:

- ✓ Students think that numbers in the absolute value was positive only

4.2.3. Students achievement trigonometric

Table 7: Summary of respondents to question 1.4 (part 1 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
1	No	%	No	%	No	%
1.4	26	36.1	39	54.2	7	9.7

From Table 7 above 26(36.1%) of the students got the correct solution, while 39(54.2%) of the students have arrived at incorrect answer and 7(9.7%) of the students did not give response for question 1.4. Simplify $\frac{sin^4x - cos^4x}{sin^2x - cos^2x}$

The correct solution was as follows

$$\frac{sin^4x - cos^4x}{sin^2x - cos^2x} = \frac{(sin^2x - cos^2x)(sin^2x + cos^2x)}{sin^2x - cos^2x} = sin^2x + cos^2x = 1$$

Some of the incorrect solution was as follows:

- ✓ $\frac{sin^4x - cos^4x}{sin^2x - cos^2x} = sin^2x - cos^2x$
- ✓ $\frac{sin^4x - cos^4x}{sin^2x - cos^2x} = \frac{(sin^2x - cos^2x)(sin^2x - cos^2x)}{sin^2x - cos^2x} = sin^2x - cos^2x$
- ✓ $\frac{sin^4x - cos^4x}{sin^2x - cos^2x} = \frac{(sin^2x + cos^2x)(sin^2x - cos^2x)}{sin^2x - cos^2x} = \sin^2 x + \cos^2 x = 0$

From question 1.4 the following difficulties of achievement are observed:

- Students were confused about factorizing the given expression
- Students were confused with trigonometric identities

4.2.4. Students achievement logarithmic function

Table 8: Summary of respondents to question 1.5 (part 1 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
1	No	%	No	%	No	%
1.5	32	44.5	34	47.2	6	8.3

From Table 8 above 32(44.5%) of the students got the correct solution, while 34(47.2%) of the students have arrived at incorrect answer and 6(8.3%) of the students did not give response for question 1.5.

The correct solution was as follows

$$f(x) = \log_a x = \frac{lnx}{lna}, x > 0, a > 0 \; and \; a \neq 1$$

Some of the incorrect solution was as follows:

- ✓ $f(x) = \log_a x = e^x$
- ✓ $f(x) = \log_a x = e^{ax}$

From question 1.5 the following difficulties of achievement is observed:

- Students were confused about the difference between exponential and natural logarithm to the base ‘e’.

4.2.5. Students achievement rational function

Table 9: Summary of respondents to question 1.6 (part 1 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
1	No	%	No	%	No	%
1.6	34	47.2	35	48.6	3	4.2

From Table 7 above 34(47.2%) of the students got the correct solution, while 35(48.6%) of the students have arrived at incorrect answer and 3(4.2%) of the students did not give response for question 1.6.

The correct solution was as follows

$$Domain\ of\ f = \mathbb{R}\backslash\{x: x^2 - 4 = 0\} = \mathbb{R}\backslash\{x: (x-2)(x+2) = 0\}$$

$$= \mathbb{R}\backslash\{-2,2\} = (-\infty, -2) \cup (-2, 2) \cup (2, \infty)$$

Some of the incorrect solution was as follows:

- ✓ $Domain\ of\ f = \mathbb{R}\backslash\{x: x^2 - 4 = 0\} = \mathbb{R}\backslash\{x: (x-2)(x-2) = 0\} = \mathbb{R}\backslash\{2\} = (-\infty, 2) \cup (2, \infty)$
- ✓ $Domain\ of\ f = \{x^2 - 4 = 0\} = \{(x-2)(x+2) = 0\} = \{-2, 2\}$

From question 1.6 the following difficulties of achievement are observed:

- Students were confused with factorization of the given expression
- Students were confused with the difference between the vertical asymptote and domain

4.3. Students' achievement Concepts in Calculus

In this study, the focus of the test was to determine how students achievement concepts in calculus through their answer to each question in the test.

4.3.1. Students achievement limit

Despite the importance of the concept of limit in calculus most students hold incomplete achievement about limit. The analysis of students test script is a more empirical data to examine how students achievement calculus.

Table 10: Summary of respondents to question 1.1, 1.2 (part 2 see appendix III)

Item number	Alternative N=72							
	A		B		C		D	
1	No	%	No	%	No	%	No	%
1.1	8	11.1	34	47.2	12	16.7	18*	25
1.2	19	26.4	20*	27.8	5	6.9	28	38.9

*correct answer

Referring Table 10, 18 (25%) of the students got the correct answer choose D for question 1.1 while the remaining 54 (75%) did not get the correct choice of this question. Though the item

was closed ended, students were asked to write their reason of choice. Accordingly, some of the reasons given for their answers were the following:

Correct reason: 1. It is a constant sequence so it is bounded

2. Constant sequence is both increasing and decreasing

Incorrect reason:

1. $\{4\}_{n=1}^{\infty}$ is a constant sequence therefore neither increasing nor decreasing but bounded.
2. It is increasing, because as n goes to infinity, the function is increasing.
3. It is decreasing, because as n goes to infinity, the function is decreasing.

According to these reason, students' wrong answers steamed from lack of knowledge about constant sequence. In everyday life, the words decreasing/increasing hold if there is a non-zero difference between consecutive terms of a given sequence of objects, but in mathematical context decreasing/ increasing refer to non-positive/non-negative difference between each term and the preceding one of a given sequence.

Students' response to question 1.2 reveals that 20(27.8%) of them answered it correctly while the remaining 52(72.2%) did not get. From the given alternatives, the one which says 'a convergent sequence must be bounded is correct and all the rest are incorrect. Though the item was closed ended, students were asked to write their reason of choice. Accordingly, some of the reasons given for their answers were the following:

- They have the opinion that a sequence is bounded, then it has an upper and lower bound, which means it is monotonic.
- This concept missing portray that getting correct answer does not indicate students achievement of the concept matter as there are few number of students who wrote the correct reason as compared to those who got the correct choice.

Table 11: Summary of respondents to question 1.3 (part 2 see appendix III)

Item	Alternative	N=72						
number	A		B		C		D	
1	No	%	No	%	No	%	No	%
1.3	21	29.2	26	36.1	6	8.3	19*	26.4

*correct answer

Students' response to question 1.3 reveals that 19(26.4%) of them answered it correctly. These students realize that limit of a function may fail to exist for different reasons. While the remaining 53(73.6%) did not get. An interesting reason to their choice that is not correct is as follows:

1. The function left side is negative and the right side is positive. These students do not achievement that $x \to c^+$ (as x tends to c from the right) takes it as c is positive and $x \to c^-$ (as x tends to c from the left) takes it as c is negative.
2. If $\lim_{x\to c} f(x)$ does not exist, then the function has a vertical asymptote at $x = c$. This student does not achievement about the non-existence of a limit because of different left and right limit.

From question 1.3 the following difficulties of achievement are observed:

- ✓ Students are confused about the left and right hand limit, the opinion that the limit value is obtained by substitution,
- ✓ They believe that if a function has a limit at a point, then it is continues are observed over generalization that students have.

Students response for question number 1.4 (part 2 appendix III)

The aim of question 1.4 was to examine whether students clearly determine the criteria for existence of a limit or not.

Table 12: Summary of respondents to question 1.4 (part 2 see appendix III)

Item number	Alternative N=72			
	Correct		Incorrect	
1	No	%	No	%
1.4	28	38.9	44	61.1

In Table 12, only 28 (38.9%) of students have got the correct answer for this question, while 44(61.1%) did not get the answer. The correct answer is: as n goes to infinity a_n must converges to a unique real number.

Some of the incorrect answers given are as follows:

- Left and right hand side limit must be equal
- $\lim_{n\to\infty^-} a_n = \lim_{n\to\infty^+} a_n = L$

From question 1.4 the following difficulties of achievement are observed:

- ✓ Students did not achievement about the difference between the limit of sequence and the limit of function, as limit of a sequence move only in one direction and limit of function move in two direction (i.e., from the left and the right).

Students response for question number 1.5 (part 2 appendix III)

Table 13: Summary of respondents to question 1.5(part 2 see appendix III)

Item number	Alternative	N=72		
	Correct		Incorrect	
1	No	%	No	%
1.5	24	33.3	48	66.7

From table 13 above 24(33.3%) of the students described the answer correctly and 48(66.7%) of the students did not describe the answer correctly.

Some of the correct answer descriptions were as follows:

- As x approaches to 'c' from the right and from the left if f has the same result 'L'
  i.e., $\lim_{x\to c^+} f(x) = \lim_{x\to c^-} f(x) = L$
- The value of f gets closer and closer to a number L as the value of x approaches to c. However, not equal to c.
- When x approaches to c but does not equal to c, if the value of f is the same number L.

Some of the incorrect answer descriptions were as follows:

- When x closer to c , then the function closer to L.
- As x approaches to c , then their exist a number L.
- $\lim_{x\to c} f(x) = L$.

From question 1.5 the following difficulties of achievement are observed:

- ✓ Students did not differentiate about the difference between symbol and meaning, as $\lim_{x\to c} f(x) = L$ is nothing but a symbol used to abbreviate the phrase 'the limit of f(x) as x approaches to c is L.

Students response for question number 1.6 (part 2 see appendix III)

Table 14: Summary of respondents to question 1.6(part 2 see appendix III)

Item number 1	Alternative N=72			
	Correct		Incorrect	
	No	%	No	%
1.6a	50	69.4	22	30.6
1.6b	20	27.8	52	72.2

Referring to Table 14 above, 50(69.4%) of the students had answered and 22(30.6%) students did not answer question 1.6a. There was a big difference between numbers of students who got the answer correctly and those who did not get the answer. The fact behind question 1.6a could be answered was they substitute the value into the function directly.

Some of the correct answers were as follows:

- $\lim_{x\to 1} \frac{\sqrt{x^2+4}+2}{x^2} = \frac{\sqrt{1^2+4}+2}{1^2} = \frac{\sqrt{5}+2}{1} = \sqrt{5}+2$
- $\lim_{x\to 1} \frac{\sqrt{x^2+4}+2}{x^2} = \lim_{x\to 1} \frac{(\sqrt{x^2+4}+2)(\sqrt{x^2+4}-2)}{x^2(\sqrt{x^2+4}-2)}$

$$= \lim_{x\to 1} \frac{x^2+4-4}{x^2(\sqrt{x^2+4}-2)} = \lim_{x\to 1} \frac{x^2}{x^2(\sqrt{x^2+4}-2)}$$

$$= \lim_{x\to 1} \frac{1}{(\sqrt{x^2+4}-2)} = \frac{1}{\sqrt{1^2+4}-2} = \frac{1}{\sqrt{5}-2} = \frac{1(\sqrt{5}+2)}{\sqrt{5}-2(\sqrt{5}+2)} = \frac{\sqrt{5}+2}{5-4} = \sqrt{5}+2$$

This is possible in both ways.

Some of the incorrect answers were as follows:

- $\lim_{x\to 1}\frac{\sqrt{x^2+4}+2}{x^2}=\frac{\sqrt{1^2+4}+2}{1^2}=\frac{\sqrt{5}+2}{1}=\sqrt{7}$
- $\lim_{x\to 1}\frac{\sqrt{x^2+4}+2}{x^2}=\frac{\sqrt{1^2}+4+2}{1^2}=\frac{1+6+2}{1}=9$
- $\lim_{x\to 1^+}\frac{\sqrt{x^2+4}+2}{x^2}=\frac{\sqrt{1^2+4}+2}{1^2}=\frac{\sqrt{5}+2}{1}=\sqrt{5}+2\ and$
- $\lim_{x\to 1^-}\frac{\sqrt{x^2+4}+2}{x^2}=\frac{\sqrt{(-1)^2+4}+2}{(-1)^2}=\frac{\sqrt{3}+2}{-1}=-\left(\sqrt{3}+2\right)$

$\lim_{x\to 1^-} h(x)\neq\lim_{x\to 1^+} h(x)$

∴ limit of h(x) does not exist.

Referring to Table 14 above, 20(27.8%) of the students had answered and 52(72.2%) students did not answer question 1.6b. There was a big difference between numbers of students who got the answer correctly and those who did not get the answer correctly. The fact behind question 1.6b could not be answered was they could not substitute the value of x into the function directly.

The procedure to get the correct answer was as follows:

$sin^2x+cos^2x=1\Longrightarrow cos^2x-1=-sin^2x$

$sin2x=\sin(x+x)=sinxcosx+cosxsinx=2sinxcosx$

$\lim_{x\to 0}\frac{cos^2x-1}{sin2x}=\lim_{x\to 0}\frac{-sin^2x}{2sinxcosx}=\lim_{x\to 0}\frac{-sinx}{2cosx}$

$=\frac{-sin0}{2cos0}=\frac{0}{2(1)}=0$

∴ $\lim_{x\to 0}\frac{cos^2x-1}{sin2x}=0$

Some of the incorrect answers were as follows

- $\lim_{x\to 0}\frac{cos^2x-1}{sin2x}=\lim_{x\to 0}\frac{cos^20-1}{sin2(0)}=\frac{1-1}{0}=\frac{0}{0}\Longrightarrow It\ does\ not\ exist$
- $\lim_{x\to 0}\frac{cos^2x-1}{sin2x}=\lim_{x\to 0}\frac{sin^2x}{2sinx}=\frac{sin^20}{2sin0}=\frac{1}{2(1)}=\frac{1}{2}$

From question 1.6 the following difficulties of achievement are observed:

- ✓ These imply that many students did not have enough knowledge about the properties of trigonometric identities.
- ✓ The disparity made in the number of respondents in questions 1.6a and 1.6b could be explained by the fact that students see limit at a point by using substitution in place of the variable. In addition, I have observed a generalization from their computation that rationalizing seems must do when the radical is involved in the limit.

4.3.2. Students achievement continuity

Table 15: Summary of respondents to question 2 (part 2 see appendix III)

Item number	Alternative N=72			
	Correct		Incorrect	
2	No	%	No	%
2	18	25	54	75

The aim of this question was to examine whether students relate the idea of limit and continuity or not. Students could apply the idea of one-sided limit at a point to answer this question. The question is to find the value of k so that the function f is continues at 0.

From Table 15 above 18 (25%) of the students got the answer correctly and 54(75%) of the students did not get the answer correctly.

The correct answer was as follows:

$$\lim_{x\to 0^-} \frac{tankx}{x} = f(0)$$

$$\lim_{x\to 0^-} \frac{sinkx}{xcoskx} = 3(0) + 2k^2$$

$$\lim_{x\to 0^-} \frac{sinkx}{x} \lim_{x\to 0^-} \frac{1}{coskx} = 2k^2$$

$$\lim_{x\to 0^-} k\frac{sinkx}{kx} \lim_{x\to 0^-} \frac{1}{coskx} = 2k^2$$

$$k \lim_{x\to 0^-} \frac{sinkx}{kx} \frac{1}{cos0} = 2k^2$$

$k(1)(1) = 2k^2$

$k(2k - 1) = 0$

$k = 0 \; or \; k = \frac{1}{2}$

$\therefore$ Only $k = \frac{1}{2}$ since $k \neq 0$

Some of the incorrect answers were as follows:

- $\lim_{x\to 0} \frac{tankx}{x} = f(0) \Rightarrow \frac{tan0}{0} = 0$

  $0 = 0$

They said that the solution does not exist.

- $\lim_{x\to 0} \frac{sinkx}{xcoskx} = 2k^2$

$\lim_{x\to 0} \frac{sinkx}{x} \lim_{x\to 0} \frac{1}{coskx} = 2k^2$ $\Rightarrow 1(1) = 2k^2$

$k = \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$

From question 2 the following difficulties of achievement are observed:

- ✓ Many students missed about trigonometric identities
- ✓ Some of them missed about basic limit application.
- ✓ Thus, students' about the idea of continuity is affected by their knowledge of trigonometric identities and application of limit.

4.3.3. Students achievement derivative concept

Table 16: Summary of respondents to question 3.1 (part 2 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
3	No	%	No	%	No	%
3.1.i	25	34.7	40	55.6	7	9.7
3.1.ii	22	30.6	41	56.9	9	12.5
3.1.iii	24	33.3	32	44.5	16	22.2

From Table 16 above 25(34.7%) of the students got the correct solution, while 40(55.6%) of the students have arrived at incorrect answer and 7(9.7%) of the students did not give response for question 3.1.i.

From Table 16 above 24(33.3%) of the students got the correct solution, while 32(44.5%) of the students have arrived at incorrect answer and 16(22.2%) of the students did not give response for question 3.1.ii.

From Table 16 above 22(30.6%) of the students got the correct solution, while 41(56.9%) of the students have arrived at incorrect answer and 9(12.5%) of the students did not give response for question 3.1.ii.

i. The correct procedure to obtain the solution was as follows:

$f'(x) = x'(x-1)^2 + x[(x-1)^2]'$

$= (x-1)^2 + 2x(x-1)$

$= x^2 - 2x + 1 + 2x^2 - 2 = 3x^2 - 4x + 1$ or

$f(x) = x(x-1)^2 = x(x^2 - 2x + 1) = x^3 - 2x^2 + x$

Therefore $f'(x) = (x^3 - 2x^2 + x)'$

$= (x^3)' - 2(x^2)' + x' = 3x^2 - 4x + 1$ which is the same as before.

Some of the incorrect solutions are:

- $f'(x) = x'[(x-1)^2]' = 2(x-1) = 2x - 2$
- $f'(x) = x[(x-1)^2]' = 2x(x-1) = 2x^2 - 2x$

ii. The correct solution was as follows:

$f'(0) = 3(0)^2 - 4(0) + 1 = 0 + 1 = 1$

The incorrect solution was as follows:

- $f'(0) = 2(0) - 2 = -2$
- $f'(0) = 2(0)^2 - 2(0) = 0$

iii. The correct solution was as follows:

The equation of tangent line to f was obtained by the following procedure:

$y - f(0) = f'(0)(x - 0)$

$y - 0 = 1(x - 0)$

$y = x$ is the equation of tangent line for f.

The incorrect solution was as follows:

$y - f(0) = f'(0)(x - 0)$

Some of them give the solution as

$y - f(0) = f'(0)(x - 0)$

$y - 0 = -2(x - 0)$

y = -2x

The other of them gives the solution as

$y - f(0) = f'(0)(x - 0)$

$y - 0 = 0(x - 0)$

y = 0

From question 3.1 the following difficulties of achievement are observed:

- The derivative achievement of the students would be determined by the number of different possible starting points that the learner may have in solving a problem whereas the depth may be evidenced by the way the learners can unpack each stage of their solution in more detail by referring to more concepts on derivatives. Furthermore in Kolisto(2005) a learner who is aware of all the possibilities of equivalently representing a given expression is said to have a breadth achievement. In light of the above fact, a few students have applied the sum and product rule instead of using product and chain rule. However, I have observed that students have series lack of depth achievement.
- The other observed idea is that students considered derivative of a function, which is obtained by using the formula. Most of the students might think that equation of a tangent line to the given function is obtained by similar formula of equation a line passing through two points.

Generally, from 3.i-3.iiithe following difficulties of achievement are observed:

- ✓ Some students started the solution correctly and ended with incorrect result; due to problem of algebraic manipulation
- ✓ Confusing the difference between equation of line and slope of line.

The aim of question 3.2 was to examine whether students understood derivative of function by quotient rule and chain rule.

Table 17: Summary of students' response to question 3.2 (part 2 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
3	No	%	No	%	No	%
3.2i	18	25	45	62.5	9	12.5
3.2ii	16	22.2	48	66.7	8	11.1

From Table 17 above 18(25%) of the students got the correct solution, while 45(62.5%) of the students have arrived at incorrect answer and 9(12.5%) of the students did not give response for question 3.2.i.

From Table 17 above 16(22.2%) of the students got the correct solution, while 48(66.7%) of the students have arrived at incorrect answer and 8(11.1%) of the students did not give response for question 3.2.ii.

i. The correct procedure to obtain the solution was as follows:

$$g'(x) = \frac{(x+1)'\left(\sqrt{x^2+2x+3}\right)-(x+1)\left(\sqrt{x^2+2x+3}\right)'}{\left(\sqrt{x^2+2x+3}\right)^2}$$

$$= \frac{\sqrt{x^2+2x+3}-(x+1)\frac{(x^2+2x+3)'}{2\sqrt{x^2+2x+3}}}{x^2+2x+3} = \frac{x^2+2x+3-(x+1)(x+1)}{(x^2+2x+3)\left(\sqrt{x^2+2x+3}\right)}$$

$$= \frac{2}{\left(\sqrt{x^2+2x+3}\right)^3} = \frac{2}{(x^2+2x+3)^{\frac{3}{2}}} = 2(x^2+2x+3)^{-\frac{3}{2}}$$

Some of the incorrect solutions are:

- ➢ $g'(x) = \frac{(x+1)'}{\left(\sqrt{x^2+2x+3}\right)'} = \frac{1}{\frac{1}{2\left(\sqrt{x^2+2x+3}\right)}} = 2\sqrt{x^2+2x+3}$

- $g'(x) = \frac{(x+1)'\left(\sqrt{x^2+2x+3}\right)-(x+1)\left(\sqrt{x^2+2x+3}\right)'}{\left(\sqrt{x^2+2x+3}\right)^2}$

$$g'(x) = \frac{\sqrt{x^2+2x+3}-(x+1)\frac{1}{2\sqrt{x^2+2x+3}}}{x^2+2x+3} = \frac{2(x^2+2x+3)-(x+1)}{2(x^2+2x+3)\left(\sqrt{x^2+2x+3}\right)}$$

$$= \frac{2x^2+3x+5}{2\left(\sqrt{x^2+2x+3}\right)^3}$$

ii. The correct solution was as follows:

$$g'(3) = \frac{2}{\left(\sqrt{3^2+2(3)+3}\right)^3} = \frac{2}{\left(\sqrt{18}\right)^3} = \frac{2}{54\sqrt{2}} = \frac{1}{27\sqrt{2}} = \frac{\sqrt{2}}{54}$$

Some of the incorrect solutions are:

- $g'(3) = 2\sqrt{3^2+2(3)+3} = 2\sqrt{18} = 6\sqrt{2}$
- $g'(3) = \frac{2(3)^2+3(3)+5}{2\left(\sqrt{3^2+2(3)+3}\right)^3} = \frac{32}{2\sqrt{18}} = \frac{16}{3\sqrt{2}} = \frac{16\sqrt{2}}{6} = \frac{8\sqrt{2}}{3}$
- $g'(3) = \frac{3+1}{\sqrt{3^2+2(3)+3}} = \frac{4}{\sqrt{18}} = \frac{4}{9\sqrt{2}} = \frac{4\sqrt{2}}{9}$

The following difficulties of achievement were observed:

- ✓ Confusing on applying derivative by using quotient rule
- ✓ Confusing on applying the derivative by chain rule
- ✓ Confusing on rationalizing square root expression to eliminate radical from the denominator

4.3.4. Students achievement integration concept

The purpose of question 4.1 was to asses to what extent students' achievement about finding the integration of the given function by some techniques of integration.

Table 18: Summary of students' response to question 4.1 (part 2 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
4	No	%	No	%	No	%
4.1a	23	32	42	58.3	7	9.7
4.1b	22	30.6	44	61.1	6	8.3

From Table 18 above 23(32%) of the students got the correct solution, while 42(58.3%) of the students have arrived at incorrect answer and 7(9.7%) of the students did not give response for question 4.1a.

From Table 18 above 22(30.6%) of the students got the correct solution, while 44(61.1%) of the students have arrived at incorrect answer and 6(8.3%) of the students did not give response for question 4.1b.

a. The correct procedure to obtain the solution was as follows:

$\int f(x)dx = \int x^2 lnxdx$

Using integration by part

Let $u = lnx$ $\quad dv = x^2dx$

$du = \frac{1}{x}$ $\quad v = \frac{x^3}{3}$

$\int udv = uv - \int vdu$

$\int x^2 lnxdx = \frac{x^3}{3}lnx - \int \frac{1}{x}(\frac{x^3}{3})dx = \frac{x^3}{3}lnx - \frac{1}{3}\int x^2dx$

$= \frac{x^3}{3}lnx - \frac{x^3}{9} + c$

Some of the incorrect solutions are:

- $\int x^2 lnxdx = \frac{x^3}{3}\left(\frac{1}{x}\right) = \frac{x^2}{3} + c$
- $\int x^2 lnxdx = 2x\left(\frac{1}{x}\right) = 2 + c$

b. The correct solution was as follows:

$\int_1^3 f(x)dx = \int_1^3 x^2 lnxdx = \left[\frac{x^3}{3}lnx - \frac{x^3}{9}\right]_1^3$

$= \frac{3^3}{3}ln3 - \frac{3^3}{9} - \left(\frac{1^3}{3}ln1 - \frac{1^3}{9}\right) = 9ln3 - 3 + \frac{1}{9}$

$= 9ln3 - \frac{26}{9}$

Some of the incorrect solutions are:

- $\int_1^3 f(x)dx = \int_1^3 x^2 lnxdx = \left[\frac{x^3}{3}lnx - \frac{x^3}{9}\right]_1^3$

$= \frac{1^3}{3}ln1 - \frac{1^3}{9} - \left(\frac{3^3}{3}ln3 - \frac{3^3}{9}\right) = \frac{-1}{9} - 9ln3 + 3 = \frac{26}{9} - 9ln3$

- $\int_1^3 f(x)dx = \int_1^3 x^2 lnxdx = \left[\frac{x^2}{3}\right]_1^3 = \frac{3^2}{3} - \frac{1^2}{3} = 9 - \frac{1}{3} = \frac{26}{3}$
- $\int_1^3 f(x)dx = \int_1^3 x^2 lnxdx = [2]_1^3 = 2 - 2 = 0$

The following difficulties of achievement were observed:

- ✓ Confusing on applying integration by part to find this integral
- ✓ Confusing on the difference between differentiation and integration
- ✓ Confusing on manipulation of the obtained integral on the given limits

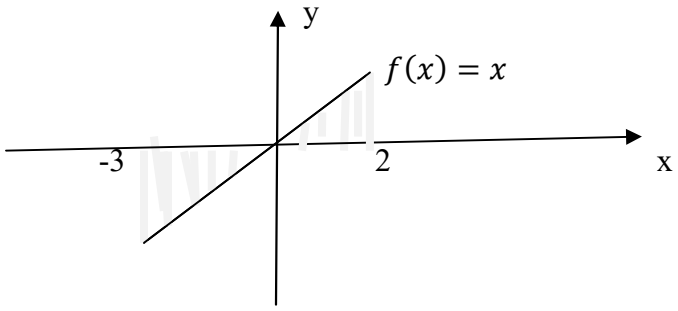
The purpose of question 4.2 was to asses to what extent students' achievement about applications of integration to find the area of the given region.

Table 19: Summary of students' response to question 4.2 (part 2 see appendix III)

Item number	Alternative	N=72				
	Correct		Incorrect		Non- respondent	
4	No	%	No	%	No	%
4.2	19	26.4	49	68	4	5.6

From Table 19 above 19(26.4%) of the students got the correct solution, while 49(68%) of the students have arrived at incorrect answer and 4(5.6%) of the students did not give response for question 4.2.

The correct procedure to obtain the solution was as follows:
Sketch the graph of $f(x) = x$ on x$\in [-3, 2]$



Area of the shaded region = $-\int_{-3}^{0} f(x)dx + \int_{0}^{2} f(x)dx$

$$= -\int_{-3}^{0} xdx + \int_{0}^{2} xdx = -\left[\frac{x^2}{2}\right]_{-3}^{0} + \left[\frac{x^2}{2}\right]_{0}^{2}$$

$$= -\left[\frac{0^2}{2} - \frac{(-3)^2}{2}\right] + \left[\frac{2^2}{2} - \frac{(0)^2}{2}\right] = \frac{9}{2} + 2 = \frac{13}{2} = 6.5\ square\ unit$$

Some of the incorrect solutions are:

- ✓ Area of the shaded region = $\int_{-3}^{2} f(x)dx = \int_{-3}^{2} xdx = \left[\frac{x^2}{2}\right]_{-3}^{2} = \left[\frac{2^2}{2} - \frac{(-3)^2}{2}\right]$

$$= 2 - \frac{9}{2} = \frac{4-9}{2} = \frac{-5}{2} = -2.5\ square\ unit$$

- ✓ Area of the shaded region = $\int_{-3}^{2} f(x)dx = \int_{0}^{2} xdx = \left[\frac{x^2}{2}\right]_{0}^{2} = \left[\frac{2^2}{2} - \frac{(0)^2}{2}\right] = 2$

The following difficulties of achievement were observed:

- Confusing on below the x-axis is negative and above the x-axis is positive
- Confusing on the given interval is not as its domain

From teachers interview the following ideas on the nature of a calculus were identified:

- Students see calculus as unreachable portion.
- Students see calculus portion as an approximation.
- Students view calculus as a dynamic process and not as a static object.

From all the above results and discussions the researcher observed that students calculus achievement were very low because of students background knowledge on pre-calculus were very low. This condition was happened from the students' negative attitude towards calculus since they here that calculus was the most difficult portion from mathematics. So in order to bring students positive attitude towards calculus the researcher taught tutorial class by separating high achiever, medium achiever and low achiever students for many times. After that students' attitude towards calculus becomes positive to the portion.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The main purpose of this study was to identify determinants of students' scholastic achievement in learning calculus in DPS. To address this study the following three research questions were formulated.

1. What are the major determinants that significantly obstruct the students' scholastic achievement in learning calculus in DPS?
2. How do students achieve the idea of calculus in DPS?
3. What are their difficulties to achieve calculus concept in DPS?

In order to deal with these research questions, the related literature had properly reviewed. There is one preparatory school in this town, 72 students from grade 12 and 3 mathematics teachers were selected for this study. Since the respondents were properly oriented, there was no vague response from the respondent. Hence no respondent was rejected. Therefore all the respondents were involved. In seeking answer for the research question the researcher employed three instruments of data collection: Achievement test, Likert scale questionnaire and interview. Initial, the questionnaires for students were administered on a pilot test. Based on these items analysis was carried out and the instruments were improved. The questionnaire was mainly focused on:

i. Items related to Library, teachers' competency and training, school facilities and parent involvement.
ii. Items related to students background knowledge on pre-calculus
iii. Items related to students knowledge on calculus

On Likert-type five points rating scale. The data collected had analyzed quantitatively using mean and percentage and qualitatively narrated in words in the descriptive survey method. Mean and percentage score was applied to compare determinants that affect students' scholastic achievement in learning calculus.

The focus of the achievement test was to identify students' achievement concept in calculus through their answer to each question in the test. The test was categorized as: Students

achievement in pre-calculus concept, students' achievement in limit concept, students' achievement in continuity concept, students' achievement derivative concept and students' achievement integration concept. In addition to these items related to determinants of students' scholastic achievement in learning calculus which contain: items related to library, teachers' competency and training, school facilities and parent involvement, items related to students' background knowledge on pre-calculus class, items related to students' knowledge on calculus were assed.

The data analysis and data interpretation shed some light on the ways in which students think about pre-calculus and calculus. The findings of this study show that many students' knowledge and achievement rest largely on isolated facts and procedures that their conceptual achievement of functions, limits, continuity, derivatives and integrals is deficient. The researcher ought to become aware of their determinants of students' calculus achievement. Diagnosing the nature of students' conceptual problems enables the researcher to develop specific teaching strategies to address such problems and to enhance conceptual achievement.

The outstanding students were that they see calculus as unreachable. This could be due to the language used in many books to describe calculus portions for example 'tends to' and 'approaches'. These words are verbs or action words and as Lauten (2010) describes, the action in this mathematical setting is 'getting to or closer to' sets up a dynamic interpretation of a calculus. These words represent a movement towards a point without ever getting there. This explains the dynamic view of the majority of students that a calculus is a process and not as static object.

5.2. Conclusions

Based on the findings of the study it is reasonable to draw the following conclusions:

1. What are the major determinants that significantly obstruct the students' scholastic achievement in learning calculus in DPS?

In general from the above results the major determinants that obstruct students scholastic achievement in learning calculus in DPS was the following:

i. Items related to library, teachers' competency and training, school facilities and parent involvement
ii. Students' background knowledge on pre-calculus class
iii. Students' knowledge on calculus

2. How do students achieve the idea of calculus in DPS?

Students' achieve the idea of calculus in the following way:

- ✓ Students see calculus as unreachable portion.
- ✓ Students see calculus portion as an approximation.
- ✓ Students view calculus as a dynamic process and not as a static object.

3. What are their difficulties to achieve calculus concept in DPS?

Some of the difficulties of calculus achievement in DPS were as follows:

- ✓ Students were confused about the left and right hand limit
- ✓ They believe that if a function has limit at a point , then it is continues at that point
- ✓ Students did not achievement about the difference between the limit of a sequence and the limit of function
- ✓ Students did not differentiate about the difference between symbol and meaning
- ✓ Students always see limit of a function at a point by using substitution in place of the variable
- ✓ The idea of continuity is affected by students knowledge on trigonometric identities and application of limit
- ✓ Some students started the solution correctly and ended with incorrect result; due to problem of algebraic manipulation
- ✓ Students confused about the difference between equation of line and slope of a line
- ✓ Students were confused to find the derivative of a given function by using one of the rule
- ✓ Students were confused to find integration of the given function by one/more of techniques

Generally, findings of this study are indicated that: Items related to library, teachers' competency and training, school facilities and parent involvement, students' background knowledge on pre-calculus, students' knowledge on calculus were some of the determinants of

students' scholastic achievement in learning calculus in DPS. Thus the finding in this study was consistent with the research literature. Finally this study cannot be considered perfect and final; the findings seem to have some practical implication to calculus education and future direction of the research.

In a situation where such educational research is scarce, research of this kind can contribute to an understanding of why differences occur in scholastic calculus achievement. It is hoped that results of this study will provide the necessary basis for calculus designers, teachers, principals and vice-principals to realize the magnitude of the problem and design viable and effective community-based intervention measures for mitigating the problem under consideration.

5.3. Recommendations

From the result obtained and conclusions made the author would like to forward the following recommendations:

- Teachers and key stakeholders would work hand in hand to improve students pre-calculus and calculus achievement and provide supplementary materials such as reference books which help students on pre-calculus and calculus portions.
- Teachers would support students in calculus achievement at all levels of the APOS framework and applying the definition of calculus portions must also be an area of improvement in mathematics courses.
- It is recommended to calculus curriculum designers regularly evaluate, revise and design by identifying the problems to work on improving the status of students learning calculus from the lower level of the country's educational system.
- It is recommended for mathematics teachers would revise the concepts of pre-calculus for students before he/she starts the lesson calculus portions.
- It is recommended for mathematics teachers that much more emphasis be placed on functions in classes prior to calculus in order for all students' achievement in learning calculus to be successful.
- Finally, this study was conducted on one preparatory school and it might be a pointer in such directions. It would have been comprehensive if more schools had been included in the study.

6. REFERENCES

Abdisa Haji. 2013. Determinants affecting land resource management in Adama woreda. Unpublished master thesis Adama science and Technology University.

Ademe Mekonen and Gebre Behute. 2000. The impact of objective type test on the learning process of high school mathematics. *The Ethiopian journal of education*

Adeyefa A.S. 2012. Under-achievement of learners in Mathematics due to perversion in methodology: the case of quadratic equation, Submitted

Adeyemi, B. 2010. Teacher Related Determinants as Correlates of Pupils Achievement in Social Studies in South West Nigeria. *Electronic journal of Research in Educational Psychology*

Akkus, R., Hand, B., & Seymour, J. 2008. Students' achievement of functions. Mathematics Teaching Incorporating Micromath

Andualem Melesse. 2006. Social interaction in calculus class room a case study of city preparatory school. Published master thesis, Addis Ababa University.

Ankomah, Y., Koomson, J., Bosu, R., and Oduro, G. K. 2005. Implementing Quality Education in Low Income Countries. Institute for Educational Planning and Administration (IEPA) University of Cape Coast Ghana.

Artigue, M. 2008. Analysis in D. Tall Advanced mathematical Thinking. Boston: Kluwer

Basit, A. 2005. Classroom Management Techniques at Secondary Level and Developing a Model for Urban Schools for District Peshawar

Bezuidenhout, J. 2001. Limits and Continuity: Some Conceptions of First-year Students in *International Journal of Mathematical Education in Science and Technology*

Breidenbach, D., Dubinsky, E., Hawks, J., & Nichols, D. 2008. Development of the process conception of function. Educational Studies in Mathematics

Carlson, M., Oehrtman, M., & Engelke, N. 2010. The pre-calculus concept assessment: a tool for assessing students' reasoning abilities and achievement. Cognition and Instruction

Clement, L.L. 2001. What do students really know about functions? Connecting Research to Teaching

Cornu, B. 2008. Calculus in Advanced Mathematical Thinking, edited by Tall, D. ME Library: Kluwer Scholastic Press

Creswell, J.W. 2008. Research design: qualitative, quantitative and mixed methods approach 3rd edition. Los Angeles University of Nebraska-Lincoln.

Darling Hammond. 2014. Does teacher Certification matter? Valuating the evidence. Educational Evaluation and Policy Analysis

Desforges, C. and Abouchaar, A. 2003. The Impact of Parental Involvement, Parental Support and Family Education on Pupil Achievement and Adjustment

Dreyfus, T. and Eisenberg, T. 2007. The Function Concept in College Students: Linearity, Smoothness and Periodicity in Focus on Learning Problems in Mathematics

Duncan son, E. 2005. Classrooms are not roadways. They are parking lots! The Science Teachers Bulletin.

Education Matters. 2008. Student achievement in mathematics – the roles of attitudes, perceptions and family background. Retrieved 26 June 2010 from Education Matters Available.

Finney, RL & Thomas, G.B. 2008. Calculus 2nd Ed. Addison-Wesley Publishing Company

Habre, S. & Abboud, M. 2006. Students' conceptual achievement of a function and its derivative in an experimental calculus course. *Journal of Mathematical Behavior*

Hardy, I. & Smith, E. 2006. 'Contesting Tertiary Teaching Qualification: An Australian Perspective' Teaching in Higher Education

Henderson, A. T. and Mapp, K. L. 2002. A new wave of evidence: The impact of school, family and community connections on student achievement. Annual synthesis.

Hiebert, J. & Carpenter, T. P. 2011. Learning and teaching with achievement. In D. Grouws handbooks for research in mathematics teaching and learning

Higgins, S., Hall, E., Wall, K., Woolner, P.& Mc Caughey, C. 2004. The Impact of School Environments: A literature review, The Centre for Learning and Teaching, School of Education, Communication and Language Science, University of Newcastle.

Hussain, I., Ahmad, M., Ahmad, S., Suleman, Q., Din, M. Q. & Khalid, N. 2012. A Study to Investigate the Availability of Educational Facilities at Secondary School Level in District Karak

Kolisto,M. 2005. Epistemological obstacles in coming to achievement the limit concept undergraduate level

Lauten, AD, Graham, K & Ferrini Mundy, J. 2010. Student Achievement of Basic Calculus Concepts: *Interaction with the Graphics Calculator in Journal of Mathematical Behaviors*

Lyons, J. B. 2001. Do school facilities really impact a child's education? CEFPI Brief Issue Track.

Martin,M., and Mullis, .2000. Elective schools in science and mathematics. Massachusetts: Boston College

Ministry of Education (MoE). 2005. Educational statistics Annual Abstract 2000/2001. MoE.Addis Ababa, Ethiopia.

Oehrtman, M., Carlson, M., Thompson, P.W. 2008. Foundational reasoning abilities that promote coherence in students' function achievement. In M. Carlson & C. Rasmussen (Eds.) Making the Connection: Research and Teaching in Undergraduate Mathematics Education

Pekrun, R., Goetz, T., Tiz, W. and Perry, R.P. 2002. Scholastic emotions in students' self regulated learning and achievement: A program of qualitative and quantitative research. Educational Psychology

Philip, H. 2000. The Evaluation of quality in Education. Paris

Rosetta Zen and Petro Di Martino. 2007. Attitudes towards calculus overcoming the positive/negative dichotomy in Italy

Ruthland, S. K. and Bremer, C. D. 2002. 'Alternative Teacher Certification Procedures and Professional Development Opportunities for Career and Technical Education Teachers' Washington D.C. ERIC Clearing house on Teacher Education.

Salas, G.L. and Hille, E. 2010. Calculus One and several variables, 6th Edition. New York: John Wiley and Sons.

Salazar, D. A. 2014. Salazar's Grouping Method: Effects on Students' Achievement in Integral Calculus. *Journal of Education and Practice*

Serhan, D. 2006. The effect of graphing calculators use on students' achievement of the derivative at a point. *International Journal for Mathematics Teaching and Learning.*

Singh, Y.K. 2014. Fundamentals of Research Methodology and Statistics. Ansan Road: New Age International Pvt Ltd Publishers.

Stewart, J. 2010. Calculus, Seventh Edition, Cengage Learning.

Tadesse Mengistu. 2006. Gender differences in calculus achievement and self-concept at fifth, sixth, seventh and eighth grades: The case of Gonder town.

Tall, D. 2006. Students' Difficulties in Calculus. Proceedings of Working Group

UNESCO. 2008. Education and Teachers Qualification in Ethiopia. Retrieved on 13-07-2009. URL:http://www.unesco.org.

Yala, P. O. and Wanjohi, W. C. 2011. Performance Determinants of KCSE in Mathematics in Secondary Schools in Nyamira Division, Kenya. Asian Social Science

Appendix- I: Questionnaire to be filled by Students in DPS

HARAMAYA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF MATHEMATICS

General direction

I would like to express my appreciation for your time and cooperation, in advance, to fill this questionnaire. The purpose of this questionnaire is to collect information regarding "On determinants of students' scholastic achievement in learning calculus in Degem Preparatory School." The information to be obtained through questionnaire is going to be used for research undertaking. So, you are genuine, frank and timely response is quite vital to determine the success of this study. Therefore, I kindly request your cooperation in filling the questionnaire honestly and responsibly.

- ✓ No need of writing your name.
- ✓ The information you give will be kept confidential and used only for this study.
- ✓ There is nothing "Right" or "Wrong" answer here and rather what is required is to show the level of your personal opinion to each item.
- ✓ Please, think how you feel about each item. Tick either in the appropriate boxes or enter a words/phrases where required.

Thank you in advance.

I. Personal information of the respondents'

Instruction: The items from 1-4 in this section request personal information.

1. Name of school _____

2. Sex: Male □ Female □

3. Age: 19-20 years □ Above 20 years □

4. Grade 12_____

II. Items related to determinants of students' scholastic achievement in learning calculus

Instruction:-The following items indicate dents/ hollow areas/ that contribute to students' scholastic achievement in learning calculus. Each item is to be responded by selecting the most appropriate response from the five alternatives scale. 1-for strongly disagree, 2- for disagree, 3- for neutral, 4- for agree and 5- for strongly agree

Please respond by marking a tick "√" against the response you think most appropriate

No	Items	5	4	3	2	1
I	**Items related to Library, teachers competency and training, school facilities and parents involvement**					
1	The library is open for me during the day time					
2	I use the library during the day time					
3	Your school library has enough number of reference books on calculus					
4	Your teacher is knowledgeable on calculus portions					
5	My parents help me in order to achieve calculus portions					
6	My parents encourage me when I do homework on calculus					
II	**Items related to students background knowledge on pre-calculus class**					
7	You have enough knowledge about evaluating the function at a given point					
8	You achieve about how to sketch the graphs of a given function					
9	You achieve about the properties of exponential functions					
10	You have enough knowledge about trigonometric identities					
11	You achieve about the concept of absolute value					
12	You have enough knowledge about power function					
13	You achieve about the method of simplifying rational functions					
14	You achieve about the properties of logarithmic functions					
	Items related to students knowledge to achievement calculus					
15	You have enough knowledge about finding limit of a sequence at infinity					
16	You achieve how to find limits of function at a given point					

17	You achieve about basic limit theorems					
18	You know how to find limits of function at infinity					
19	You have enough knowledge about the two sided limits					
20	You have enough knowledge about continuity of a function at a point					
21	You achieve how to check continuity of a function on an interval					
22	You achieve about applications of limits					
23	You have enough knowledge about differentiation of a function at a point					
24	You achieve how to check differentiability of a function on an interval					
25	You achieve about how to find the derivative of power, simple trigonometric, exponential and logarithmic functions					
26	You have enough knowledge about how to find the derivative of combination and composition of functions					
27	You achieve about how to find the derivative of a function by chain rule					
28	You achieve about how to find higher order derivatives of a functions					
29	You achieve about applications of differential calculus					
30	You achieve that integration is the reverse process of differentiation					
31	You achievement about how to find the integral of power, simple trigonometric, exponential and logarithmic functions					
32	You have enough knowledge about finding the given integrals by applying techniques of integration					
33	You achieve about applications of integral calculus					

Appendix-II: Interview Guides for Mathematics Teachers in DPS

HARAMAYA UNIVERSITY

POSTGRADUATE PROGRAM DIRECTORATE

COLLEGE OF NATURAL AND COMPUTITIONAL SCIENCES

DEPARTMENT OF MATHEMATICS

Title: "Determinants of students' scholastic achievement in learning calculus in Degem Preparatory School"

General information: Name of the school: _____ Date of Interview _____

Interviewee's name: _____ Sex: _____

Starting time _____ Finishing Time _____

Objectives

The objective of this interview is to gather necessary information about determinants of students' scholastic achievement in learning calculus in Degem Preparatory School. That helps to get additional information for further investigation of the study. The interview is prepared in unstructured and open ended questions. Therefore, I would like to express my appreciation for your time and cooperation, in advance and interviewed in the issues. So, your genuine, frank and timely response are quite vital to determine the success of this study. Therefore, I kindly request your cooperation to interview in the issues honestly and to give your responses for the following question.

1. What is your experience with the running of the schools in your town regarding the following issues? a. Teachers competency and training b. School facilities
   c. Parent involvement
2. How students achieve about the idea of calculus?

Appendix – III: Calculus Achievement Test for Grade 12

HARAMAYA UNIVERSITY

POSTGRADUATE PROGRAM DIRECTORATE

COLLEGE OF NATURAL AND COMPUTITIONAL SCIENCES

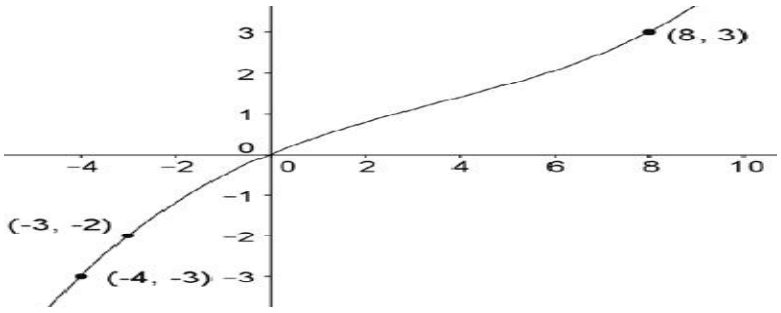
DEPARTMENT OF MATHEMATICS

Name _____ Section _____ No _____

Part 1: Background knowledge on Pre- calculus

1.1. Given the function f, defined by $f(x) = 3x^2 + 2x - 4, then\ find\ f(2)$

1.2. Use the graph to solve f(x) = -3 for x



1.3. Express $f(x) = |x + 1|$ without about value

1.4. Simplify the expression $\frac{sin^4x - cos^4x}{sin^2x - cos^2x}$

1.5. Write the equivalent form of the function f(x) = $\log_a x, a > 0, a \neq 1 \ \& \ x > 0$ with natural logarithm to the base 'e'

1.6. Find the domain of the rational function f(x) = $\frac{x}{x^2-4}$

Part 2: Achievement of calculus Concept

Item 1: Achievement of limit concept

1.1 . Given the sequence $\{4\}_{n=1}^{\infty}$ which one you think is correct about this sequence?

A. It is increasing B. It is decreasing C. It is bounded D. All

Why you think so?

_____

_____

1.2. Which one of the following you think is true about a number sequence?

A. A divergent sequence must be unbounded

B. A convergent sequence must be bounded

C. A bounded sequence must be convergent

D. A monotonic sequence must be convergent

Why do you think so?

_____

_____

1.3. Let f be a function and $c \in \mathbb{R}$. If $\lim_{x \to c} f(x)$ doesn't exist, then which one of the following must be true?

A. f(x) becomes large enough when x gets closer and closer to c

B. $\lim_{x \to c^+} f(x)$exist but different from $\lim_{x \to c^-} f(x)$

C. f(x) is defined at x = c

D. None

Please give reason for your answer

_____

_____

1.4. If $\{a_n\}$ is a sequence what condition must be satisfied so that $\lim_{n \to \infty} a_n$ exists?

_____

_____

1.5. Given a function f and a number c. Describe in your own words what it means to say that limit of a function f as $x \to c$ is some number L?

_____

_____

1.6. Evaluate the limit of the following functions (Show all the necessary steps clearly)

a. $h(x) = \frac{\sqrt{x^2+4}+2}{x^2}$ at $x = 1$

b. $f(x) = \frac{cos^2x-1}{sin2x}$ at $x = 0$

Item 2: Achievement of continuity concept

2. For non-zero real number k, let the function f(x) be defined by f(x) = $\begin{cases} \frac{tankx}{x}, x < 0 \\ 3x + 2k^2, x \geq 0 \end{cases}$,

then what is the value of k so that f is continuous at x = 0?

Item 3: Achievement of derivative concept

3.1. Let f(x) = x(x-1)^2, then

i. Find $f'(x)$

ii. Evaluate $f'(0)$ iii. Find the equation of the tangent line at (0, 0)

3.2. Let$g(x) = \frac{x+1}{\sqrt{x^2+2x+3}}$, then

i. Find $g'(x)$ ii. Evaluate $g'(3)$

Item 4: Achievement of Integration Concept

4.1. Let f(x) = $x^2 lnx$, then find

a. $\int f(x)dx$ b. $\int_1^3 f(x)dx$

4.2. Let f(x) = x, then find the area of the region enclosed by the graph of f and the x-axis from x = -3 to x = 2.