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The Effectiveness of a Proposed Integrative Program for Developing Some Mathematical Concepts and Skills Necessary for Students Learning Geography

Dissertation
Zur Erlangung des Doktorgrades der Naturwissenschaften (Dr. rer. nat.)

vorgelegt an der
Fakultät für Angewandte Informatik
der Universität Augsburg

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aus Assiut (Ägypten)

Augsburg, im Dezember 2006

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Tag der mündlichen Prüfung: 02.05.2007

Dedication

This work is lovingly dedicated to the spirit of my parents, whose love for me was never doubted, and my debt to them will never be fully paid.

Acknowledgments

It is impossible to list all those individuals who helped me on research. The undertaking of this study necessitated the advice, help, and corrections of many others far more skilled in this field than I am. Debt therefore truly extends to all those who participated in helping me to achieve this academic milestone as I will always remember with gratitude the contributions of those wonderful people.

Endless thanks are expressed to Prof. Dr. Ulrich Wieczorek, my main supervisor and friend throughout the years I spent at Augsburg University, not only for helping me to conceptualize, implement, and successfully finish this study but also for helping me whenever I needed help, guiding me at the appropriate times and for doing so much for me during my study at Augsburg University. His assistance throughout this entire process has been gratefully received, and it is my wish that all students have such an enjoyable time while completing their dissertations as I did under his supervision. Moreover, the many opportunities he has provided me with all over the years.

Many thanks to PD. Dr. Thomas Schneider for introducing me to educational research and for doing such an outstanding job of making the subject accessible, it is rare to find such a wonderful teacher who can make such material accessible to students. He helped me to understand many of the important issues impacting a research study. His guidance into how to write down a study like this was immensely helpful.

I am extremely grateful to my parents for their love and support and for always pushing me to the right direction and encouraging me to reach new horizons and for letting grow in me the positive attitude towards the educational process.

I'd like to express my deepest thanks to my wife and my children for all that they have done to help me successfully complete this dissertation. Their love, support, and patience have been a source of assistance to me, and the discussions I had with them motivated me to complete this study. Their constant, cheerful assistance has been an essential part of my endeavors in this study.

I am grateful to the students of universities in Bavaria in Germany who participated in this study. I could not have completed this study without their help and effort.

Finally, I'd like to thank the management and staff at the Institute of Geography at Augsburg University (Germany). I thank them for making such a wonderful environment available to me as I was working on this research. The opportunity to work at the geography department, where so much of this study was conducted, was truly a pleasure by virtue of its beautiful campus and friendly people. I thank them for the quietness and peacefulness - a true luxury - they provided me with while I was completing this study.

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1. Einleitung und Problemstellung

Alle Gesellschaften interessieren sich heutzutage für die Entwicklung und Verbesserung der Bildung, insbesondere der höheren Bildung. Es besteht natürlich kein Zweifel, dass diese eine bedeutende Rolle in allen Ländern spielt, sowohl in den Entwicklungs- als auch den Industrieländern. Die Bildung befähigt Völker, wirtschaftliche, gesellschaftliche und politische Probleme zu meistern.

Die Geographie ist eine der ältesten Wissenschaften und hat Bildungsrelevanz. Sie besteht, seitdem der Mensch versucht, sich auf der Erde zurecht zu finden und seine Umgebung zu ordnen. Mühsam war er bestrebt, seine Umwelt in den verschiedenen Epochen zu entwickeln und zu verbessern.

In der neueren Zeit entwickelte sich die Geographie besonders schnell. Ein Grund für diese Entwicklung waren z.B. die technischen Entwicklungen und die Entwicklungen in Wissenschaften, die eine Beziehung zur Geographie haben, wie z.B. die Geologie, die Wirtschaftswissenschaften u. a. Das alles führte dazu, dass die Geographie nicht nur als akademisches, sondern als praxisorientiertes Studienfach betrachtet wird, welches nicht durch Frontalunterricht vermittelt werden kann.

Die Mathematik als wichtige Hilfswissenschaft der Geographie besteht nicht nur aus mathematischen Aussagen, sondern sie erfordert ebenso eine präzise Denkart und liefert Methoden für Problemlösungen. Deshalb muss sich das Interesse für die Mathematik nicht nur auf das Erlernen mathematischer „Concepts“[(1)], Tatsachen und Fertigkeiten beschränken, sondern auch die Beziehungen zwischen der Mathematik und anderen Wissenschaften und Studienfächern aufzeigen, die bei der Entwicklung der Gesellschaft und bei der Verbesserung der Fertigkeiten (Fähigkeiten) der Studierenden helfen können. Das kann z.B. durch die Verbindung dieser Fertigkeiten (Kompetenzen) bei den Geographiestudierenden realisiert werden.

Die rasante technische Entwicklung ist ein wichtiges Merkmal unserer heutigen Zeit. Sie erfordert, dass der Studierende bestimmte Begriffe und Fertigkeiten, wie etwa Fertigkeiten zur Bewertung von Problemlösungen, zum Interpretieren und Ordnen von Information sowie vorausschauendes Handeln unbedingt beherrschen muss. Es ist eine wichtige Voraussetzung, Verbindung zwischen den verschiedenen Studienfächern zu erfassen, damit größere Zusammenhänge besser verstanden werden können. Ein gutes Beispiel dafür ist die

(1) Definition: Unter „Concepts“ versteht man die geistige Vorstellung eines Modells im Kopf. (Eigene Definition)

Beziehung zwischen Mathematik und Geographie. Diese kommt z.B. beim Zeichnen von geographischen Objekten zum Tragen, wo besonders geometrische und mathematische Fertigkeiten erforderlich sind.

Die Pädagogik bemüht sich darum, immer neue Methoden zu entwickeln, die das Lernen leichter machen. Dies beschränkt sich nicht auf ein bestimmtes Fachgebiet, sondern umfasst alle Gebiete des menschlichen Wissens. Es lässt sich bemerken, dass es viele Forschungen, Experimente und Projekte gibt, die in erster Linie die Studienfächer, ihre Ziele, Inhalte, Didaktik, Methodik usw. zu entwickeln versuchen. Forschungen dieser Art führt auch die Geographiedidaktik durch, welche die Geographie als Bezugswissenschaft hat.

Die Geographie unterteilt sich in unterschiedliche Teilgebiete. Diese erfordern auch mathematische Fertigkeiten wie z.B. Rechnungen mit Zeitvariablen, Berechnungen zur Verteilung von Wärme, Luftdruck, Niederschlägen, ebenso wie das Messen von Windstärke auf bewegten Objekten (z.B. Schiffen). Dazu gehört auch die Kartographie, z.B. mit Flächen - und Maßstabsberechnungen. Diese Zweige erfordern das Beherrschen von Begriffen und Fertigkeiten, die eine Beziehung zur Mathematik haben.

Die geographischen Aussagen haben besondere Eigenschaften, die einer Erklärung mit Hilfe von z. B. Landkarten, Bildern, Figuren und Diagrammen bedürfen. Dadurch wird das Erlernen neuer geographischer Aussagen, Methoden und Begriffe erleichtert.

Wegen der schnellen technischen Veränderungen in der Welt haben die Studierenden oft das Gefühl, dass sie mit der Entwicklung quantitativer Methoden in der Geographie nicht zurechtkommen. Eine Ausbildung in diesen Gebieten und die Vermittlung von für die Geographie relevanten mathematischen Methoden ist daher wichtig.

Viele Studien und Forschungen haben sich auf die Wichtigkeit dieser Themen und die Weiterentwicklung des geographischen Lernens konzentriert. Sie haben versucht, die starke Beziehung zwischen der Geographie und anderen Studienfächern zu berücksichtigen (z.B. Muir, S., 1983; Enedy, J. D., 1993; Fred, G., 1993; Kaplan, R., 1993; George, W., 1997; Wieczorek, U., 1997; Joyce, B.R. Weil, C., 2000; Association of American Geographers., 2001; Mark, G.; Boyan, B., 2002) und stießen auf die Wichtigkeit der mathematischen „Concepts“ und Fertigkeiten. Diese könnten der Geographie dabei helfen, die verschiedenen geometrischen Figuren der Geographie einfacher zu vermitteln und zu beherrschen.

2. Ziel der Arbeit

Diese Arbeit zielt zuerst auf die Bestimmung einer Liste von mathematischen „Concepts“ (d.h. grundlegenden Vorstellung) und Fertigkeiten ab, die für das Studium der Geographie unbedingt notwendig sind, insbesondere solche, die eine Beziehung zur Anfertigung und zum Verständnis von Landkarten haben. Die vorliegende Arbeit versucht, den Mangel in diesen Bereichen im Geographieunterricht durch ein pädagogisches Programm zu beheben, das sich auf die starke Beziehung zwischen Geographie und Mathematik bezieht, um die für die Geographie relevanten mathematischen „Concepts“ und Fertigkeiten bei der Geographie zu entwickeln und zu stärken. Dieses Programm wurde zusammen mit einer Gruppe von Studierenden der Geographie erprobt. Es wird vorgeschlagen, die bis heute verwendeten Methoden im Geographieunterricht zu verbessern.

Neben der Liste der mathematischen „Concepts“ und Fertigkeiten, die für die Geographie und für den Geographieunterricht unverzichtbar sind, hat die vorliegende Arbeit noch andere Ziele, die in den folgenden Punkten zusammengefasst sind:

2.1. Der Autor der vorliegenden Arbeit möchte wissen, inwieweit die Studierenden des Faches Geographie an bayerischen Geographischen Instituten die notwendigen mathematischen „Concepts“ und Fertigkeiten der Geographie beherrschen;
2.2. Der Autor macht einen Programmvorschlag, der den Studierenden des Faches Geographie an bayerischen Geographischen Instituten bei der Entwicklung mathematischer „Concepts“ und Fertigkeiten helfen kann;
2.3. Der Einfluss dieses Programmvorschlags soll gemessen und bewertet werden.

3. Bedeutung der Arbeit

Die Bedeutung der vorliegenden Arbeit kann in den folgenden Punkten zusammenfasst werden;

3.1. Diese Arbeit kann bei der Bestimmung mathematischer „Concepts“ und Fertigkeiten - für Studierende des Faches Geographie an bayerischen Geographischen Instituten - hilfreich sein und ihr Studium erleichtern und beschleunigen;
3.2. Durch diese Arbeit will der Autor feststellen, inwieweit die Geographie -Studierenden die notwendigen mathematischen „Concepts“ und Fertigkeiten der Geographie beherrschen;
3.3. Diese Arbeit ist ein Versuch zur Entwicklung und Verbesserung der Didaktik und Methodik beim Erlernen von Geographie nach neuen internationalen Maßstäben;
3.4. Die Ergebnisse dieser Arbeit sollen die Probleme bei den Studierenden hinsichtlich der mathematischen „Concepts“ und Fertigkeiten, die in der Geographie nötig sind, aufzeigen;
3.5. Die Arbeit gibt den Studierenden Anreize, neue Methoden beim Erlernen der notwendigen mathematischen „Concepts“ und Fertigkeiten der Geographie anzuwenden.

4. Die Hauptfragen der Arbeit

Die vorliegende Arbeit versucht auf die folgenden Fragen zu antworten:

4.1. Welches sind die mathematischen „Concepts“ und Fertigkeiten, die für Studierende des Faches Geographie notwendig sind?

4.2. Inwieweit beherrschen die Studierenden des Faches Geographie an bayerischen Geographischen Instituten die für die Geographie notwendigen mathematischen „Concepts“ und Fertigkeiten?

4.3. Wie sieht das vorgeschlagene Programm für die Entwicklung und Verbesserung mathematischer „Concepts“ und Fertigkeiten aus, die für das Erlernen der Geographie in Bayern notwendig sind?

4.4. Welchen Einfluss hat dieses Programm auf die Entwicklung und Verbesserung der mathematischen „Concepts“ und Fertigkeiten der Geographie bei den Studierenden des Faches Geographie?

5. Rahmen der Arbeit

Die vorliegende Arbeit beschränkt sich auf:

5.1. Auswahl von mathematischen „Concepts“ und Fertigkeiten, die für das Erlernen der Geographie notwendig sind;

5.2. Gruppen von Studierenden des Faches Geographie an bayerischen geographischen Instituten;

5.3. Eine bestimmte Vorstellung für die Entwicklung mathematischer „Concepts“ und Fertigkeiten, die für das Erlernen der Geographie notwendig sind;

5.4. Den Einfluss des vorgeschlagenen Programms, d.h. seine Messbarkeit und Überprüfbarkeit.

6. Die Arbeitsmittel dieser Untersuchung

Folgende Arbeitsmittel wurden zur Anfertigung dieser Untersuchung verwendet:

6.1. Eine Liste für mathematische „Concepts“ und Fertigkeiten, die Studierende der Geographie an den bayerischen Universitäten verwenden;

6.2. Ein Test für die mathematischen „Concepts“, den Studierende an bayerischen Universitäten abgelegt haben. Die „Concepts“ sind für den erfolgreichen Abschluss des Studiums der Geographie notwendig;

6.3. Ein Test für mathematische Fertigkeiten, den die Studierenden an den Universitäten abgelegt haben. Die Fertigkeiten sind für das allgemeine Verständnis von Geographie notwendig;

6.4. Ein Programmvorschlag für die Entwicklung der mathematischen „Concepts“ und Fertigkeiten, der für Studierende der Geographie an Universitäten hilfreich sein könnte;

6.5. Ein Bewertungstest für diesen Programmvorschlag;

6.6. Kriterien für das statistische Messen und Bewerten dieses Programmvorschlags.

7. Struktur der Arbeit

7.1. Theoretischer Teil

Dieser Teil behandelt folgende Punkte:

7.1.1. Die Geographie, ihre Bedeutung und ihr Wesen, sowie die Bedeutung des Erlernens der Geographie;

7.1.2. Die mathematischen und geographischen „Concepts“, ihre Merkmale und ihre Bedeutung, damit zusammenhängende methodische und didaktische Fragen, sowie ihre Bewertungsmethoden und die Beziehung der mathematischen Fertigkeiten zur Geographie;

7.1.3. Eine Analyse der vorherigen Studien- und Forschungsarbeiten, die dieses Thema behandelt haben, sowie eine Analyse der Inhalte der Schulbücher für Geographie und der Lehrpläne in den bayerischen Schulen bis zum Abitur, denen die wichtigsten „Concepts“ und Fertigkeiten der Mathematik entnommen wurden, die für das Erlernen der Geographie notwendig sind.

7.1.4. Ein bewerteter Test, um festzustellen, inwieweit die Studierenden diese „Concepts“ und Fertigkeiten beherrschen;

7.1.5. Vorbereitung eines Unterrichtsprogramms und eines Auswertungstests für dieses Programm, um seinen Einfluss auf die Studierenden der Geographie zu messen und zu bewerten.

7.2. Empirischer Teil

Dieser Teil enthält folgende Punkte:

7.2.1. Durchführung von Prüfungen zu mathematischen „Concepts“ und Fertigkeiten, die für die Geographie unabdingbar sind, um die Schwierigkeiten in diesem Bereich abzuschätzen, und einen Erwartungshorizont aufzustellen;

7.2.2. Auswahl verschiedener Gruppen von Studierenden an den bayerischen Universitäten aus unterschiedlichen Studienniveaus (311 Personen; Testbögen für 500 Personen wurden verschickt);

7.2.3. Durchführung von Tests mit verschiedenen Gruppen zur Feststellung der Fähigkeiten in Bezug auf mathematische „Concepts“ und Fertigkeiten;

7.2.4. Auswahl von Zwei Gruppen von Studierenden des Instituts für Geographie an der Universität Augsburg, um das vorgeschlagene Programm für die Entwicklung und

Verbesserung einiger, vorher festgelegter, mathematischer „Concepts“ und Fertigkeiten durchzuführen;

7.2.5. Vortest über Kenntnisse und Fertigkeiten mit den Zwei Probandengruppen, bevor das Programm praktisch unterrichtet wurde;

7.2.6. Haupttest über Kenntnisse und Fertigkeiten mit den Zwei Probandengruppen zu den mathematischen „Concepts“ und Fertigkeiten mit den Probegruppen, nachdem das Programm praktisch unterrichtet wurde, um das Niveau der Studierenden zu bewerten;

7.2.7. Anwendung angemessener statistischer Methoden, um Ergebnisse und Niveauunterschiede zwischen den Studierenden zu ermitteln;

7.2.8. Bestimmung und Bewertung des Einflusses des vorgeschlagenen Programms;

7.2.9. Erklärung und Analyse des Programms.

7.2.10. Vorschläge für das Geographiestudium.

8. Zusammenfassung der erzielten Ergebnisse

Die Untersuchungen der Arbeit wurden mit einer Vielzahl an Studierenden der Geographie an den bayerischen Universitäten durchgeführt. Die erreichten Ergebnisse dieser Arbeit können wie folgt zusammengefasst werden:

Nachdem der Autor eine Liste mit den mathematischen „Concepts“ und Fertigkeiten erstellt hat, die für das Fach Geographie unabdingbar sind, hat er anhand dieser Liste eine Gruppe von zu bewertenden Testaufgeben erarbeitet, um zu messen, inwieweit die Studierenden diese mathematischen „Concepts“ und Fertigkeiten beherrschen. Die Ergebnisse dieser Tests waren höchst unterschiedlich. Die Ergebnisse wurden in einem eigenen Kapitel der Arbeit vorgestellt.

Das Ergebnis war wie folgt: Die allgemeinen „Concepts“ werden zu 65 % und die allgemeinen Fertigkeiten zu 63% beherrscht. Dies führte zu dem Urteil, dass man hinsichtlich der allgemeinen mathematischen „Concepts“ und Fertigkeiten der Studierenden der Geographie nicht zufrieden sein kann.

Aufgrund dieses Mangels hat der Autor eine Gruppe von Lektionen (Unterrichtseinheiten), die den Studierenden bei der Entwicklung und Verbesserung ihrer mathematischen „Concepts“ und Fertigkeiten helfen können, entworfen. Diese Einheiten wurden im Unterricht erprobt. Es wurden außerdem bestimmte Regeln entwickelt, um festzustellen, inwieweit dieses Programm den Studierenden bei der Entwicklung und Verbesserung ihrer mathematischen „Concepts“ und Fertigkeiten helfen kann.

Die statistische Auswertung zeigt, dass das vorgeschlagene Programm für die Entwicklung der Studienfächer von großer Bedeutung sein kann. Das Programm ist auch für die

Geographie und ihre Beziehung zu den anderen Wissenschaften sehr wichtig. Es zeigt sind, dass dieses Programm gut brauchbar ist, um auch interdisziplinäres Lernen zu fördern.

9. Begriffsklärung

9.1. Das Programm:

Unter diesem Begriff wird eine Gruppe von hierarchischen Lerneinheiten verstanden, die nach den gewünschten Zielen angeordnet sind und durch ihre wissenschaftlichen Inhalte eine gute und starke Beziehung zueinander haben. Die wissenschaftlichen Inhalte sind Themen der mathematischen Geographie, die darauf abzielen, die mathematischen „Concepts" und Fertigkeiten bei den Studierenden der Geographie zu stärken.

9.2. Skills:

Die vorliegende Arbeit betrachtet die „Skills" als diejenige Fähigkeiten, welche bei der schnellen und exakten Anfertigung von Landkarten, Figuren und statistischen Formel notwendig sind.

9.3. Die Geographisch-Mathematische Fertigkeit:

Unter diesem „Begriff" versteht man die Verwendung von Symbolen, Regeln, mathematischen Arbeitsweisen und das Zeichnen von geometrischen Formen, die Formulierung von statistischen Aussagen, sowie die Bestimmung der Beziehung zwischen verschiedenen derartigen Aussagen mit großer Exaktheit.

9.4. Die „Concepts":

Die vorliegende Arbeit definiert den Terminus „Concepts" als ein Wort, Satz, Idee oder geistige Vorstellung, mit deren Hilfe zwischen Sachen, Ereignissen, Gruppen, Ordnungen, bestimmten Situationen, Meinungen u.a. unterschieden werden kann. Diese Inhalte der „Concepts" sollen den Studierenden helfen ihre wissenschaftlichen Fragestellungen zu lösen und erklären die mathematischen Besonderheiten, welche mit den geographischen Themen verbunden sind.

9.5. Die Geographisch-Mathematischen „Concepts":

Der Begriff der „Geographisch-Mathematischen Concepts" wird in dieser Arbeit wie folgt definiert: Sie sind eine allgemeine Idee, konkrete oder abstrakte geistige Vorstellung, die sich auf bestimmte Gegenstände, Erlebnisse, Gedanken oder Personen beziehen. Für diese Dinge kann ein Symbol oder ein bestimmter Name verwendet werden, der eine Beziehung zu Begriffen, Symbolen, Themen oder Fragen der Geographie hat, insbesondere zu geographischen Fragen, die eine Beziehung zur Mathematik haben. Diese Beziehung kann bei der Lösung der geographischen Fragen hilfreich sein.

Abstract in English

Geography, as a science, is considered on of the great ancient disciplines. Since man knew settlement and system on the earth, he has been undertaking the mission of developing and advancing everything around him all over the successive ages of history. So is the case with geography which has witnessed a rapid development during the modern age. The processes of modern development and advancement required the development of different sciences to cope with the different variables surrounding us. Hence, developing geography, as one of the various learning aspects, has become very important.

Throughout the course of this occurring development, geography has been divided into many branches and majors, such as the mathematical aspects which deal with calculating time and the distribution of temperature, pressure, and wind as well as the cartographic processes which are related to space, the different distributions on maps, and the graphical representations. These branches and aspects necessitate that learners should master some of the concepts and minor skills attached to these aspects and which are closely related to math.

Based on this ground, the idea of the present study came to the scene: The present study aimed at identifying some of the mathematical concepts and skills required for learning geography and measuring to what extent these concepts and skills are available in students majoring in geography. It also aimed at suggesting a program for developing these mathematical concepts and skills which are needed for learning for geography-section students. Out of these main objectives, some questions were suggested to be answered by the study. The concepts and skills used in the study were identified throughout literature, research studies, and the teacher guides used by both math and geography teachers in Bavaria.

Based on the identified concepts, tests that aimed at assessing to what extent these concepts and skills were available were designed. Then, they were administered to a sample taken from geography-section students at Bavaria in Germany. This sample consisted of (311) students. Results of administering the test to the sample of the study indicated that the targeted students had no sufficient concepts and skills although these concepts and skills from an essential foundation on which geography learning is based. Results indicated that these mathematical concepts and skills were available with a total degree of 62% which is an unsatisfactory degree. Therefore, the researcher suggested a program for developing these concepts and skills in the light of tests' results.

He relied on scientific bases for proposing programs and put into consideration the degrees to which these concepts and skills were available covering (and concentrating on) them according to the degree to which each skill and concept was available. The suggested program was administered to two experimental groups consisting of (40) students at the geography section in the University of Augsburg. Results of the program administration to the sample of the study revealed the effectiveness of the suggested program and indicated to what extent students needed rehabilitation and therapeutic programs that help them focus on both cognitive and skilful achievement simultaneously without advantaging one aspect at the expense of another.

Furthermore, the study reached some other important results among which are that it is necessary to have a minor course dealing with math to be taught to geography-section students. Also, the study indicated that it has been necessary to show the integration that

really exists between the different subject matters throughout training programs and the non-separation between the theoretical study and the practical aspect in different schools through holding training programs at universities targeting teachers to provide them with innovative teaching methods and styles in their majors to enable them to cope with the requirements of the modern scientific development.

1. Problem and Significance of the Study

1.1. Introduction and Problem of the Study

One of the most prominent purposes of education in modern society is providing individuals with techniques for attaining suitable knowledge, training them on different methods of thinking, and using it appropriately according to the requirements of modern life and the ever changing needs of the labor market.

Thus, educators always seek to uncover the factors and conditions that are responsible for facilitating learning. This effort is not limited to a certain field; rather it is related to different aspects and fields. It is observed that there are many researches, experiments, and projects aiming at developing projects or academic syllabuses, including objectives, methods of teaching and instructional aids [PARKS, 1997, p 106].

Geography, as a school subject, is one of the most sensitive subjects that deal with what goes on in society and the current problems related to human beings and territories and their interaction (together). Therefore, specialists in these subjects always seek elements that increase effectiveness and the possibility of achieving these objectives in order to face current advances in an efficient way [TIKUNOV, 1996, p 478].

School Geography derives its facts, data, and information from geographical sciences that are updated and simplified to achieve educational purposes. Thus, when teaching certain concepts and skills to the students, the scientific material should become a means to instruct students in specific concepts and skills, which, in turn, are relevant to their life, influencing their interests and tendencies. Thus, the actual practice becomes a scientific field for teaching skills, making a student feel that he possesses a considerable amount of knowledge, leading to the formation of a convenient affective structure that helps support these skills [CRONE, 1968, p 86., ISHIKAWA & KASTENS, 2005, Pp 184-197].

The present era, which is characterized by technological advancement, requires that a teacher should possess certain skills such as estimation, problem solving, data explanation and information organization, in addition to measurement, prediction, and not to mention the integration of subjects to benefit from their interrelationships.

With the changing needs of society, and the quantitative breakthrough of information that necessitates reconsidering priorities related to basic mathematical concepts and skills required for preparing the learner of geography, there are many shapes and graphs associated with geometrical and arithmetic skills, which result in the necessity of the integration between geography and mathematics.

It is worth mentioning that all processes of mathematical geography, whether they are included in maps and graphs or not, are classified under the chronographic technique that means methods and techniques of scientific achievement in mathematical geography. What is meant are not actual maps and graphs, but analyses and predictions derived from the school subject concerning present and future events, as well as assuming what is hoped for life on earth [JOHNSON, 2000, p 220].

Therefore, skills that are based on such backgrounds are no doubt more powerful and stable since they depend on conscious practical studies and effective planning, including the nature of relationship among different aspects. Thus, judging what enables the individual to understand the concept of a certain skill requires observing, knowledge and behavioral attitudes, in order to provide a valid judgment that is closer to objectivity concerning the level of performance in skills and competence of certain concepts.

Geographical skills provide the necessary tools and techniques for us to think geographically. They are central to geography's distinctive approach to understanding physical and human patterns and processes on earth. We use geographical skills when we make decisions which are important to our well-being, where to buy or rent a home; where to get a job; how to get to work or to a friend's house; where to shop, vacation, or go to school. All of these decisions involve the ability to acquire, arrange, and use geographic information; daily decisions and community aids are linked to thinking systematically about environmental and societal issues [PALMER, 1994, p 39].

Many studies emphasize the fact that drawing maps is one of the components of good teaching of geography since it represents different phenomena on the earth surface with their interrelationships as the main milestone on which teaching geography is based, including learning, drawing, and specifying distances and areas. Concepts and skills represent a central aspect and a main dimension of curricula since they organize things, events, and different phenomena in a more limited number of divisions or categories which create a few concepts and skills that include a great deal of knowledge and facts. These represent a main function of concepts and skills in the field of classifying practical knowledge.

The use of concepts and skills as a teaching approach helps the students to learn how to select an appropriate way, and to deal effectively with human problems. In addition to decreasing the necessity of re-learning and helping learners in research and making them organize the learning experiences according to certain patterns [RAISZ, 1981, p 316].

The main reasons for the importance of mathematical concepts and skills in geography are:

(1) Enabling students to contribute to problem solving during the learning process and daily life.
(2) Helping the learners to increase understanding of science and its nature since science is a series of mental conceptions that are connected with each other.
(3) Learning the basic elements of any science helps the learner to explain and apply facts and phenomena. In other words, learning a certain concept or generalization of a certain stage will help to explain new situations and events, whether familiar or unfamiliar. Hence, the function of information is achieved.
(4) Demonstrating the connection between different branches of science, and encouraging open thinking, which is considered an essential element in creative thinking.

For example, maps are the distinctive medium of geography, and the fundamental document required for teaching it effectively. Thus, there are many difficulties which are associated with learning geography more than those facing students during observation.

Topographic geography, for instance, are important documents characterized by being accurately selected, containing many symbols that require a reasonable degree of competence on the part of learners concerning some concepts and skills, such as specifying distances and areas, identifying sites, explaining map symbols, and drawing all kinds of maps that in turn requires several relevant concepts and skills [MUIR, 1983, p 16].

KAPLAN emphasized that an individual, who is specialized in geography, should possess the abilities of artists, and mathematicians as well. Therefore, the role of geography is demonstrated concerning its relationship with both mathematics and art, in addition to some other sciences like Botany and Agriculture [KAPLAN, 1990, p 39].

More directly related to mathematics are other dimensions. The problem format dimension exists from nonverbal to verbal, amount of information given is often one-dimensional without considering various points along a continuum: A problem contains only essential information, essential and extraneous information, essential or implied information, or it may lack sufficient information to obtain a solution. Directly related to this dimension are a number of solutions: The problem which has many solutions; the problem which has only one solution; and the problem which has no solution at all. Degree of understanding of a problem situation initiates the learning process as the learner identifies: facts, question, relationship, operations, a number of sentences, and standard algorithms. Solution procedures process as the learner develops.

There are one-step, two-steps, multiple-step, and process problem situations. This dimension introduces the next dimension and serves to separate the kinds of problem situations. Situation classification includes example, exercise, and problem. Exercise may be routine or non-routine. More directly related to the teaching of mathematics is the heuristic [HEDLEY, 1990, p 180].

Furthermore, geographical information is seen as having a distinctive nature of its own. This necessitates using explanations and interpretations throughout maps, pictures, graphs and shapes. These things play important roles in directing students to various places and sites as well as enabling to develop the abilities to: (1) understand and design maps; (2) read them; (3) use them; and (4) acquire many geographical facts. However, the existing teaching techniques hinder the achievement of such objectives.

Therefore, learning geography is based on two main objectives: showing space allocation of individual phenomena and processes on the earth's surface which is only accessible by using maps, as well as identifying phenomena and processes in action or past. As it is not possible to directly observe them, such conditions have to be created in the classroom which enables direct observation. The geography classroom must enable the realization of both objectives [SLAVKO, 2001, p 179].

With the concept of integration as a principle, it is possible to unify many seemingly independent functions, many phenomena that appear unrelated to each other within one unified, yet diversified scheme. Integration is a functional principle, and as such it offers more promising bases for the solution of problems like the interaction of mind and body, the difference between physical interaction and mental interaction in general; the difference between reflexive action and intelligent behavior, thought, and action, which, when viewed through the dualistic approach, are perplexing to say the least [TABA, 2000, Pp 66-67].

It is true that integration is a blanket term. As found in current use, it might mean almost everything or anything. But, properly used, it can be of inestimable value as a basis for the analysis of situations and problems in which many deciding factors are emergent and unique. It is an operational term, describing the functions which are performed, not the specific outcomes resulting from those functions.

Many studies dealing with the relationship between mathematical skills and concepts on one hand, and geography on the other, have all emphasized the fact that mathematical skills have an important role in teaching certain topics in academic syllabus, especially geography, whose learning, acquiring, and improvement facilitate learning many other skills. Acquiring mathematical concepts and skills helps the learner understand mathematical ideas and concepts, and increases comprehension of mathematical systems.

Moreover, acquiring mathematical concepts and skills facilitates the performance of many other tasks and permits the learner to concentrate appropriately on solving mathematical problems, developing mathematical abilities, and implementing drawings and calculations that are associated with geography, like distance, speed, and time [LOCKLEDEGE, 1993, p 4].

With the enormous progress in different fields of knowledge, geography is divided into many branches, such as those concerned with mathematical processes or such as calculating time, and divisions of temperature or rain, measuring the intensity of wind, in addition to cartographic classifications concerned with areas, and different divisions on maps and graphs which require competence of concepts and skills connected to those aspects that are, in turn, connected to mathematics.

Technological change led to the feeling of inability among learners to cope with modern variables, especially in quantitative information breakthrough, and communication technology. If learners do not engage in training programs in that field, they will be isolated from what goes on around them.

Hence, new legislation in the education branch concerning information technology emphasized the fact that any certificate of practicing teaching is invalid unless the learner spends 24 weeks in schools practicing and using modern methods and techniques of teaching to help him in performing the teaching process easily and accurately [FISHER, 2000, p 52].

In the light of the integration principle among different academic subjects, geography is observed to require a considerable amount of mathematical knowledge to help the learner understand many abstract concepts and skills. The researcher here noted, through reviewing many previous studies and researches in the field, that there is a problem exemplified in the lack of true understanding of certain concepts and skills connected to mathematics during studying geography. He has also observed, through interviews, that learners lack the necessary concepts and skills required for studying geography.

The previously mentioned observations have drawn the researcher's attention to the importance of certain mathematical concepts and skills that help the learners study geography, as well as the importance of achieving competence in such concepts and skills whether they are arithmetic or geometrical.

Therefore, the present study aims at specifying a list of necessary mathematical concepts and skills for studying geography and the extent to which students are competent in such concepts and skills, in addition to designing a suggested program in order to develop these concepts and skills. *Therefore, the study is an explorative one.*

1.2. Aims of the Study

The study aims at the following:

1.2.1. Specifying certain mathematical concepts and skills that are necessary for learning geography to geography students.
1.2.2. Recognizing the extent to which certain mathematical concepts and skills exist among students.
1.2.3. Designing a suggested program to develop some mathematical concepts and skills that are necessary for learning geography.
1.2.4. Recognizing the effect of the suggested program on developing certain mathematical concepts and skills that are necessary for learning geography.

1.3. Significance of the Study

The significance of the study is represented in the fact that it may help in:

1.3.1. Specifying a list of some concepts and skills that are necessary for learning geography to geography students.
1.3.2. Recognizing the extent to which the students possess these concepts and skills.
1.3.3. Responding to the modern universal approaches of constructing and developing the curriculum.
1.3.4. Contributing to specify the indicators concerning the importance of the mathematical concepts and skills that are necessary for learning geography.
1.3.5. Stimulating strong motives among learners to apply modern approaches and models of teaching the necessary concepts and skills for learning geography.

1.4. Questions of the Study

The study attempts to answer the following questions:

1.4.1. What are the necessary mathematical skills required for learning geography?
1.4.2. What are the necessary mathematical concepts required for learning geography?
1.4.3. To what extent do certain mathematical concepts and skills, which are necessary for learning geography, exist among learners?
1.4.4. What would a suggested program to develop certain necessary mathematical concepts and skills for learning geography be like?
1.4.5. What is the effect of the suggested program on developing certain mathematical concepts and skills that are necessary for learning geography?

1.5 Limits of the Study

The present study is limited to:

1.5.1. Only some mathematical concepts and skills which are necessary for teaching and learning geography.
1.5.2. Groups of geography students of Universities in Bavaria.
1.5.3. A suggested program for developing certain mathematical concepts and skills.
1.5.4. Measuring the effect of the suggested program.

1.6. Instruments of the Study

1.6.1. A list of some mathematical concepts and skills which are necessary for studying and learning geography.
1.6.2. An achievement test of certain necessary mathematical skills for learning geography.
1.6.3. An achievement test of certain necessary mathematical concepts required for learning geography.
1.6.4. A suggested program to develop the above mentioned mathematical concepts and skills required for learning geography.
1.6.5. An achievement test of a suggested program to develop some mathematical concepts and skills for learning geography.
1.6.6. A measurement of the effect of the suggested program to develop some mathematical concepts and skills for learning geography.

1.7. Procedures of the Study

The study attempts to answer the previously mentioned question throughout the following procedures:

First: To answer the first and second questions, "what are the necessary mathematical concepts and skills required for learning geography?", the following procedures will be followed:

1. Reviewing the previous literature and research studies dealing with the concepts and skills required for learning geography in general, and the mathematical concepts and skills in particular.
2. Conducting a theoretical study of the mathematical concepts and skills in terms of their definitions, characteristics, types, stages of teaching them, and methods used to evaluate them.
3. Conducting a theoretical study dealing with the mathematical concepts and skills, and their relationship with learning geography.
4. Analysing the textbooks and courses of general geography and the geography of maps and space which involve the mathematical concepts and skills required for learning geography so as to identify the mathematical concepts and skills required for learning geography.
5. Analysing the teacher's guide and the textbooks of mathematics and geography from the primary stage to the university stage in Bavaria province so as to identify the most important concepts and mathematical skills required for learning geography which were studied in the different educational stages.
6. Throughout the previous steps, a final list of concepts and mathematical skills required for learning geography is developed.

Second: To answer the third questions, "To what extent are some mathematical concepts and skills, which are necessary for learning geography exist among learners?", the following procedures were followed:

1. Preparing an achievement test for the mathematical concepts required for learning geography for geography-section students so as to measure the cognitive aspect and performance aspect of these concepts.
2. Preparing an achievement test for the mathematical skills required for learning geography for geography-section students so as to measure the cognitive aspect and performance aspect of these skills.
3. Displaying the prepared tests over some jury so as to assure their validity and reliability.
4. Piloting the tests so as to assure to what extent they are valid to be used in the study.
5. Administering the geographical mathematical concepts and skills tests to a group of geography-section students in different universities in Bavaria.
6. Analyzing and interpreting the test results.

Third: To answer the fourth and fifth questions, "what is the form and effectiveness of a suggested program for developing some of the mathematical concepts and skills required for learning geography for geography-section students in Augsburg University?", the following procedures were followed:

1. Reviewing the previous list which includes the limits of the mathematical concepts and skills required for learning geography.
2. Designing the program in the light of the results of the second and third questions by suggesting a group of 12 lessons and designing the activity book which includes the activities related to each lesson, and assigning a test through which the effectiveness of the program is measured.
3. Administering the suggested program to a group of geography-section students (20 students for the year 2005 and another 20 students for the year 2006). The pre-test was administered to the study samples, and then, the program was taught, and finally, the post-test was administered.
4. Reaching the suggestions and recommendations.
5. Displaying some suggested research studies.

Throughout presenting the study schedule in chapter one, we can display the theoretical background that shows the main components and basics of the study. This is shown in chapters two and three, while chapter four illustrates the tools of the study and the methods followed in designing them. Chapter five displays the study results which are elaborated in the following pages.

2. The Necessary Mathematical Concepts for Learning Geography

The current century has undergone a series of rapid changes in different fields of life due to the tremendous technological and scientific progress. Therefore, it has become so difficult to instruct students in an ideal way during their years of study. Thus, educators have concentrated on forming a conceptual structure among young learners within each level of study. In other words, attention was directed towards forming concepts and increasing their depth gradually in the learners' minds. Knowledge and facts have become no more than an addition to concepts in different fields.

Throughout the previous introduction, and before going through concepts, their meanings and their characteristics, it is necessary to illustrate some of the basics on which the study is based, and whose main objective is to reach the ideal style of teaching geography, its importance, its identity, and to what extent it is related to the mathematical concepts, which are regarded as one of the most important aspects of the study.

2.1. The aims of learning geography

Studying geography, as a school subject, aims at enabling students or human beings in general to interact with other people on the one hand, and to interact with the surrounding environment on the other. It prepares the individual to learn for life. Also it is considered one of the keys required for understanding the world around us as it establishes the standards required for this understanding. In addition, geography enables the individual to practice long-life learning and deals with life-related concepts, knowledge and experiences. In other words, geography is closely related to human beings and any other thing related to their thoughts. The goal is simple; it is represented in creating a geographically informed person, someone who understands people, places, and environments from a spatial perspective, and an individual who appreciates the interdependent world in which we all live. In this world all comes together into the contexts that shape our lives: the school, the family, society in general, occupations and careers. Hence, geography helps us to understand and appreciate those contexts [GEORGE, 1997, p 206].

For many people geography means knowing where places are. It is true that knowing where places are as well as their characteristics is important, just as knowing the alphabet is important for reading, or the multiplication tables for arithmetic. However, geography involves much more. Geography is the study of places on earth and their relationship with each other, often the study of geography begins with one's home community and expands as a person gains a greater experience.

Thus, geography provides a conceptual link for children; between home, school, and the world beyond. Geographers study how people interact with the environment and with each other from place to place and they classify earth into regions in order to draw generalizations about the complex world in which we live. Because it deals with where and how people live, geography is rich in material that relates to international understanding, multi-cultural concerns, and environmental education.

The tools of geography help us understand places. The most identifying tool with geographers is the map, but they also use different kinds of statistical information, photographs and images of many kinds, and a wide variety of data collected by other methods. They also rely upon their own observations and those of others found in sources such as descriptive geography, histories, diaries, and journals.

Besides, MCKEOWN emphasizes that geography is an ideal disciplinary vehicle for environmental education; however, non-geographers are rarely aware of the vast geographic interest, research, and literature related to the environment. Geographers study the environment in four major ways:

(1) The natural environment using scientific methods and techniques.
(2) The impact of human behavior on the environment.
(3) Environmental influence on human behavior.
(4) The different cultural perceptions of the environment and how these perceptions are expressed in the surrounding landscape [MCKEOWN, 1994, Pp 40-42].

Within these avenues of inquiry, geography examines patterns of environmentally related topics at different scales: local, regional, and global; and the environmental education is shaped by four current activities: the development of science and geography standards, and the creation of environment education certification standards.

Many educators in general, and many geography instructors in particular, emphasized the importance of learning geography for students:

(1) Students' attainment of geographical information that is related to their actual life.
(2) Helps students' to acquire and attain the geographical concepts which are related to the surrounding environment.
(3) Helps students' to master learning-related skills, such as social skills, manual or motor skills, and mathematical skills.
(4) Identifying the methods used for data collection, such as observation, recording, explanation, and modeling.
(5) Helping students to conceptualize different universal phenomena and to develop attitudes.
(6) Recognition of natural resources, and methods of their exploitation in a useful way [JENNIFER & LEINHARST, 1998, Pp 93-97].

Furthermore, LEE and JONES identify some objectives of learning geography:

(1) Realizing generalizations, facts and concepts that are related to geographical topics.
(2) Developing the desirable attitudes, values, tendencies, and behavioral patterns.
(3) Developing geographical skills, whether they are manual or mental [LEE & JONES, 1993, Pp 223-226].

This is what PALMER identifies as some of the aims of geography:

(1) Geography contributes to developing a positive attitude towards work and desirable studying habits.
(2) Studying the interaction between man and natural circumstances.

(3) Providing learners with knowledge which helps them to recognize the nature of their country, its resources, and the efforts made by government to exploit such resources.
(4) Studying the skills that are related to maps and concepts in different educational stages.
(5) Helping in forming the universal mentality that is able to understand matters through the ongoing events [PALMER, 1994, Pp 37-38].

Besides, CARY and PHILIP identify some objectives of learning geography as follows:
(1) Enabling students to acquire some useful geographical knowledge in the surrounding environment.
(2) Enabling students to acquire geographical and social skills.
(3) Enabling students to acquire mental abilities which include making judgments, solving problems, and using scientific methods in their life [CARY & PHILIP, 1991, Pp 206-209].

In order to achieve the aims of learning geography in different educational stages, there should be a balance between these aims and their appropriateness to learning environment on the one hand, and their appropriateness to the learners on the other. Therefore, good performance of both the teacher and the learner depends mainly on competence of those aims. This requires special skills that help estimate the learner's experiences and the context of the different topics, in addition to explaining experiences and new dimensions to this context.

2.2. The importance of learning geography

Learning geography is very important in the sense that it develops positive attitude towards work and studying. In this regard, FRANCES states that learning geography helps in the formation of the skills which are related to connecting geographical information to their explanations and deduction of certain relevant results [FRANCES, 1993, p 1].

The International Geographical Conference emphasized the importance of learning geography and divided this importance into two main parts: (1) Learning geography helps us understand the world around us with all the educational figures and graphs included in it, and (2) it helps us to understand the society in which we live. This can be illustrated in the following lines [points 2.2.1 and 2.2.2 after RUTH, 1994, Pp 3-4]:

2.2.1. Geography helps us understand the world

1. Geography teaches students important skills:

Through observation of geography students, it is apparent that geography students learn to read maps and interpret information at local and global geographical scales. They are able to use data from maps, tables, graphs, and texts to recognize patterns and solve problems. Students can also integrate concepts from many different areas of science, social science, and the humanities, and apply critical thinking to understanding and dealing with current issues of local, national, and international importance.

2. Geography helps students learn about the world:
   Knowing something about where places are and what they are like is important. As a dominant "superpower" and a major player in international affairs, the United States needs citizens who have basic knowledge of other parts of the world as well as their own country and who can have understanding of the regional relationships.

3. Geography contributes to international understanding:
   The world's economies are increasingly linked to an international network of trade and exchange. If our competitors know more about us than we do about them, they have an advantage in serving our markets and negotiating trade agreements, and we are placed at a disadvantage in reaching their markets. Well-planned geography education at all grade levels will help make us more aware of other countries and cultures.

2.2.2. Geography helps us understand our own country

1. Geography and citizenship:
   Knowledge of geography helps us to be better citizens. Through geography we learn to locate important events. We can understand the relationship between geography and national or international policies and we can use geographical knowledge to make informed decisions regarding the best use of the nation's resources. Finally, geographic knowledge helps us to ask important questions about policies that lead to changes in the landscape and land use. Geographically informed students will be effective leaders of their countries.

2. Geography and economics:
   There is a close relationship between geography and economics. The location of natural resources, the shape of transportation networks and technology, the level of industrialization or energy production, and many other geographical factors influence the kind of economy a country or region will have. Trade patterns are fundamental elements of both geography and economics.

3. Geography and history:
   Geography provides important clues to the past. Landforms and climate are related to migration patterns, land use, and the rise and fall of civilizations. How people use the land also has a strong bearing on the economic progress of countries and regions. Thus, knowing what the landscape was like in the past is important for understanding historical processes; such as knowing who lived in a place, how they lived, and how they used the land.

4. Geography and the environment:
   Many human geographers examine the relationship between humans and the environments in which they live, and physical geographers are concerned with how natural systems work. Geographers conduct research to understand the impact of environmental factors on human individual and group behaviour, to identify the ways in which humans change the environments in which they live, and to determine the long-term environmental impacts of social processes, such as population growth and technological development. These are key issues for

determining government and private sector environmental policies with which an education citizenry should be acquainted.

The previous illustration of the importance of geography, we can emphasize the fact that learning geography helps in being competent in certain skills that should be possessed by the learner such as the aspects of theoretical knowledge, and the cognitive bases that are necessary for efficient performance, as well as the valid application of knowledge in actual teaching situations leading to efficiency in performance. It is emphasized that the importance of learning geography is based on the fact that it:

(1) Helps to educate learners and prepare them for good citizenship in society.
(2) Considers the learner's growth at each stage.
(3) Makes the surrounding environment understandable, and prepares the learners to accept the idea of change and development and encourages the tendency to contribute to current events.
(4) Helps the learners to acquire necessary trends, skills, and attitudes for achieving good citizenship in a democratic society [RUTH, 1994, p 4].

This is what SEBBA emphasized regarding the importance of teaching geography, and for this purpose, she identified some objectives of learning geography:

(1) Extending the students' awareness of, and developing an interest in their surroundings.
(2) Accurately observing and developing skills of enquiry.
(3) Identifying and exploring features of the local environment.
(4) Distinguishing between the variety of ways in which land is used and the variety of purposes for which buildings are constructed.
(5) Recognizing and investigating changes that take place in the local area.
(6) Relating different types of human activity to specific places within the area.
(7) Developing concepts which enable students to recognize the relative position and spatial attributes within their own environment.
(8) Understanding some of the ways in which the local environment affects people's lives.
(9) Developing an awareness of the seasonal changes of weather and of the effect which weather conditions have on the growth of plants, on the lives of people and animals and on other people's activities.
(10) Gaining some understanding of the different contributions which a variety of individuals and services make to the local community.
(11) Starting to develop at students an interest in people and in places beyond their current experiences.
(12) Developing an awareness of culture and ethnic diversity within our society while recognizing the similarity of activities, interests and aspirations of different people.
(13) Extending and refining the students' vocabulary and developing their language skills, mathematical concepts and numeral skills.
(14) Developing students' competence to communicate in a variety of forms including pictures, drawings, simple diagrams and maps [SEBBA, 1991, p 3].

Based on this, we can say that learning geography is considered a key for learning different concepts, whether they be general or specific, and this was mentioned by HOLLOWAY who emphasized the fact that learning geography is considered one of the main important keys for learning concepts, such as population distribution concepts, the environmental division, the geographical or astronomical locations, or the geographical shapes, such as the natural phenomena or population distribution, or whatever is related to the different kinds of geography, such as natural geography or climatic geography, and the related concepts which help in learning geography and which are regarded as the proper approach or the right track for studying it [HOLLOWAY, 2003, Pp 187-205].

There are also many calls for emphasizing the importance of information technology in learning geography. Learning geography concentrate on using effective methods in addition to the necessity of teaching special skills and creativity in using information in the teaching process and all relevant topics [LIBEN & DOWNS, 1993, p 739].

Thus, it is clear that geography seeks to achieve different aims such as developing skills among learners to enable them to deal and interact with the situations facing them in daily life. Based on the previous illustration of the importance of geography, and on what some educators and scientists mentioned about the importance of studying and learning geography, we are tempted to illustrate the identity and nature of geography which the learner should know before proceeding in learning it. The following lines present the nature of geography.

2.3. The nature of learning geography

Geography is of a particular nature as it cares for man and environment, the interaction between them, the product of this interaction, and the subsequent or resultant advantages and disadvantages. It is concerned with the distribution, connection, and analysis of phenomena (whether they are natural or human) and the interrelationships among them. It cannot be considered a subject dealing with nature without the human element; rather, it is a mixture of both of them.

Geography is the study of the patterns of spatial distribution and interactions across space. Patterns of all kinds of phenomena have been studied. One of the key tools of geographers is used to highlight important patterns. Because patterns are often complex, geographers are sometimes obliged to study several types of maps before drawing their conclusion.

We have illustrated an example of the nature of geography and how it deals with the environment which surrounds us or through the globe as a whole. This can be presented in the following [SAVAGE & ARMSTRONG, 1987, p 35]:

1. *Earth studies*: The subject matter in earth studies shares some common ground with geology. Earth studies lessons focus on topics such as climate, soils, water, and major terrain features. Geography interested in earth studies seeks to promote a better understanding of the physical environments of our planets.

2. *Area studies*: Area studies include the studies of regions. These may be political regions (e.g. China), physical regions (a desert), or culture regions (New England). Many other kinds of regions can be studied as well. Area studies emphasize the

unique feature of selected sections of the emphasized. Area studies lessons are very common in the elementary social studies program.

3. *Interactional studies*: As the name suggests, interactional studies are concerned with the patterns of interaction of phenomena in the physical and social world. Some topics that interest geographers who specialize in interactional studies are:
   (1) The patterns of locations of services in cities,
   (2) The change of population in places,
   (3) The relationship between transportation systems and patterns of residence, and
   (4) The distribution of manufacturing facilities of various types.

This is what BARTLETT focused on concerning how geography deals with the phenomenological nature; he states that it emphasizes the character of place and the meaning attached to it and the attitudes that people usually form towards some particular places. These areas are the main concern of the geographers [BARTLETT, 1982, p 3].

However SEBBA emphasized the existence of a problem in learning geography, and this is attributed to the nature of geography itself as a school subject. When learning geography students face tasks of great complexity. We can say that we do not fully understand or appreciate this. Not only is there a need for abstract deductive thinking, but also there is the need to learn observation and inductive thinking. Other disciplines are more selective and less concerned with observation and induction. And as geographic databases proliferate in spatial and thematic cover, the need to be able to manage systems and to glean information is pressing. The thinking process involves relating the observation of places to ideas and theories [SEBBA, 1991, Pp 15-22].

In this respect we can illustrate some of these difficulties which stand as obstacles in the way of learning geography, and this was emphasized by MARK and BOYAN. Geography is an integrative discipline, and therefore data necessarily spans a wide range of perspectives and interests, from the social to the physical and all points in between. Arising from this complex mix of perspectives, and coupled with a growing infrastructure for gathering information, the following problems arise [MARK & BOYAN, 2002, Pp 1-15]:

(1) *Data volume*: Like many disciplines where data mining is applied, geography is rich in data. Knowing which portions of a dataset to analyse, and which to ignore becomes problematic.

(2) *Complexities caused by data gathering and sampling:* Although data is available in increasing volume, it is still often the case that we must resort to surrogates or aggregates for the phenomena of interest, rather than to direct measurements [YUAN, 2001, p 17].

(3) *Complexities caused by local relationships*: Earth systems are so intrinsically interconnected that it is difficult to isolate an analysis conducted on some part of a system from the effects of other un-modelled aspects. The outcome often appears in statistical form.

(4) *Complexities associated with the domain itself*: Interesting and relevant signals in data are often entirely hidden by stronger patterns that must first be removed. For example, the cyclic natures of many geographical systems (daily, annual, and

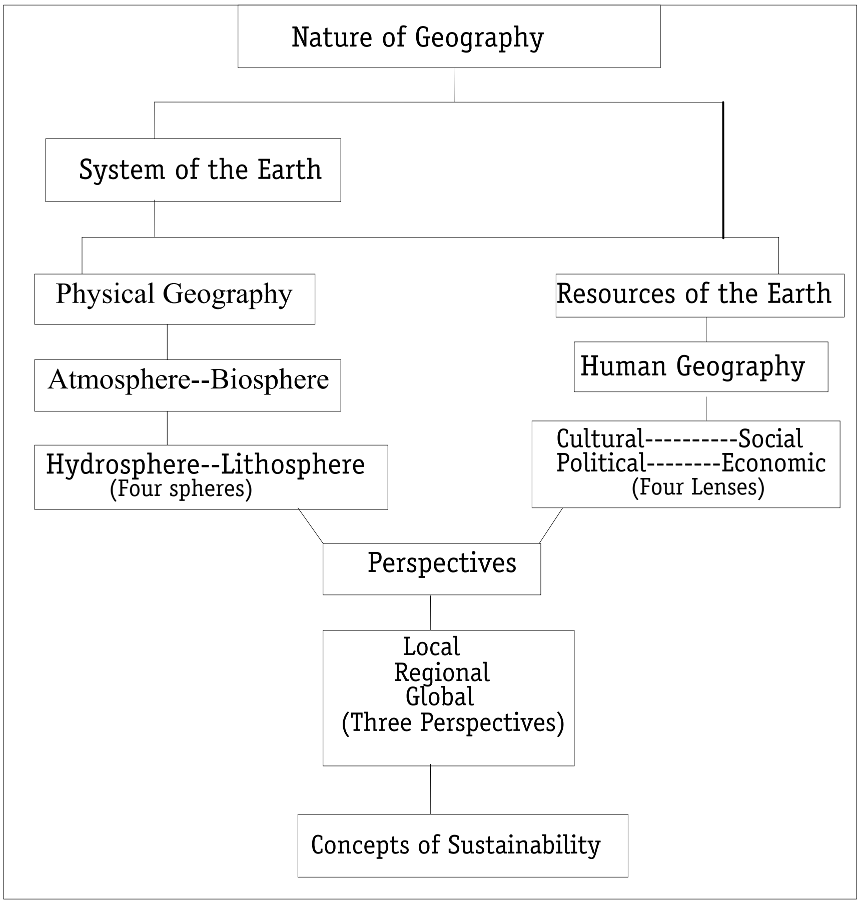
sunspot) impose a heavy signal on data that can overshadow more localised variance [RODDICK & LESS, 2001, Pp 33-50].

(5) *Lack of appropriate methods*: While the existing techniques described in section 1.1 are useful for exploring a dataset, they fail to offer the explicit connection to theory or explanation that characterizes deduction. The best that can be managed in a computational setting is a kind of low-level explanation offered in the language of the underlying feature-space, not in a higher form, as domain knowledge.

(6) *Difficulty in formalising the geographic domain*: There is, as yet, no universally accepted conceptual model of geography, and the models that are currently implemented in commercial GIS vary significantly from each other, often in quite fundamental and philosophical ways. This leads to three distinct problems:
   (6.1) Data is often intrinsically non-commensurate in the sense that it cannot be directly compared or combined.
   (6.2) It is difficult to apply formal geographical knowledge to the process of knowledge discovery, since such knowledge is not readily available.
   (6.3) When new knowledge is uncovered it is difficult to represent that knowledge formally - there is nowhere to put it [MARK & BOYAN, 2002, Pp 1-15].

Throughout the previous about the nature of learning geography, we can indicate this nature in the following figure:

Figure (1)
Nature of geography [own draft after Bird, 1989, Pp 42-44]



Therefore, the practical aspect of this subject represents a new trend that enhances the relationship between geography and society, and the interaction with other subjects for future planning. Every place has its geographic features that distinguish it from other places on the one hand, and integrate it with others, on the other. This clarifies the practical and applicable aspects of geography.

Furthermore, Geography plays a basic role in providing learners with scientific principles that may help them to understand different geographical phenomena, and recognizing the natural and human systems that organize these phenomena. It also attempts to develop various skills, such as drawing, reading, and explaining maps and graphs, in addition to learning through demonstrations, observing and explaining natural and human phenomena [LIBEN & DOWNS, 1993, Pp 739-752].

Moreover, it is supposed that a geography learner should be aware of the nature of the subject he is learning so as to be able to accept the changes and developments in curricula, as well as the difficulties involved in geography, such as spatial dimensions of distant parts of the world.

Concepts have occupied a prominent status in the teaching process, since they are considered abstracts that organize phenomena in a few clusters through which we can summarize a great number of facts. As a result, they help in decreasing the enormous quantity of facts that the learner should know and understand. They also simplify and explain natural and human phenomena, indicating the relationships among them as well as the reasons of their occurrence.

Throughout the previous background about geography, its concept, nature, importance and the nature of studying it, which is regarded as one of the basic foundations on which the study is based, we find it essential to present a background on these concepts regarding their meaning, their importance, the importance of studying them, the methods of teaching them, and the geographical and mathematical concepts which are related to learning geography. This will be illustrated in the following pages.

2.4. Identity of concepts

A concept has many definitions that vary according to different specialists and their field of specialization, as well as their interest in certain aspects of the concepts:

The dictionary of education defines a concept as “an idea or representation of a common element, through which we can distinguish between different categories or classifications, or any intellectual or abstract conception of a situation, matter, idea, opinion, or mental image” [GOOD, 1979, p 138].

SHAFRITZ and ROGET’S add that a concept is:

(1) A general idea or understanding.
(2) A thought or a notion.
(3) An abstraction of observed events that represents the similarities or common aspects of the objects or events [SHAFRITZ, 1988, p 117, ROGET’S, 2004, p 1].

ERIC & STEPHEN say that concepts are seen as mere abstractions that are represented in verbal symbols referring to them. This is accomplished by summarizing situations, things, or events and classifying them in categories based on differences or similarities [ERIC & STEPHEN, 1999, p 6].

NOVAK states that a concept is a group of stimuli that have common characteristics. These stimuli may be presented in things, events, or persons that usually have a label of their own since all concepts indicate different categories of stimuli [NOVAK, 1998, p 937].

It should be noted that the previous definition is broad and general and it ignores ideas, intellectual structures, and abstraction.

SAVAGE & ARMSTRONG define concepts as "Labels applied to phenomena that share certain characteristics or attributes; for example, the concept 'automobile' refers to something that has the following attributes among others:

(1) It functions as a personal vehicle with four wheels and,
(2) Powered by a gasoline or diesel engine (also, but rarely, by an electric motor), or
(3) Direction of movement controlled by a circular steering wheel" [SAVAGE & ARMSTRONG, 2000, p 218].

According to ANDERSON concepts can also be defined as "abstractions that refer to different categories of things, situations, events, or ideas that have certain characteristics in common" [ANDERSON, 1995, p 519].

LOOCKE emphasizes that since a concept indicates a direct conception of the extent of commonality among things and situations exemplified by it (as it happens when we hear the word 'a triangle' that indicates a hierarchical shape having three dimensions, a base, and a form like a mountain); thus a concept is an abstraction of common elements among a group of situations, things, or ideas [LOOCKE, 1999, p 254].

MERRILL & TENNYSON identify a concept as "a group of things, symbols, or special events that are categorized based on common characteristics, and that can be named by a certain label" [MERRILL & TENNYSON, 1977, p 14].

KLAUSMEIER defines concepts as "mental constructs which are the critical components of the individual's continuously changing and enlarging cognitive structure and are the basic tools of thought, or they are socially accepted meanings of words that comprise much of the subject matter of science, English, mathematics, and social studies which children and youths learn during the school years" [KLAUSMEIER, 1980, p 23].

PINKER says that "a concept is an intellectual conception that is given a label or a symbol to signify a certain event or phenomenon; it is formed through combining common characteristics of individuals involved in such a phenomenon or event" [PINKER, 1997, p 660].

WENCHI & LAWRENCE define a concept as "the accumulated information in memory that represents a category, where a category is a set of things in the world that, for some reason, is perceived as the same things" [WENCHI & LAWRENCE, 2000, p 8].

GARDNER stresses the fact that “a concept is not only a word or term, but also content and a significance of such a word or term in the learner’s mind. Thus, defining by a word or term, it is considered a verbal significance. For example, the word ‘Lake’ is a term that refers to a certain concept as a result of realizing common elements involved in the phenomenon of having a gap in the earth surface” [GARDNER, 1999, p 10].

From the preceding definitions, we find that the symbol or term is stable, but the concept to which it refers changes and develops according to an individual’s maturity, learning, and experiences. It can be noted that the previous definition added a new characteristic to the ‘Concept’, which develops and changes according to individual maturity. Nevertheless, it ignored the aspects of ideas, intellectual conception, and abstraction.

TREVOR states that “a concept is a general idea which represents a group of things, events, and relationships, having certain characteristics in common (e.g. fruit, mountain, market.)” [TREVOR, 1988, p 125].

PRICKETTE sees a concept “as a mental construct that frames a set of examples sharing common attributes; high level concepts are timeless, universal, and abstract. To determine if something is a concept, we should make sure it can be defined as a set of common characteristics that result in numerous examples of the concept; for example, the Civil War is not a concept, but ‘war’ is a concept. Concepts can be foundational organizers for both the integrated curriculum and for the single-subject curriculum; they serve as a bridge between subjects, topics, generalization, and levels of thought” [PRICKETTE, 2001, Pp 35-36].

GAGNÉ, in his definition of a concept, refers to it as the statement used to classify things, objects, events or relations. For example, consider the concept 'alien' which means a citizen of a foreign country. He goes on saying that a person’s knowledge of sentences signifying the concept does not mean that he acquired it, since he has to be able to distinguish and classify the statements signifying the concept. GAGNÉ also states that a concept cannot be acquired unless an individual has previous information associated with this concept, for example, the concept of the 'radius' cannot be acquired, unless an individual has previous information about the circle, and the circle size and the tangency [GAGNÉ, 1992, Pp 59-60].

It can be noted that the previously mentioned definitions of a concept ignored the known fact that a concept is an intellectual conception or that abstraction is an essential quality of a concept. Thus, we conclude that different definitions involve a consensus on two basic elements of a concept:

The first is that a concept is an abstract word, term, idea, or intellectual image.

The second is the existence of one or more common characteristics for the same concept that can be indicated by a certain label or symbol.

PAULA states that VYGOTSKY described the concept as being part of a system representation encompassing both levels of abstraction and degree of relatedness to a reality constructed of other concepts. This multidimensional representation supports the development of interlinked hierarchies that rely on existing concepts to facilitate the installation of a new concept [PAULA, 2003, Pp 2-5].

The previous definition the concept used by the present study stresses that a mathematical concept means mathematical ideas, abstracts, graphic, and many issues related to various situations which are in contact with some mathematical matters, such as addition, abstraction, math graphics, similarity and numbers.

The geography concepts: BARTLETT defines geographical concepts as abstractions or generic ideas, such as location. The major process involved is geography research in the following:

(1) Observation, selection of and recording of data.
(2) Description and classification of data.
(3) Analysis and interoperation of data.
(4) Reporting and presenting findings.
(5) Applications of findings, for example, to prediction and planning [BARTLETT, 1982, p 48].

This study stresses that geographical concepts mean a group of things, symbols, or special events that are categorized and based on common characteristics, and (that) can be named by a certain label concerning the geographical concepts, for example climate, mountain, sea, valley, slope, section, and the other concepts which related with geography and mathematic.

Therefore, in the present study a concept can be defined as a word, term, idea, or abstract intellectual image each of which refers to things, events, ideas, or persons through the use of a certain symbol or label that helps the learner in problem solving and in explaining mathematical phenomena that are connected to geography.

Throughout the previous illustration, we can derive the main criteria played by the concepts during the learning process.

2.5. Critical role of concepts in human learning

As stated previously, concept learning plays a critical role in human development in terms of its interaction with the learning process. Some of the salient issues surrounding concepts and human learning are briefly stated and described below.

First, concepts enable abstract thought on the part of individuals.

Supported by concepts of a lower level and often "concrete" in nature, abstract thought can therefore be viewed as existing within a hierarchy of ideas. The concept of democracy, for example, would not be possible without the supporting ideas of common good, safety, security, health, and responsibility, the development of concrete concepts that make possible the abstraction of ideas within learners, without which learners would be unable to build more complex ideas and solve the associated problems. We can easily see via such a hierarchy that concepts are critically important in establishing the notion of abstract thought, and by implication, of human learning [GAGNÉ, 1990, Pp 37-38].

Second, concepts provide all learners with the opportunity to order and categorize objects and events, thereby eliminating the need for memorization.
Without the abstraction and classification function provided by concepts, the world would quickly become an unmanageable series of disconnected facts and experiences, quickly overwhelming the learner, and putting such a high cognitive load on mental processes that additional learning would be virtually impossible. In fact, instruction itself would not even be possible without the notion of concepts, as no instructional system could ever deliver a meaningful system of knowledge by presenting only discrete, disjointed facts. Further, such categorization and grouping also adds meaning to an individual's learning process. This meaningful ordering and grouping greatly enhances an individual's learning experience, and greatly increases the upper bound as to how much can be learned by a single person, some arguing for limitless learning [GAGNÉ, 1990, Pp 39-40].

Third, concepts perform a critical role in the ability for humans to think and communicate.
It has long been argued by cognitive psychologists that people think and communicate via symbol systems. These symbol systems are said to enable individuals to encode outside events (such as new knowledge, or experiences) into a symbolic representational form which may then be stored in the person's long-term memory. It is the concept which forms the "glue" between symbols, outside events and knowledge, and the learner's own symbolic representation. A concept can be represented by a symbol, the symbol stored in memory, and then the symbol recalled when concepts are used to classify new situations, solve a problem, or perhaps, develop a new concept or principle by combining existing concepts. Without these tools, humans would lose the ability to think and communicate effectively [GAGNÉ, 1990, p 43].

Finally, concepts are critical components in problem solving activities.
Occupying a lower level in GAGNÉ'S intellectual skill hierarchy than problem solving, concepts form the link between facts and information (i.e., mere verbal information) and the higher-order processes required to create solutions (i.e., problem solving). Expanding on the role of concept and knowledge of problem solving, there are four functions of concept that help in problem solving (three of which have already been mentioned in the preceding paragraphs): classification, inference (i.e., inferring properties of classes which are not yet known, but can be hypothesized from the existing knowledge of the class), combination (i.e., combining existing concepts to create new concepts), and communication. It is through the mechanism of concepts that individuals are able to understand and overcome problems of all types, simple or complex [GAGNÉ, 1990, p 44].

Throughout the brief illustration of the role of concepts in learning as stated by educationalists, we can illustrate some of the characteristics of these concepts, especially because they are common characteristics which are represented in concepts in general, and the mathematical geographical concepts in particular, in the following way.

2.6. Characteristics of geographical and mathematical concepts

Concepts are perhaps the most fundamental and central units of cognition. There are other types of representations, such as images and music, but the Representational Theory of the Mind assumes that at least prepositional mental states, such as beliefs, desires and knowledge, have semantic content that relates them to things in the world and that can be used in psychological explanations. These mental states are represented using concepts. The concept in general has several traits or characteristics [FODOR, 1998, Pp 6-8., KLAUSMEIER, 1980, Pp 20-26., CARY & PHILIP, 1991, Pp 206-209., WILSON, 1995, Pp 26-55., GUSTAFSON, 1996, p 27]:

1. *Learnability:* Concepts differ in their liability to be learned. This means that certain concepts can be learned faster than others, such as those concepts which have evidences that can be concretely realized. Individuals may differ in the degree of learning and maturity and their ability to learn such concepts. For example, the cognitive mapping uses a general term that applies to a series of methods for measuring mental representations. This technique attempts to describe mental images which subjects use to encode knowledge for math or geography and the information attributed to them, most researchers treat cognitive mapping as a tool that can usefully summarize and communicate information rather than as a literal description of mental images.

2. *Usability:* Concepts differ in their usage. In other words, there are certain concepts that are used more than others in understanding laws and problem solving. Individuals also differ in their ability to use different concepts according to the degree of learning and maturity.

3. *Validity:* The validity of concepts is determined according to the extent of consensus among experts on their definition or significance. The concepts of chemical, physical, and biological classification are more valid than those connected to behavioral sciences. While specialists in zoology agree on the significance of the concepts associated with different animal categories, we cannot find such an agreement among specialists in behavioral sciences in concepts like 'freedom'. The validity of a concept increases with the increase of individual learning and specialization.

4. *Generality:* Concepts differ in the extent of their generality according to the number of concepts included. The greater the degree of generality for a certain concept, the fewer its distinguishing characteristics are. For example, the concept of geographic forms which have general characteristic such as (hills, mountains, etc.). The number of distinguishing characteristics of a certain concept increases with the decrease in generality.

5. *Capability:* The capability of a concept is determined according to its facilitation of acquiring further concepts. The necessity of instructing students in broad concepts that have a strong explanatory power, facilitate the learning of other concepts. However, the structure of any concept gets more complex according to the generality of the concept and the number of relationships included.

6. *Realization:* Concepts differ in the quality of evidences that enable an individual to realize a certain concept sensually or mentally. For example, the concept of 'a sea' has many examples that can be seen and observed, whereas a concept like 'time' has no examples that can be sensually realized. The greater the maturity of an individual, the greater his ability to realize the less obvious concepts, a student learns concepts through vision or usage, but the more mature he gets, the higher is his ability to learn concepts through symbols.

7. *Multiplicity*: Most concepts have signifying examples, but concepts that differ in the number of these signifying examples, in turn differ in quality. Some examples are conceptual, while others are imaginary. With the increase in maturity, comes the belief in new models. Individuals differ in the number of models and in their nature that can be understood by the same concept. The student who lives in an environment that is full of rivers and lakes finds difficulty in conceptualizing the form of a desert country.

8. *Abstraction:* Concepts differ concerning the aspect of abstraction. For instance, concepts like mountain, river, island, are characterized by a low degree of abstraction, whereas concepts whose characteristics can be specified through realization or recognition like statistics or intelligence are characterized by a high degree of abstraction. Analyzing several examples of human behaviors and comparing them to each other in the light of certain purposes and results might be helpful.

9. *Complexity:* Concepts differ in some characteristics that are necessary to define them. The higher the degree of complexity in a concept is, the more it is considered complex. For example, the concept of 'rectangle' is a simple one, since it is based on a limited number of characteristics (base, height, parallelogram sides), while 'morality', on the contrary, is considered a complex concept to a great extent, for it is distinguished by a high number of characteristics that include concepts like ideas, customs, traditions, institutions, and each of them is in turn distinguished by another group of characteristics. The more complex a concept is the both its ability to organize and construct great numbers of concepts and facts will be, which leads in turn to difficulties for students to understand the concept. This creates a problem for geography teachers, since teaching geography includes many concepts that can be considered complex, like sectors and contours.

10. *Variability:* Concepts differ according to the number and qualities of things included in their categories. Thus, we find that an abnormal concept does not have variability, and is not known to many people, while something like graphics is characterized by a high degree of variability.

11. *Concentration:* Some concepts can be derived from one or two main characteristics that refer to the idea of the concept, while others cannot be understood without concept. Others cannot be understood without considering a number of characteristics that are equal in their importance for concept definition. It should be noted that combined concepts are characterized by a high degree of dimensional concentration, contrary to isolated concepts. For example, a

geographic concept is characterized by variability, distinctiveness, and learnability, whereas the mathematical concept is characterized by a kind of abstraction that requires a great effort on the part of the learner in order to understand and achieve it.

Throughout the previous characteristics that the study adopted as milestones that should be represented in the concept as part of the educational process that helps learners to master and apply what they have already learned in novel situations, it has become important to clarify the ways of acquiring concepts which do not differ within the different school subjects, except in the ways of learning it. Therefore, we mention some theories in this regard.

2.7. Acquiring geographical and mathematical concepts

Learning concepts is considered one of the important educational objectives at all levels of learning, Therefore teachers and curricula experts make a great effort to determine the concepts learned by students of different stages of education, and to develop the procedures which guarantee successful learning. Learning a concept means any activity that requires a person to combine two or more things or events.

The process of concept formation is not a quantitative overgrowth of the lower associative activity, but a quantitative new type. Unlike the lower forms, which are characterized by the immediacy of intellectual processes, this new activity is mediated by signs [PAULA, 2003, p 2].

This activity performed by an individual in order to classify concepts, is supposed to develop concepts. A person is considered a successful learner of a concept, when he accomplishes the new classification process in a reasonably correct way. There are many points of view concerning learning concepts; therefore, the researcher will present some opinions of psychologists:

2.7.1. AUSUBEL’S View**:** in his theory of learning, AUSUBEL concentrates on meaningful learning that means learning, which occurs as a result of introducing new information to the mind. This information is connected to previous information stored in the cognitive structure of the individual's brain. In other words, the new information is of the same quality as the stored information or at least similar to it. He explains that his theory applies only to reception (expository) learning in school settings. He states that there are differences between reception learning and rote and discovery learning. Rote learning does not involve sub-assumption (i.e., meaningful material) while in discovery learning the learner must discover information through problem solving [AUSUBEL, 1968, p 11].

AUSUBEL’S classified types of meaningful learning into four basic categories arranged hierarchically from bottom to top as follows:

(1) Representative learning.
(2) Concepts learning.
(3) Issues learning.

(4) Exploratory learning [AUSUBEL, 1967, Pp 15-23].

He believes that a concept may have a logical meaning and a psychological one. From the logical point of view, a concept refers to phenomena in a certain field that are combined and classified according to common features. A concept includes what is called criterion features or distinctive features that indicate a group of characteristics in each of the units forming the concept category and distinguishing them from the units of other categories. For example, the feature 'height' that distinguishes a hill from a mountain and the existence of a peak to distinguish between mountains and knolls, but they belong to a broader concept which is 'relief'. Ausubel differentiates between two basic stages of learning a concept:

(1) Forming a concept. It refers to the stage in which we discover the features that distinguish concepts that belong to a certain category from others. Hence, a student can recognize the features of a mountain by form and height.
(2) Learning the meaning of the concept label. It refers to acquiring functional concept's so that a student might remember what he has learned and used in new situations [AUSUBEL, 1963, p 47].

2.7.2. KLAUSMEIER'S View: KLAUSMEIER states that there are four stages of acquiring concepts. They are:

(2.1) *Concrete Stage:* At this stage, the learner is able to recognize a previously encountered item if the item is presented in the same spatial orientation or context in which the item was used during instruction. For example, the learner can recognize an instance of a rectangle if that instance is identical in shape, size, and orientation with the rectangle used during instruction. No generalizing has yet taken place in the mind of the learner at this stage of concept acquisition, so the learner can only notice that the concept instance shown is the identical item used during instruction.

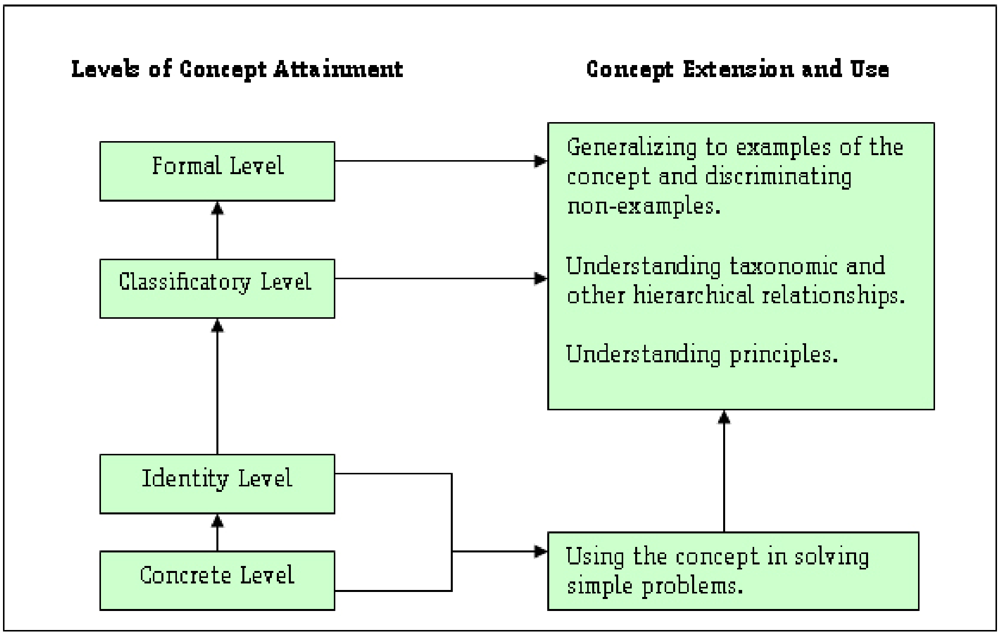
(2.2) *Identity Stage*: The learner can now recognize a previously seen item presented in a new context. For example, the learner can now identify the identical rectangle that is previously presented during instruction (as in Stage l), but now turned at any angle (say, for example, crookedly skewed at 67°). Generalization has now begun to take place in the mind of the learner, allowing the learner to demonstrate a slightly more advanced use of the concept, and its recognition in spite of limited variation of the surrounding context.

(2.3) *Classificatory Stage:* The learner has moved to a more sophisticated level of generalization, and can now recognize two or more objects as being members of the same class, and can ultimately recognize any example and non-example of the concept. For example, shown a series of geometrical shapes (including rectangles of various sizes and aspect ratios, squares, circles, polygons, etc., and in any spatial orientation), the learner can demonstrate that we can select only those shapes that fall into the rectangle class. At this stage, naming the object is not requisite, nor is an explanation for why or how the learner has made these selective decisions. At this point, generalization has now extended more fully to identification of all class examples and non examples.

(2.4) *Formal Stage:* The learner has achieved complete acquisition of the concept, and is able to identify, classify, name, and cite critical attributes of the object class. Further, the learner is able to identify the object in virtually any context without being distracted by irrelevant details in test objects. At the formal stage, the verbal information used by authorities in naming and describing the object is also known by the learner, as is a listing of (and the ability to apply) critical attributes. For example, given the same presentation of objects as in the classificatory stage, above, the learner will demonstrate that he can select the correct objects. He will also be able to name the object class (rectangle), state its critical attributes (parallel sides opposite each other, 90 degree angles at all four corners), and explain why a particular selection was made (using the critical attributes), and not be deterred by variations (a square, for example, is also a rectangle [KLAUSMEIER, 1980, Pp 26-55].

According to KLAUSMEIER, in order for a learner to achieve this level, the learner must be able to mental processes at the classificatory level, as well as either hypothesize, evaluate, infer, or conduct meaningful reception operations [KLAUSMEIER, 1992, Pp 267-286]. This can be noted in the following figure.

Figure (2)
Level of concept attainment and use [KLAUSMEIER, 1992, p 270]



2.7.3. SAVAGE and ARMSTRONG'S View:

The acquisition of concepts technique focuses on teaching certain concepts that the teacher has selected for students to learn using the following steps:

(1) Introducing the concept.
(2) Presenting examples of the concept.
(3) Presenting non examples.
(4) Providing a mixture of examples and non examples of the concept to define it.
(5) Providing opportunities for students to find additional examples of the concept [SAVAGE & ARMSTRONG, 2000, p 228].

2.7.4. BRUNER'S View: A major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based on their current/past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure. Cognitive structure (schema, mental models) provides meaning and organization to experiences and allows the individual to go beyond the information given [BRUNER, 2001, p 1].

He supposes that every person has an internal energy for learning, and what is required is enriching the surrounding environment so as to exploit such energy to the fullest. He states that an individual's thinking develops through his interaction with his environment; he also hypothesizes the existence of three interrelated patterns of thinking; the first pattern is usually common among young children, and then the rate of the second and third patterns increases with age and maturity. These patterns are:

(1) Sense-related descriptive pattern in which an individual deals with things and situations through direct senses
(2) Conceptual pattern in which an individual deals with things or events through mental images and those representing them.
(3) Symbolic pattern in which an individual deals with things and events through symbols; this usually occurs after the development of language skills [BRUNER, 1990, Pp 12-15].

BRUNER states that a theory of instruction should address four major aspects:

(1) Predisposition towards learning.
(2) The ways in which a body of knowledge can be structured so that the learner can most readily grasp it.
(3) The most effective sequences in which material is presented.
(4) The nature and pacing of rewards and punishments [BRUNER, 1967, Pp 115-117].

Good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. He holds that an individual in a single situation can practice these patterns, and it continues throughout his life. It is interesting to note that practicing the third pattern efficiently is associated with developing language skills since language can transform experiences into terms and symbols. In addition, language helps in forming adaptive images for mental processes even in the absence of things and events of the surrounding environment. Moreover, an individual can acquire higher levels, for language makes it possible to find relationships among events or things, and to organize them in an ever developing hierarchy [BRUNER, 1996, Pp 105-110].

He also admits that any concept can be taught to any child at any age if it is properly introduced. He continues saying that any subject can be taught effectively and sufficiently to any child at any stage of growth. The following example is taken from BRUNER: The concept of prime numbers appears to be more readily grasped when the child, through construction, discovers that certain handfuls of beans cannot be laid out in completed rows and columns. Such quantities have either to be laid out in a single file or in an incomplete row-column design in which there is always one extra or one too few to fill the pattern. These patterns that the child learns happen to be called 'prime'. It is easy for the child to go from this step to the recognition that a multiple table, so called, is a record sheet of quantities in completed multiple rows and columns. Here is factoring, multiplication and primes in a construction that can be visualized:

(1) Instruction must be concerned with the experiences and contexts that make the student willing and able to learn (readiness).
(2) Instruction must be structured so that it can be easily grasped by the student (spiral organization).
(3) Instruction should be designed to facilitate extrapolation or fill in the gaps (going beyond the information given) [BRUNER, 1973, p 17].

2.7.5. GAGNÉ'S *Views:* GAGNÉ holds that learning a concept requires that an individual should be able to distinguish among different stimuli or distinguish concept models. These models or examples may be positive or negative. He also believes that a concept cannot be acquired unless there is information connected with it. For example, the concept of 'latitudes and longitudes' cannot be acquired without enough information about direction in the earth and the imagination degree, it also requires additional information such as the design style or math abilities, in order to increase the rate of retention of concepts.

GAGNÉ holds that we should introduce a number of stimuli or examples that are familiar to the students. Then, we should introduce unfamiliar examples. Accordingly, we can conclude that learning is accomplished through organized abilities in a hierarchical way, which are graduated from the simple to the more complex, from the easy to the difficult, from the special to the general and from the concrete to the abstract.

GAGNÉ established a learning hierarchy in three successive steps:

(1) Specifying objectives, results, and expected behavior in the end of the learning process.
(2) Specifying the requirement of acquiring such an expected behavior.
(3) Stopping at the limit which represents what the individual has acquired before, or what he can actually perform [GAGNÉ, 1992, Pp 59-61].

2.7.6. ERIC & STEPHEN mention a group of elements regarded important or essential for the process of learning and acquiring concepts throughout concepts learning tasks and the educational conditions related to the proposed educational ideas, notions and models aiming at learning concepts. These elements are represented in:

(1) *The definition of the task*: Understanding the meaning of the task is regarded as one of the important matters which help learners understand the objective of the task which he/she performs and the purpose that lies behind what he/she does.

(2) *The nature of instances encountered*: Also the nature of the proposed model should help the individual to know or recognize the connections or branches related to it, the number of meanings of this model, the extent of its being annoying or irritating while the learners deal with it whether they encounter it

by chance or on purpose (i.e. by a method which was previously prepared), whether they can master the requisites of the proposed models, and whether it is sufficient for them to learn the concept thoroughly through it.

(3) *The nature of validation*: It refers to understanding the nature of the effectiveness of the presented model. That is to say learners are able to benefit from it in their learning for a long period of time, and that it is available to learners whenever they need it. Also this implies that learners should identify the main objective of the model. That is to say they should identify the main purpose of learning this particular model and to know its evaluation standards.

(4) *The consequences of categorization*: The model should contain all the conditions of productive learning and how the learners can come to the right judgment and the product of learning that, and also to reach the wrong or incorrect assumptions that he/she may give. Through identifying what is right and what is wrong, he/she can recognize the differences existing in his/her learning.

(5) *The nature of imposed restrictions*: To determine the characteristics or qualities, learners should be able to repeat the model several times, and also to maintain and keep it for a long period of time without forgetting it, and also to use it quickly and smoothly with other educational examples and to produce quick and right decisions in other educational experiences [ERIC & STEPHEN, 1999, p 105].

This study agrees to the previous views on the process of learning concepts in mathematics and geography, and we can say that in the light of the previous demonstration, there are some considerations that should be regarded during learning a concept such as:

(1) Pre-readiness of the learner.
(2) Starting with examples from the surrounding environment and helping the student to attain the relationships that connect the concepts.
(3) Graduation in learning concepts from the general to special, and from the concrete to the abstract.
(4) Positive participation of the students like answering the definition of concepts through demonstrative examples and classifying examples and non- examples that a teacher poses whether they are related to the subject or not.
(5) Using the technique of reinforcement whenever possible.

When learning concepts, we should put into consideration that there are certain factors, the most important of which are the learner's characteristics, and the characteristics of both the concept and the learning situation.

The present study is based on the different strategies in acquiring the concepts related to the study according to the differing topic. Throughout this illustration, it is necessary to show to what extent learning concepts in general is important, which is applied to studying the mathematical geographical concepts in particular about which many educators and thinkers have already spoken. This will be illustrated in the following pages.

2.8. The Importance of learning geographical and mathematical concepts

Most educators believe that learning concepts is considered among the most important objectives that are emphasized by schools in learning most subjects in general, and geography and math in particular, due to the nature of these subjects, having strong relationships and accurate correlation with concepts. They also emphasize the importance of learning concepts in bringing about a great benefit for the learner as follows [ERIC & STEPHEN, 1999, Pp 279-299., JONASSEN, 1994, Pp 50-56., BRUNER, 1990, Pp 24-25., KLAUSMEIER, 1980, p 42., JARVIS, 1988, Pp 125-126., CLEAF & DAVID, Pp 216-218., SNOW, 1995, Pp 127-130., JOYCE & MARSHA, 1996, Pp 148-151]:

1. Understanding the basis of science and its general framework depends mainly on concepts whether as a kind of generalization that summarizes common features among many partial facts, or as partial points in understanding laws and principles.
2. Comprehending concepts makes the school subject more comprehensive and makes facts meaningful. This (no doubt) has an effect on decreasing the rate of oblivion.
3. Concepts provide the main elements in the field of planning the curricula of geography and math, and establishing the basis for selecting and organizing the learning activities, situations, and experiences.
4. During the process of acquiring concepts, the learner practices mental skills like organizing, correlating and distinguishing common features, all of which are mental skills that are rarely cared for by current teaching strategies.
5. Learning concept helps in explanation, prediction, and application, since learning a concept in a certain stage aids the learner in explaining situations or new events, that may be unfamiliar to the learner or he may not have learned before.
6. Self-learning has become a modern educational approach to which all academic curricula obviously responded.
7. Being competent in understanding concepts and generalizations of geography or mathematics means the ability to study and practice many skills that require studying such a science.
8. It contributes to facilitate the selection process of the content of the school syllabus with the relationship between facts and educational situations and forming basic concepts as the main criterion for selection.
9. It constructs the successive and connected school curriculum in different educational stages.
10. It helps to connect the school topics and to achieve cognitive integration in constructing the curriculum.
11. It helps curriculum designers and its executive authorities in developing and improving curricula and makes them objective and clear.
12. It allows the flexible addition of new facts without causing imbalance in the learner's cognitive system.
13. It helps both the teacher and the learner to understand the nature of science concerning its subject and method.
14. It helps the learner to retrieve what he has learned, and therefore decreases the need for repeating learning as a result of oblivion.
15. It contributes to facilitating the transfer of learning to other new educational situations.

16. It helps in decreasing complexity of the environment since concepts classify things and situations. Thus, concepts are considered some of the important messages that aid students to recognize the environment.
17. It decreases the need for learning when the students' are confronted with new situations.
18. It helps to direct, predict, and plan any activity.
19. It allows organization and connection among groups of things and events
20. It provides the learner with most thinking basics.
21. It helps to explain natural and social life, in addition to making the appropriate response.
22. Without learning concepts, the level of experience becomes very low.
23. The attempt to teach facts only will be useless; since facts are numerous, to the extent that it will be impossible to teach them all, and their multiplicity will increase more and more.
24. Children learn concepts rapidly, and this may help to interpret new situations and experiences that may appear.
25. It helps to increase the student's achievement if teaching techniques that concentrate on using concepts instead of traditional teaching techniques are used.
26. A teacher can use concepts for individual learning through adapting facts, examples, and experiences so as to be appropriate for students.
27. It helps to solve problems if a student is able to develop a construct of concepts in a good way.
28. Using concepts as a basis for teaching may help to facilitate the process of communication, for they reinforce the ability for interaction.

According to what was previously mentioned, it is clear that there is almost a consensus among educators concerning the importance and benefits of concepts. Indeed, concepts represent a vital element in the educational process and express an idea that may be undoubtedly understood. However, the benefit of concepts cannot be achieved unless there is a successful teacher that admits its value and realizes how to teach them. Therefore, it is obvious that learning concepts achieves many objectives in this study whether in geography or in math (as well). These objectives are represented as follows:

(1) Relating facts, things, and phenomena, so as to be stable, not subject to change contrary to information based on facts.
(2) Concepts simplify the study of the environment, and decrease its complexities, since they classify things and phenomena into categories.
(3) They increase the students' interest, and their abilities to use the functions of science in order to discover and learn new things.
(4) They increase the student's ability to explain events, and use information in problem solving.
(5) They lead to re-stating topics, writing books, and organizing other concepts based on the essential concepts.
(6) They are considered a basis for teaching the structure of the educational subject.
(7) They may help to increase the achievement of the students if they are used as a teaching technique instead of the traditional method.

There is no doubt that concepts are of great importance for facilitating the learning process. The importance of these concepts has already been presented with a special focus on the geographical-mathematical concepts and their importance for learning geography. Consequently, we can present a classification for these important concepts tackled by the present study in the following section.

2.9. Classification of geographical and mathematical concepts

A theory of concepts tries to explain what it is that unites and binds a group of individuals or events together. Sometimes concepts can appear to be very simple at least on the surface; concepts such as chair, dog and cat seem to be self-evident; everybody knows what they are. On the other hand there are concepts, such as time, democracy and love that everybody knows but does not really know what they are. There are many implications of concepts that will be mentioned here.

2.9.1. GAGNÉ'S *classification of concepts;* GAGNÉ *classifies concepts into two categories:*

2.9.1.1. *Material concepts*: Mathematic concepts refer to those concepts which are used to describe things or topics that can be seen and observed directly such as the concepts of a mountain, sea and island. These concepts can be developed among students through direct experience or observation by using instructional aids that demonstrate such concepts. Such concepts are the easiest kinds to understand in the educational process.

2.9.1.2. *Abstract concepts*: They refer to those concepts that an individual cannot see or observe their representations due to their enormous size, such as the concept of world land; or due to the fact that they are not concrete, and thus, cannot be experienced, such as the concept of 'triangle' or 'rectangle'. Such concepts require a number of connected concepts. Besides, such concepts may be highly abstract, including a great number of concepts, such as 'earthquake' or 'volcano', which are seen as part of natural phenomena. It is noticeable that students experience some difficulties with abstract concepts in geography lessons, especially beginners [GAGNÉ, 1992, Pp 52-57].

2.9.2. VYGOTSKY'S *classification:* VYGOTSKY'S classification distinguishes between two kinds of concepts according to the nature of learning situations which are:

2.9.2.1. *Instinctive concepts:* They are concepts that the individual can acquire as a result of daily acquaintance with life situations, and his interaction with the environment. Children, for example, pick up most of geographic concepts, such as mountain and triangle; these concepts represent part of our mental structure since early childhood.

2.9.2.2. *Scientific concepts*: They are referred to as these concepts that are intentionally required, whether from the individual or from an external source, such as the concepts that the learner tries to know their meanings by himself without the help of the teacher, or those concepts learned in classrooms, field studies, and field trips [VYGOTSKY, 1978, p 11].

Also PAULA states that VYGOSKY'S model deals with the classification of a concept as a behaviour that begins meaninglessly with the individual or it is a behaviour that stimulates the individual's curiosity to be well-acquainted with more knowledge, whether it is known to him or not, as in the case of the signs and gestures of the human being and which become meaningful signs later on. These sings are useful to the communicative process in the post-learning. This usually happens during the social interaction. Thus a concept is acquired along the different stages in lifetime. It differs and varies from a period to another. In addition, the concept, in its development, needs social interaction without which it is not acquired [PAULA, 2002, p 12].

2.9.3. SAVAGE and ARMSTRONG classified concepts according to their basic characteristics into conjunctive concepts and disjunctive ones:

2.9.3.1. *Conjunctive concepts*: All defining attributes of conjunctive concepts must be present for something considered a proper example of this type. For example, the conjunctive concept of triangle has the following attributes:

(1) Exactly three dimensions,
(2) A closed, two-dimensional figure, (three interior angles), if any of these attributes is missing, it will not be considered a triangle.

2.9.3.2. *Disjunctive concepts*: In the case of disjunctive concepts, it is not necessary that all definitions of the concept be present so as to be considered a proper example of the concept; a point in a football match is an example of disjunctive concept. However, to record an extra point, three definitions of the concept that refer to extra points should be considered:

(1) The ball can be run into the end zone for touchdown;
(2) The ball can be passed into the end zone and caught by an offender following a touchdown; or,
(3) The ball can be kicked (not punted) to the end over the crossbar following touchdown. If any one of these three contributes is present, an extra point is scored. Therefore, disjunctive concepts are somehow more difficult to learn than conjunctive concepts.

2.9.3.3. *Relationship concepts*: Attributes of relational concepts bear a specific relationship to one another. There is a relationship between an attribute related to cover (miles) and an attribute concerned with time (hours). Mastery of related concepts requires students to understand not only each attribute but also the natural relationship among attributes. As a result students need to learn relationship concepts [SAVAGE & ARMSTRONG, 2000, p 221].

2.9.4. TREVOR and JANICE classified concepts, saying that some concepts are quite simple whilst others are more complex. It is important that we teach concepts for several reasons. Firstly to attempt the teaching of facts only would be futile; facts are so numerous that to teach them all would be impossible. The number of facts increases daily and can soon become out of date. Secondly, children develop a growing store of concepts which help them to understand and interpret new situations and experiences as they arise. Thirdly, concepts act as organizers and summaries for us when meeting new experiences, and finally they are anchor points in learning to which the teacher will want to return from time to time in order to stress their role in learning [TREVOR & JANICE, 1988, Pp 125-127].

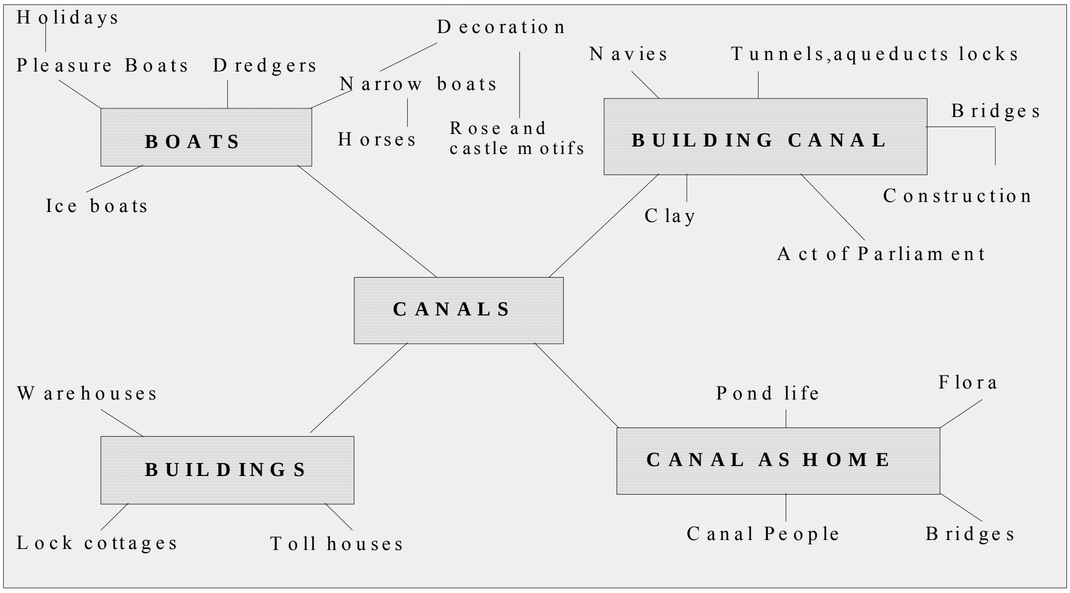
In integrated studies three concepts have been identified which are common to Geography and science and most of the primary school curriculum. These are:

Similarity / Difference
Continuity / Change
Cause / Consequence

These three concepts are concerned with ways of classifying and examining subject matter. Similarity / Difference are obviously concerned with classifying subject matter. Continuity / Change can be used to know whether the study of the same things differs from others and why things change. It is not expected that the children will be able to grasp those concepts although it may be possible in some cases that children will become able to use and begin to understand the actual terms.

The main use of these three concepts for teachers in planning topics is to enable them to examine possible contents in a selective way so that the content can be 'pruned' to that which is relevant and meaningful and contain a relativity coherent progression in concept development. It has been a common practice in topic planning to draw up a topic or a web. For example, a possible topic web on 'canals' may look like this:

Figure (3)
The 'webs' and 'canals' between the concepts [BRUNER, 1990, p 116]



This topic web concerns itself only with those things related to 'canals' and all the contents related to that topic. It would be possible to develop the web much further including many more items which could be argued and which are related to the topic of 'Canals'. Yet it would be difficult to show a purposeful relationship between 'bridge construction' and 'water birds' or 'holiday'. Alternatively, the three concepts can be used as 'organizers' around which the content can be grouped. This has the effect of pruning and limiting the content to those items which are relevant and purposeful.

We can demonstrate an application in geographic concepts, for example, the first type is exemplified in studying anthropology, since the Mongol race has a group of traits represented in the form of eyes and hair and the yellow skin, as well as the big head and moderate height. These qualities distinguish all that race individuals. Concerning the second type of concepts, it appears separately like the concept of 'industry', explained as a certain condition of production, whereas the third type of concepts is represented in a concept relating two or more characteristics. They are most difficult for children since children lack experience in realizing relationships. The most common relationship concepts in geography are those connected to time and space like longitude and breadth lines [BRUNER, 1990, p 116].

Throughout the previous illustration of the theories that dealt with classifying theories, we can also classify the mathematical concepts in the light of what the learner studies in the primary stage till the university stage. This will be clarified in the following pages. The National Council for Teachers emphasizes the following concepts [NILSON, 2002, p 334., CHIN & TALL, 2001, Pp 1-8]:

(1) *Number and operations* - accuracy in counting, numerals, addition and subtraction, and strategies for whole-number computation that students studied in primary five.
(2) *Algebra-sorting* - classifying and arranging objects by size, number and other properties, sequencing, patterns, representations of symbolic notations, symbols for qualitative change and other strategies that students studied in the primary stage seven or eight years ago.
(3) *Geometry-identifying* - drawing, and comparing two-and three-dimensional shapes; representing shapes from different perspectives; recognizing geometric shapes in the environment and other similar strategies which students studied in the primary stage seven or ten years ago.
(4) *Measurements* - attributes of length, volume, weight, area, and time and comparing objects to these attributes; selecting appropriate unit and tool for measuring attributes; comparing estimates and other similar strategies which students studied in the primary stage seven or ten years ago.
(5) *Data analysis and probability* - sorting and classifying objects in sets, representing data using pictures and graphs, discussing experiences as likely or unlikely and other similar strategies which students studied in the primary stage eleven years ago.
(6) *Problem solving* - identifying - analyzing, and other similar strategies which students studied in the primary stage eight years ago.
(7) *Reasoning and proofing* - using pattern recognition and classifying skills to justify answers; strategies that students studied at all levels of education.
(8) *Communication* - using oral and pictorial language to convey mathematical thinking, listening to others and evaluating ideas; strategies that students studied at all levels of education.
(9) *Connections* - using experiences to make linkages between one mathematical concept and another and mathematics and real life; strategies that students studied at all levels of education.
(10) *Representation* - representing understanding through oral or written the language, gestures, drawing and symbols; strategies that students studied at all levels of education.

2.10. The difficulties affecting the learning of concepts

One of the most important properties of concepts is that they are semantically available. A thought may be true or false, depending on the conditions or state of that particular part of the world which this thought is about. Concept learning is accomplished in mutual relationships between the student and the teacher throughout the frame of the educational situation. We will discuss these factors and the difficulties related to each of them, whether in general learning or in learning math and geography.

Many educationalists emphasized the existence of many educational problems that students face during the learning of concepts. Some of these problems are related to learners themselves, the educational process, the information being taught and delivered, the learning context and environment (as the surrounding environment helps improve the learning process), or the evaluation process and the problems which are related to it. In the following pages, those previously-mentioned problems will be demonstrated as follows [GEOFFREY, 1994, Pp 17-22., JONASSEN, 1997, Pp 289-308., MERRILL, 1993, Pp 2-22]:

2.10.1. *The student's:*

2.10.1.1. *Positive Self-Concept*: Learning is a non-starter if people do not believe they are capable of learning, perhaps because they think they are too old, or there might be another reason. They may have a block about a particular matter which goes back to previous negative experiences in school or elsewhere. Or they may compare themselves (or have been compared) unfavorably with someone else, or simply lack the social confidence. The need for a positive self-concept or sense-efficacy is stressed in humanistic and social learning theories.

2.10.1.2. *Open Mind*: Learning is equally a non-starter if people think that there is nothing to be learned, that they know it. Whereas the first condition is often a problem with learners, the second one often impedes the successful or experienced person, and the openness is not just to new ideas, but also to new beliefs, practices, relationships and approaches, a point made in theories of adult learning which stress the need sometimes to unlearn before one can re-learn, but also more generally in cognitive-field theories of learning.

2.10.1.3. *Ability*: Although 'lack of ability' sometimes provides a convenient excuse for teachers and trainers, ability is an important condition of learning. However, there are profound disagreements not only on what factors affect it (heredity/environment/age/cognitive enrichment) but also on what it is (unitary or multiple, analytic or practical, convergent, divergent). What do you understand by ability, intelligence, and aptitude? What kind of demands does your subject or field place on people?

2.10.1.4. *Priorities*: Learning will not take place unless it is given some priority amongst all the other things that may occupy our minds and lives. It thus involves a preference on the part of the learner which usually displaces also, in terms of attention, time and effort. Prioritization implies some kind of motivation which may be external/ intrinsic: a key element in research on personality and learning.

One of the difficulties that encounter learning concepts of mathematical geography is represented in the fact that students lack the mental and individual skill to form concepts such as the ability to distinguish, organize and evaluate ideas, which are processes that are not mechanically successive, but which occur in a rotating process aiming at allowing a room for new information. Without allowing room for discovery and exploration, reaching a concept will be limited and immature.

2.10.2. *The Process:*

2.10.2.1. *Active*: Learning implies doing. It is essentially an active rather than a passive process. Such 'doing' may range from simple repetitive or rote learning (skills have to be practiced until they become 'over learned' or quasi-automatic) to the much more complex activities of relating, questioning, re-constructing, interpreting and evaluating information. Active learning is not always overt or obvious; it is as much an attitude or approach to learning as an observable activity. What is 'learning' to the learner?, is a key theme in cognitive theory.

2.10.2.2. *Reflective*: Learning often requires not only active engagement, but reflection during and after the event, a kind of personal de-briefing of the process. This is important not only in learning but in learning about learning, thinking about thinking and becoming more aware of oneself and the learning task and the learning situation. An idea which has emerged in particular from studies of experimental learning and reflective practice in professional fields which have also identified cognitive, emotional, organizational and cultural barriers to such reflection.

2.10.2.3. *Processing*: Only in the simplest kinds of learning do things 'come out' in the form they 'went in', i.e. pure reproduction or regurgitation. Most learning involves some degree of processing or transformation of information, and this requires the learner to develop schemas, scripts, or strategies approach, ways of thinking, procedures to accomplish this on aspect of learning explored particularly by modern cognitive psychologists who have developed information-processing models of learning, perception and memory.

2.10.2.4. *Information*: There should always be some input or content to be learned. This input is not just represented in pieces of information in the form of facts or data, but also in something for the mind to work on (i.e. procedures, skills, concepts, ideas, emotions, and preconceptions). Therefore, the development of information in certain forms, such as lectures, written material, verbal exchange, and experience, is a sign of learning; a point associated mainly with information-processing models, but implicit in all theories.

One of the most prominent difficulties faced by teachers when teaching geography or math is that syllabuses do not contain the methods of teaching them. In the case of long syllabuses, there is an urgent desire to cover the aspects of the syllabus by the end of the school year. The result is to oblige students to learn, and then the learned concepts will be mere verbal covers that are not realized.

2.10.3. *Information:*

2.10.3.1. *Patterned*: We usually find it difficult to learn things which are random, chaotic or lacking in form. Both the early Gestalt and more recent cognitive theories place great emphasis on structure in learning, hence the need for 'advance organizers', introductions, signposts, overviews, resumes, summaries, and so on. Indeed, a good deal of learning is driven by the attempt to find or give a form, although this need for structure may go with both the subject and the person.

2.10.3.2. *Meaningful*: Learning involves relating things to our own mental world to make sense of them. And such meaning can have emotional and existential overtones; it is part only of that may be accomplished or understood, but is likely to be forgotten, or discarded afterwards. Meaning 'in itself' is a central theme in cognitive psychology; meaning 'for us' concerns humanistic psychology.

2.10.3.3. *Embedded*: A lot of learning in formal education is not immediately relevant to social situations. However, a lot of informal learning is deeply embedded in the situation in which it is learned, particularly in know-how or the procedural knowledge. Indeed people may learn things in this way even when they haven't learned them formally at school or college. Experience does not in itself guarantee learning but provided that some other conditions are fulfilled, it can be a powerful source of it.

2.10.3.4. *Embodied*: Just as learning may be embodied in situations, it may be embodied in people, who provide us with a living exemplar or a demonstration of what remains otherwise purely abstract or intellectual: an example that we may imitate or reject. Social learning theory points to the importance of peer learning, modeling and socializing in this broader sense on influence which may reinforce or run counter to formal teaching and training. Such modeling may relate to procedure, attitudes and values as well as roles.

2.10.4. *Environment:*

2.10.4.1. *Stimulus*: Attention can never be taken for granted. Consciousness is a market-place full of competing interests and demands. Unless learning stimulates attentions, it will either not engage it in the first place or fail to hold it after a while. Both the content and mode of presentation should be stimulating, although one can be geared to sustained, unvarying attention, but education and training methods and environments are often rather repetitive and hence boring. The concept of a stimulus is central to behavioral theory.

2.10.4.2. *Support*: Too little stimulus will fail to hold attention, but too much stimulus can induce confusion, anxiety and withdrawal. Learning requires a measure of security, trust and support in the learning environment. The right mix of stimulus/security will vary from person to person and situation to situation, but since learning often involves a degree of risk and exposure, teachers and trainers need to think carefully about how to manage this and any related sense of threat to the person.

2.10.4.3. *Feedback*: We do not learn simply by doing. We learn by getting feedback on what we do so that we can modify our approach or behaviour as necessary. Feedback need not be immediate but it should be informative and explanatory. The older behaviorists' concept of 'knowledge of result' was reformulated more elegantly by post-war cybernetic learning theory in the modern word, and its importance as a condition of learning is now generally accepted.

2.10.4.4. *Reward*: The old pleasure/pain principle was developed into concepts of reward and punishment by behaviorist learning theorists, who also noticed that lack of either (being ignored) could lead behaviour to 'fade'. So either intrinsic or extrinsic reward can be subjective things. However, one can be fairly sure that people will not learn if they are constantly punished, discouraged, criticized, held up to scorn, put down; this is common sense, but not always a common practice.

Scientific and life concepts are formed by the students, almost without purposeful learning before joining school; learning conditions should be suitable for supporting and developing concepts in the right level and direction.

2.10.5. Assessment:

As we noted earlier, the assessment of a participant's learning should be built into the overall design of the course, because it is affected by other elements, notably the aims and methods. Assessment goes beyond the informal, natural appraisal or feedback function described in the micro-model, because it is overt, formalized and often counts towards. Trainers hence will typically be concerned with three types of assessment.

Assessment in this context is regarded as an important aspect of the educational process through which the students' educational levels and achievement abilities can be identified. The present study is greatly concerned with assessment as a stage of the evaluation conducted by the study. It is mainly used to identify to which extent do students composing the study sample master study concepts and skills. Also, it is used in the different stages of teaching curriculum to identify the effectiveness of the program in developing the mathematical concepts and skills required for learning geography. This is clearly indicated by diagnosis, continuous assessment, and summarizes assessment. It is also evident in the following elements:

2.10.5.1. *Diagnostic*, which assesses the participant's learning or level at the beginning of the course or event, perhaps through an initial test or assignment, or through a supervisor's report,

2.10.5.2. *Continuous,* which tasks intermittent samples of the participant's work during the course e.g. through tests or assignments often accumulating these towards an overall judgment,

2.10.5.3. *Terminal*, which assesses learning at the end of course, usually through examinations or projects.

Essentially, no matter how carefully one controls the aspect of external learning conditions described previously, instruction nevertheless can only make the occurrence of the crucial internal, idiosyncratic event of learning more probable. The careful design of instruction can surely increase its probability, and, by so doing, make the entire process of learning more certain, more predictable and more efficient. But the individual's nervous system must still make its own individual contribution. The nature of that contribution, of course, defines the need for the study of individual differences [JOYCE, 1992, p 371].

Finally, learning to attain a concept is influenced greatly by teacher's effort to form and clarify a concept through searching for a position of the concept in the lesson being taught, and the learning conditions that support reaching a concept, since it helps the learner to find a certain strategy to obtain appropriate information, A teacher provides examples and demands readings and experiments about the topic, and concentrates on the basic features of the concept through questions, signs, and interrelationships among previously formed concepts. The most important factor may be the teacher's understanding of the nature of the concept.

In the light of this presentation of the difficulties that stand as obstacles in the way of teaching concepts, how to deal with them, and the obligation for both teachers and learners to understand them, we can present some of the strategies which help teach concepts as clarified by the senior educationalists in the field. This is evident in the models of teaching concepts.

2.11. Models of teaching concepts

Concepts are the most fundamental constructs in theories of the mind. Given their importance to all aspects of cognition, it's no surprise that concepts raise so many controversies in philosophy and cognitive science. Should concepts be thought of as bundles of features, or do they embody mental theories to most people: Are concepts mental representations, or abstracts entities [ERIC & STEPHEN, 1995, p 3].

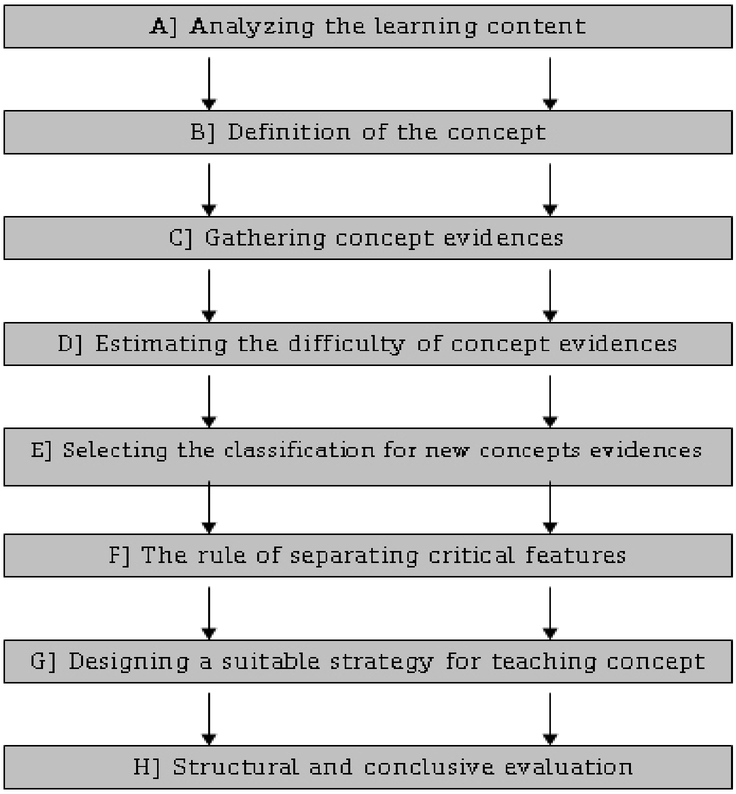
Many researchers in the field of teaching recently cared about teaching concepts due to their great benefits for both teacher and learner, as well as the school curriculum. So, many theories and educational models appeared to attain the best possible results concerning appropriate understanding and awareness on the part of learners. In the following section, the researcher will attempt to shed the light on some models of teaching concepts which are divided into many types:

The first type: Deduction-Teaching Models

MERRILL & TENNYSON'S Model is known as "a deductive model for teaching concepts in which the learning process moves from the general to the specific, and from the whole to the part". *He* prepared a deductive model based on their numerous researches to teach concepts moving from general to special, and from the whole to the part, including the following basic steps [JOYCE, 1996, Pp 15., MERRILL, 1998, Pp 6-11., MERRILL, 1993, Pp 2-22]:

Figure (4)

MERRILL and TENNYSON'S model [MERRILL, 1993, p 19]



PARK & TENNYSON hold that providing explanatory examples side by side with definition is much better than merely providing a definition of the concept for the student in learning the meaning of the concept [PARK &TENNYSON, 1986, p 15].

If we are to demonstrate MERRILL & TENNYSON'S model in teaching the concept of "the natural relief of Germany", a teacher may follow these steps:

(1) A teacher shows a graph representing relief meaning; then starts to analyze the graph into its branches.
(2) The teacher writes the definition of each concept on the blackboard such as 'east, west, knoll, mountain, sea, day, night,.....etc.
(3) The teacher shows two additional boards representing relevant examples and irrelevant ones.
(4) The teacher discusses each concept or information with the students, and specifies the main and common features of each concept.
(5) Students classify examples into relevant and irrelevant showing the reasons of classification.

The second type: Induction-Teaching Models

TABA'S *model:*

TABA'S model for teaching concepts is considered one of the best methods in helping students to learn concrete concepts and classify their relevant examples. Her conception depends on induction, and it is considered a teaching approach on induction and deduction with students using the processes of combining, organizing, and classifying concepts and generalization leading to developing thinking and creative abilities [TABA, 1966, p 286].

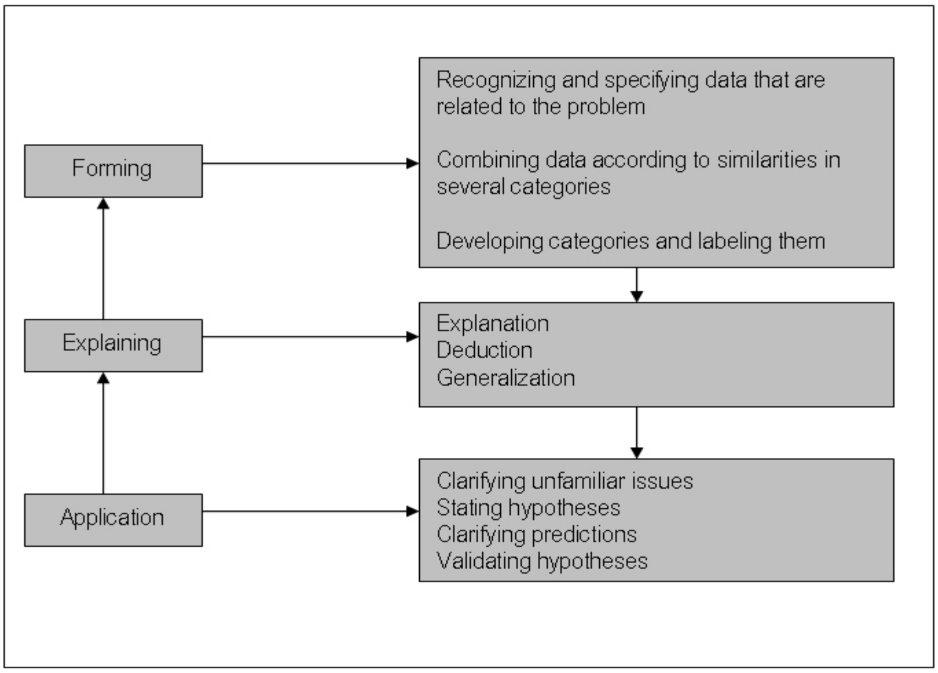
JOYCE states that TABA divides the inductive method into three parts or three inductive thinking skills: The first inductive thinking skill consists of concept formation, which occurs when students identify the relevant information, create logical categories based on similarities of the information, and then label these categories. The next inductive thinking skill (according to Taba) is interpretation of data. Students re-evaluate the information or data that they have categorized and begin to form opinions of how the different categories relate to one another. This stage is when students form generalities about the information. The final inductive thinking skill is application of principles. In this final stage, students use their formed generalities or proposed relationship about the information to predict outcomes or classify new information based on their specified criteria and determined relationships [JOYCE, 2000, Pp 130-141].

The researcher tries to explain TABA'S instruction model, which is represented in:

1. Forming concepts.
2. Explaining data.
3. Application.

We can note this in the following figure [TABA, 1989, p 66].

Figure (5)
TABA'S Model [TABA, 1989, p 66]



The third type: Induction and Deduction Teaching Models (GAGNÉ'S model)

GAGNÉ is considered one of the most prominent American psychologists who contributed to finding a model for teaching concepts based on broad assumptions that are testable and applicable in teaching. GAGNÉ'S model was distinguished by deriving from the theories of 'stimulus and response', and 'perception and knowledge', in addition to their implications in the field of programmed learning, and exploratory or inductive learning. In his definition of concepts, GAGNÉ refers to the fact that a concept is the statement which is used to classify things or events [GAGNÉ & MERRILL, 1990, Pp 23-30].

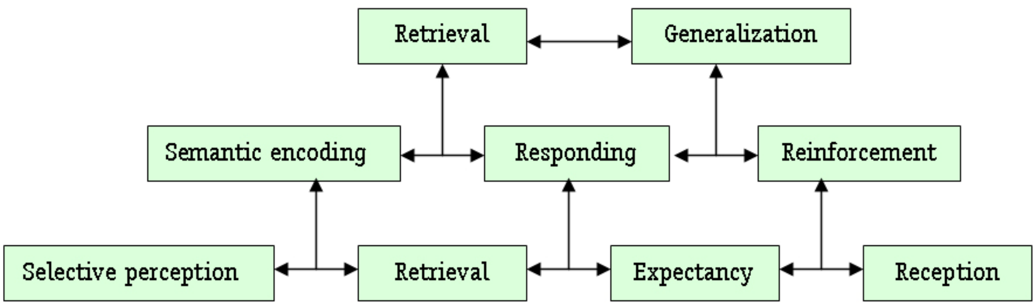
Learning concepts, according to GAGNÉ, means learning how to combine ideas or things based on common features, in spite of the existence of secondary differences among elements of the same categories, Therefore, it is obvious that, according to GAGNÉ, learning is fulfilled through hierarchical organization that is graduated from the simple to the more complex, from the easy to the difficult, from the special to the general, and from the concrete to the abstract [GAGNÉ & MERRILL, 1990, Pp 37-45].

GAGNÉ'S instructional model: GAGNÉ constructed general instructional modeling in which he specified eight instructional patterns arranged from the simple level at the base of the hierarchy, ending with the more complex one at the top, so that any type of learning in the higher levels might include all instructional patterns that precede it in the hierarchy. Doing a task analysis of learning and training task identifies prerequisites. Learning hierarchies provides a basis for the sequencing of instruction. In addition, the theory outlines nine instructional events and corresponding cognitive processes:

(1) Gaining attention.
(2) Informing learners of the objective.
(3) Stimulating recall of prior learning.
(4) Presenting the stimulus.
(5) Providing learning guidance.
(6) Eliciting performance.
(7) Providing feedback.
(8) Assessing performance.
(9) Enhancing retention and transfer [GAGNÉ & MERRILL, 1990, Pp 23-30].

These events should satisfy or provide the necessary conditions for learning and serve as the basis for designing instruction and selecting appropriate media.

Figure (6)
GAGNÉ'S Model [GAGNÉ & MERRILL, 1990, p 23]



We can note that, in GAGNÉ'S model of teaching, each teaching pattern has conditions of its own that should be followed and controlled to achieve effective teaching and learning. Learning according to GAGNÉ is that cumulative process that may occur when a learner becomes competent in previous teaching patterns in the hierarchy since learning verbal relations depends on learning stimulus and response. Similarly, learning a concept requires learning distinction and verbal correlation. The increase of probability in learning laws and principles relies on the extent to which a learner understands the concepts involved in a certain principle [PARK & TENNYSON, 1986, Pp 153-158].

The fourth type: Concept Mapping

NOVAK and Others in Cornell University developed a learning model that was called "concept mapping" and that was derived from AUSUBEL'S *theory* of meaningful learning. The aim was representing cognitive structures for students before and after learning. However, the ultimate aim was to provide the learner with an instrument that helps overcome the problem of memorizing concepts [NOVAK, 1990, p 938].

Concept mapping is a conceptual plan that represents a group of concepts included in a certain topic, which in turn are arranged hierarchically. They are arranged by placing general or comprehensive concepts on top of the map, then gradually descending on the condition, in which similar concepts in the generality dimension are placed beside each other.

JARVIS and HOLFORD believe that, "concepts map" was designed to clarify relationships among concepts in a geographical way. An arrow demonstrating the correlation between the two concepts relates each two concepts. Maps are formed with the correlation among a higher number of concepts that provide the content and cognitive structure of the subject in the form of maps [JARVIS & HOLFORD, 1998, Pp 1-2].

The use of concept mapping has become a common way to recognize changes occurring in the cognitive structure of the learner. In this context, BONNER states that concept mapping provides a clear representation for the students to enable them to understand the way in which concepts are related to and connected with each others. It also helps students to achieve meaningful learning when they perform an activity, such as evaluating individual concept mapping [BONNER, 1999, Pp 11-40].

Concept maps are divided into two types: The first is 'one-dimensional maps' which are formed by groups or lists of concepts tending to be vertically arranged. They provide a preliminary representation of conceptual organization of a certain field or part of it. On the other hand two-dimensional maps combine the advantages of both vertical and horizontal dimensions. Thus, they allow representing relationship among concepts to its fullest.

Conceptual instruction typically implements inquiry strategies. The inquiry strategy, also called the "exploratory strategy" or "discovery approach", makes use of examples and non-examples, and requires that learners use induction to determine the underlying concept. After learners induce the concept being taught, they create their own examples of the new concept, and are provided feedback by the instructor as to the correctness of their proposed concept instances. The expository strategy employs a different instructional approach by presenting the concept, its name, and its critical attributes, followed by the presentation of examples and non-examples. This more didactic approach does not make use of inquiry-discovery processes, but rather presents all known information about the concept directly to the learner. As such, the expository approach can be more efficient in terms of instructional time, as the direct verbal information pertaining to the concept can be delivered directly to students without the need for long periods of student discovery and exploration [RAY, 2003, Pp 12-13].

Throughout the previous presentation, PLOTNICK gives an example of applying the teaching models.

(1) Creativity tool: Drawing a map can be compared to participating in a brainstorming session. As one puts ideas down on a paper, the ideas become clearer and the mind becomes free to receive new ideas. These new ideas may be linked to ideas already on paper, and may also trigger new associations leading to new ideas [PLOTNICK, 1997, Pp 1-3].

(2) Hypertext design tool: As the World Wide Web becomes an increasingly powerful and ubiquitous medium for disseminating information, writers must move from writing text in linear fashion to creating hypertext documents with links to other documents. The structural correspondence between hypertext design and concept maps makes concept mapping a suitable tool for designing the conceptual structure of hypertext. The structure of both hypertext document and a concept map can be seen as a directed graph or a knowledge graph [RODRIGO, 1992, p 142].

(3) Communication tool: A concept map produced by one person represents one possible way to structure information or ideas. This is something that can be shared with others. A concept map produced by a group of people represents the ideas of the group.

(4) Learning tool: NOVAK'S original work on concept mapping deals with learning. Constructivist learning theory argues that knowledge should be integrated into existing structure in order to be remembered and receive meaning. Concept mapping stimulates this process by making it explicit but it requires the learner to pay attention to the relation between concepts [PLOTNICK, 1997, Pp 1-3].

(5) Assessment tool: Concept maps can also be used as assessment tools. The research team around NOVAK at Cornell found that an important by-product of concept mapping is the ability to detect or illustrate the "misconceptions" learners might have as explanations of content matter. The conceptions students may have are often incomplete and deficient leading to misunderstanding of instruction. Concept maps drawn by student express their conceptions and can help the instructor diagnose the misconceptions that make the instruction ineffective [JONASSEN, 1996, Pp 271-272].

The relation between this study and the concepts models

Throughout the illustrated teaching models which the study is consistent with, and which are related to teaching concepts in general, and concepts and skills in particular, we find out that TABA'S model is regarded as one of the best teaching models that help learners learn abstract concepts easily. TABA divides concepts into some minor concepts based on the main concept. Also, there is another model, MERRILL & TENNYSON'S model, which relies on deductive learning. This model is compatible with the mathematical concepts that require thinking and reasoning (e.g. parallelism and other mathematical operators). To enable our students to learn the different concepts across the various educational stages, we find that the best model that serves this purpose is NOVAK'S model, which depends totally on AUSUBEL'S theory. It is commonly used in comparison so as to infer the similarity between the geographical concepts and the mathematical ones. This is also evident in GAGNÉ'S model which depends mainly on the stimulus and response. Based on this, the present study makes the best use of the theories which deal with teaching geographical/mathematical concepts and skills. It attempts building a program based on those theories and teaching those concepts according to the nature imposed by each topic. This procedure is expected to facilitate the learning process for students. This is illustrated in the following example, which involves position, movement, size, weight, duration and temperature. Teaching shape, space and measures across the key stages may help students to:

(1) Develop their awareness of position, distance, movement and direction, and use their awareness to refine their responses,
(2) Develop their awareness of shape, size and weight and begin to use their understanding to recognise similarities and differences,
(3) Develop their awareness of time, duration and the sequence of everyday events and use simple criteria to classify objects in their environment, measure by direct comparison and, later, use standard measures to help them plan or make decisions, and
(4) Acquire mathematical language associated with shape, space and measures and use directional symbols.

Throughout the previous illustration, it was necessary to present how to evaluate these concepts in the light of the nature of each concept. This can be evident in the following illustration.

2.12. Evaluation of concepts

Evaluation is the collection, analysis and interpretation of information about any aspect of a program of education or training as part of a recognised process of judging its effectiveness, its efficiency and any outcome it may have [GREG & LTDI, 2000, p 66].

Evaluation of concepts is considered one of the main processes in evaluating the aspects of cognitive learning. Evaluation of concepts can be accomplished through the use of more than one evaluative method, like any other aspect of learning that can be evaluated through oral and written tests, in addition to discussion and observation.

It can be said that a learner would acquire a certain concept if he was able to express this concept verbally, recognize negative and positive examples of the concept, apply this concept to new life situations, and realize the main concept and its accompanying sub-concepts. The main concepts usually include certain sub-concepts that are not tied to the dimensions of a single general concept; rather, they have other relationships at different levels, contributing to the formation of other main concepts and dimensions.

ERIC & STEPHEN state that there are two levels of measuring the degree of acquiring concepts: The learner's identification of a concept, and the ability to use it in new situations. Acquiring a concept can be realized when the learner is able to express the concept in a verbal way, and distinguish things and phenomena, which means to classify them into specific categories in order to recognize negative and positive examples of the concept [ERIC & STEPHEN, 1999, p 65].

SNOW emphasized that the most important criterion in the evaluation of acquiring concepts is the student's understanding of the concepts, and his ability to classify them in new situations. Therefore, new models appeared to measure the degree of acquiring concepts, such as the model that divides the degree of acquiring concepts into two levels [SNOW, 2002, Pp 11-28]:

The first level: Measures the learner's ability to distinguish relevant and irrelevant examples. The learner can specify the concept examples from among various examples, justify the reason for choosing these examples, exclude the negative examples of the concept, and justify the reason for selecting negative examples.

The second level: Measures the learner's ability to distinguish the concept characteristics; the learner can specify the conditions that should exist in the concept examples, identify the common features between the concept and other concepts, provide a precise definition of the concept, and cite the different methods for using the concept.

It was noted through the previous studies, the different perspectives of concepts and their learning that dealt with aspects of evaluation and measurements by using achievement tests depending on the cognitive aspect. However, the present study relies on the achievement test that measures the extent to which the student knows the concept, and can apply such knowledge in answering the subsequent question of the concept. It should be mentioned that there is a cognitive aspect and an applicable aspect for each concept measured by a cognitive test.

Finally, and after demonstrating concepts evaluation, we come to the most important aspect of the study, which is represented in: highlighting the relationship between the mathematical concepts and geography; a topic to which the following section will be devoted

2.13. The relationship between mathematical concepts and learning geography

Scientific progress is based on scientific principles, the most prominent of which is teaching mathematics at a large scale. Nevertheless, the actual reality shows a high degree of reluctance to studying mathematics that has become a frustrating subject though it is very important for any contemporary advancement. Mathematics should be used by students to develop mental abilities since mathematical thinking expands the intellectual horizon and creativity. Hence, using mathematical information in programming thinking, directing behaviour, and solving social problems according to scientific principles will result in great benefits.

Mathematics can provide students with powerful ways of exploring, investigating and understanding the world. The potential to apply the skills of making comparisons, identifying differences, investigating relationships and establishing connections reflects the importance of the subject across the curriculum during the school years. Mathematics is vital in everyday life as it encourages logical reasoning and the ability to think in abstract ways. At the earliest stages of development, where thinking centers around concrete situations and events, students strive to make sense of experiences and sensations that involve changes in pattern, quantity, space and time. Such experiences help them approach problem situations flexibly, move from random to trial, improve, anticipate and predict responses. Increasingly, students will plan, reflect and come to recognise and evaluate alternative solutions. In this way, mathematical skills and understanding are built on the earliest perceptual and cognitive learning [LAUREEN, 2003, Pp 78-89].

For example, we find that some geographical concepts that are related to mathematics such as the equator, longitude lines, and height distribution (hypsographic curves), represent complexities. There are many studies that emphasized the importance of mathematical concepts in studying geography such as KAPLAN'S study which aimed at recognizing the role of mathematical knowledge in children's understanding of geographical concepts and skills .The study included 64 children, (16 from each grade), their age ranged from 3 to 6 years, interviewed and asked about certain points related to geography and mathematics. It was found that there is a positive relationship between geographic and mathematical performances. Also, it was found that some inaccurate children in mathematics achieved low scores of accuracy in geographic information. The study recommended the necessity of creating harmony between mathematical knowledge and geographical knowledge [KAPLAN, 1993, Pp 2-6].

ENEDY emphasized that the methods and procedures used in teaching geography have become increasingly important as non-geography teachers attempt to present geographical concepts in history, literature, languages, math and science. The mathematical concepts of mean and medium are easy measures that can be used especially by the mathematician or geographer also to teach the concept of mean centre. Population data for national administrative units such as states of the U.S. and provinces of China are applied to a procedure to produce mean centre that reveal locations and densities that can be used to compare these countries of approximately the same physical size [ENEDY, 1993, Pp 23-27].

SHAW emphasized that an in-class activity is that which is designed to improve students basic math, reading and reasoning skills while at the same time involving them in the applications and understanding of geographical concepts. The activity is appropriate for a freshman-level course in human geography but should also be suitable for use in high schools or community colleges. The activity, which involves applying the concepts of natural increase of application, net migration, physiological and agricultural densities as well as urbanization, is completed by pairs or groups of students working cooperatively. The article begins by discussing context within which the activity is developed, its role in the curriculum, and the teaching challenges faced. It goes on to describe the development of the activity, its implementation in the classroom, the advantage of the cooperative in-class approach, and the learning outcomes obtained. Finally, the activity is provided in a form ready for use in the classroom [SHAW, 1998, Pp 253-260].

FRED emphasized interaction among academic subjects through designing a guide for teaching mathematics through geography by providing the learner with mathematical experiences in real context. Application can occur through geography that helps a student to explain experience, communicate, and search for many solutions for complex problems [FRED, 1993, Pp 1-3].

This study considers skills and concepts as part of a connected series of knowledge, emphasizing the necessity of introducing mathematics practically. We can also study geography through learning some skills, and concepts of mathematical deduction and integrated programmed activities. In order to explain certain geographical concepts like distance, area, size, ratio, and means, a student should understand them through mathematics to be able to deal with them easily, For example, in order to divide population and their growth at different life stages in a graphic design, a student has to know how to prepare such a graph. This, in turn, leads to the necessity of understanding related concepts of mathematics.

According to what was previously mentioned, we find that a mathematical concept is a generalized or specialized abstract idea that has a common characteristic such as parallel, analogy, and group or category. We may then conclude that learning geography based on observing phenomena and processes on the earth surface occurs. Students should search and think of the formation of such phenomena to discover their results. Through research and thinking based on observing phenomena and their causes of formation, a researcher can learn an enormous quantity of facts, concepts and geographical generalizations.

Students can also acquire some geographical concepts and skills that are considered basic requirements for a competent learning. A student may feel a great difference between what he hears and he reads about mountains and knolls especially if he lives in an environment that has no mountains on the one hand, and what he sees of mountains and knolls even in pictures or models on the other [ANDERSON, 1988, p 25].

This cannot be achieved unless the learner is able to imagine mathematical concepts and geographical shapes. He can imagine the shape of a mountain as a triangle. In addition, the spatial ability does not develop without a parallel growth of mathematical imagination. A teacher should keep these facts in mind when he uses concepts in his teaching. He should make a great effort to make his students aware of the correlation between mathematical and geographic concepts to achieve a better understanding. Then, a student can be aware of sizes of different shapes like a cylinder, or cube, and compare them to natural sizes in order to comprehend and explain maps such as those of temperature and relief that are used in the teaching process.

According to the previous demonstration, we find that mathematical concepts are closely related to geography and its concepts and skills. In order to benefit from these facts, a teacher should follow the inductive technique in teaching concepts to students through beginning with partial concrete situations, then directing students to realize relationships and common features to reach the desired concept through creating experimental situations to distinguish among different concepts.

Developing concepts is considered an educational task aiming at increasing the students' understanding of geographical facts that enable them to graph a concept and realize its content, and the concept must be concerned with the mathematics curriculum so as to expand the students' knowledge of numbers, computation, estimation, measurement, geometry, statistics, probability, patterns, and function. The need for this kind of broadened curriculum is acute, and examination of a textbook series shows the repetition of topics, approach, and level of presentation in grade after grade. This standard suggests that students should be encouraged to solve problems, investigate, and use mathematics to find out things they do not already know, whether in geography or in any subject [REIGELUTH, 1999, Pp 104-105].

VATTER emphasized the importance of learning mathematical concepts and the related life concepts that learners can realize through the learning process. This is emphasized by the real-learning program of the mathematics programs which focuses on the so-called mathematical civic concepts which are related to society and mathematics, such as the origin or the ethnic group to which one belongs, sex or gender, poverty, health or environment and many other issues that are concerned with the relationship between these concepts and mathematics, and how these concepts can be developed, and the related evaluation styles or techniques. This is what the present study seeks to emphasize in regard to the different educational concepts and the surrounding environment [VATTER, 1994, Pp 396-401].

SAVAGE and ARMSTRONG emphasized the importance of some geographical concepts which are closely related to the mathematical processes, and which include: the surrounding environment, the geographical shapes and figures, the latitudes and longitudes, population distribution, interaction with reality, and many other geographical concepts which are related to mathematics that help student’s to identify the most important geographical concepts which are directly or indirectly related to mathematics till the main inventory of mathematical geographical concepts, which is regarded as one of the main objectives of the study, is reached [SAVAGE & ARMSTRONG, 1987, p 40].

Also RICHARDSON emphasized that developing geographical concepts is accomplished through certain principles such as attempting to solve problems, exploiting observation, experimentation, and trips. For example, the concept of ‘a valley or a plain’ as geographical concepts can be the basis of planning various experiences and educational activities, as well as behavioral situations directing students in understanding the nature of concepts through mathematical understanding of the shape of valleys and plains, and how to delineate them mathematically [RICHARDSON, 2000, Pp 432-437].

Through the previous demonstration that dealt with the relationship between mathematical concepts and learning geography, the main concepts of the study can be illustrated as follows [BARTLETT & BERNARD, 1982, Pp 113-116., SAVAGE & ARMSTRONG, 2000, Pp 327-351., REIGELUTH, 1999, Pp 432-437., HARTE & DUNBAR, 1994, Pp 52-85., STOLTMAN, 1992, Pp 1-39., GAGNÉ & BRIGGS, 1992, 145-160., ROSS, 1994, Pp 11-24., CHARLES, 2005, Pp 1-15., WIECZOREK, 1997, Pp 6-9]:

(1) The Concept of Drawing Scale:

The scale is a key on a map that uses a small measure to represent a larger area on the earth. The length of the scale represents a specific distance, usually in miles or kilometers. For example, I inch (2.5cm) on the Burkina map equals 250 miles (400 km) on the earth. Or it is the ratio between two dimensions, the first of which is on the map, whereas the second is in reality. Thus, we have to identify its forms that are usually provided on maps:

(1) It may be illustrated in the form of a fraction or a ratio representing the relationship between units of measurements on the map and what encounters them in reality such as:

$$\frac{1}{1000}, \frac{1}{5000}, \frac{1}{10000}$$

or in the form of a ratio such as (1:1000) and (1:5000). This means that each unit of measurement (mm, cm, inch, foot etc) on the map is represented by 1000 or 5000 in reality.

(2) A direct or written form such as: 1cm for each 3 km, or 1 inch for each 6 miles.

(3) A linear form such as a straight line divided into equal parts representing measurement units.

(4) A time form which is a comparative line between time and distances that is usually used in recognizing time differences and distances among various places.

(5) A web-net form that can be used to measure the decimal numbers, and the percentages of inches and centimeters.

The degree of benefit resulting from the use of the drawing scale depends on the extent of the student's understanding of the concept and his knowledge of its different representations on maps.

The scale is an abstract and very difficult concept; teachers' utilization of scale is one of their most challenging tasks. Scale is difficult because it requires the concurrent under subordinate understandings. Each of these can frustrate students in the early elementary grades. First we appreciate scale; a person needs to know that mountains, rivers, oceans, and so forth can be visually depicted in a convenient way. Second, a youngster looking at a photograph of a mountain needs to recognize that there is knowledge of physical size relationship between the size of the mountain as it exists on the earth's surface and the size as it is depicted in a photograph.

It is one of the basic concepts in analytical geometry, which is known in modern mathematics by its metric function. It is used geographically in measuring distances between different points on maps and their counterparts in reality through using a ruler or a thread in case of unstraight lines on maps, or the meter, inch, and mile, in reality. It is also used in recognizing the time taken between different places through the calculation of the distance and time.

(2) The Concept of Magnifying & Minimizing:

This concept is used in designing maps. It can be fulfilled by linear or drawing methods through the use of rectangles or triangles, or by the use of mechanical instruments, like the pantograph, or by the use of photographic methods of any required ratio.

(3) The Concept of Longitude & Latitude:

"Longitude" and "latitude" are two of the mathematical concepts which are commonly used in geography. Consistent with this, "longitude bows" are semi-circles that have definite and fixed length. They are attached at the Northern Pole and the Southern Pole.

They therefore form major circles, which approach each other at the northern and southern poles, whereas they are further separated at the Equator. These lines are 360 in numbers. Each degree represents a minute of time that in turn, is divided into seconds. The Greenwich line is considered the separating edge or the zero line which divides the globe into 180 lines on the east side and 180 on the west. Concerning the distance among these longitudinal lines, they vary greatly since the distance changes between the Equator, and the two poles. It decreases whenever we get far from the Equator to the north or the south.

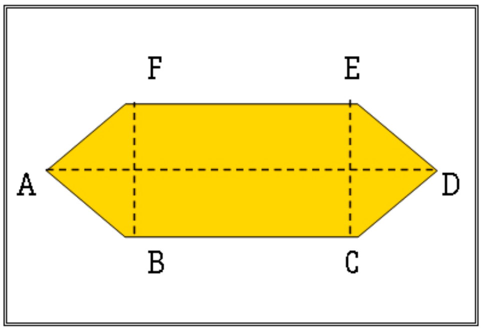
Learning to find distance using longitude: "Longitude", as a mathematical concept, should not be introduced to students until "latitude" is thoroughly and completely understood by them. Meridians (longitudinal lines) extend from poles and are numbered according to their distance, in degree of a circle, from the prime Meridian which is given the number "zero". The Prime Meridian passes through Greenwich, near London in England.

Meridians are farthest apart at the equator and converge at the poles. As a result, using longitude to measure distance is more complicated than using parallels of latitude that are equidistant. For example, Philadelphia and Pittsburgh are both approximately 40° north latitude. They are separated by 5° longitude; they are about 265 miles (427 km) apart. New Orleans and Houston are also separated by 5° longitude but are both at 30° north latitude. The distance between New Orleans and Houston is 300 miles (482 km).

Concerning latitude lines: They are circles that divide the globe parallel according to levels to the Equator, and whose length decreases till it becomes zero at the northern and southern poles. The geographical latitude of any line or circle is measured by the degree of the angle represented by the line connecting the centre of the globe and one point of that line on the globe. The latitude circles extend towards the east and the south in a parallel way representing circles that surround the globe, which are far from each others with equal distances in the north and the south of the Equator intersecting with the longitude lines forming right angles. The circumference of each circle is about 40000 kilometers, divided into 360 degrees. Thus, the average of a latitude degree on the globe is about 111.1 kilometers, or 69.05 miles with a slight difference as a result of the kurtosis of the earth at the two poles. This concept is used in specifying geographical positions and directions on maps and in reality.

(4) The Concept of Area:

It is one of the basic mathematical concepts that are used in surveys or divisions of land to specify their areas and provide accurate results. For instance, an area on the map can be measured through dividing it into geometrical shapes, such as a triangle, circle, or rectangle, the areas of which calculated by the use of mathematical rules, and summing the units to get the area like in the following shape:



The previous shape can be divided into simpler geometrical shapes by drawing the line AE, for example. Then, we draw perpendicular lines from the points of the previous shape in order to calculate each part, and finally, we calculate the whole sum of values to get the area of the shape.

(5) The Concept of Direction:

It means the place or position of a phenomenon in relation to what is attached to it. Thus, what a learner should study is the position of the phenomenon on the map in order to realize the relationship of such a position with all natural and human neighboring phenomena. In order to recognize directions, the learner has to study the longitude and latitude lines, as well as the real or geographical north.

In other words, the meaning of location refers to a position on the surface of the earth, or it is the quality of whereness.

Direction is usually given in one of two ways:

(1) Compass direction.

(2) Bearings (these can be in one of two forms: true bearing and compass bearings).

(3) Direction is sometimes given by referring to the points of a compass:

- 4 cardinal points (north, south, east, west)
- 4 major intermediate points (north-east, south-east, south-east and north-west) and
- 8 minor intermediate points (north-north-east, east-north-east, east-south-east, south-south-east, south-south-west, west-south-west, west-north-west and north-north-west). With all these points we have what is called a sixteen-point compass.

(6) The Concept of Time:

It is one of the physical mathematical concepts that are used in geography, through which we can measure the time taken to reach a specific distance. The unit of measuring time is the hour, or seconds.

(7) The Concept of Speed:

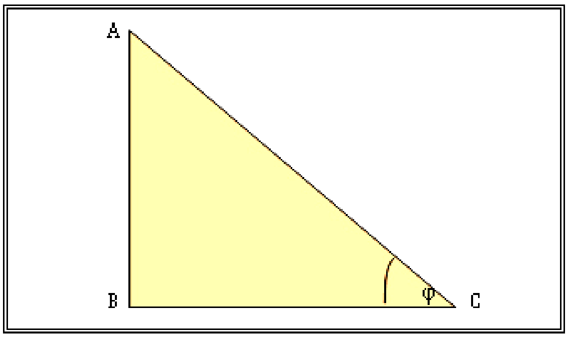
It is one of the physical mathematical concepts that are used in geography, since it represents a directed quantity V that means the ratio of change in distance in relation to time [THE FREE ENCYCLOPEDIA, 2001, p 1].

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Its unit of measurement is kilometers/hour and mile/hour. It is used geographically as in the following example: The sun rays take a distance of 149 million kilometers to reach the surface of the earth in a time of 8 minutes. Then, the speed of rays reaching the earth equals 18.625 million kilometers/minute. Speed is divided into two types: regular speed and changeable speed which is usually used in the measurement.

(8) The Concept of Projection:

It is a mathematical concept that signifies a certain dimension by use of another. It is used geographically to recognize skews and deviations from places and directions. Drawing the globe on a sheet of paper is the clearest use of the concept of plans, as illustrated in the following example:



Through the previous figure, we can find the (tan), (sin), and (cos) as follows:

$$\tan\varphi = \frac{AB}{BC}$$

$$\varphi = \arctan\frac{AB}{BC}$$

$$\sin\varphi = \frac{AB}{AC}$$

$$\cos\varphi = \frac{BC}{AC}$$

This is used to measure the regression of mountains or different shapes of relief on the surface of the globe.

(9) The Concept of Ratio:

It is a relationship between two real numbers, for instance the ratio between the two numbers 10 and 30 is 1:3. It is sometimes written as $\frac{1}{3}$. Generally, the ratio between the two numbers A, B is written as A : B or $\frac{A}{B}$. A ratio is dealt with like fractions concerning the fact that we can multiply or divide each of its parts on any number without changing its value. For example 25 : 30 = 5 : 6

And also, $\frac{3}{4}:\frac{5}{6} = 6:5$

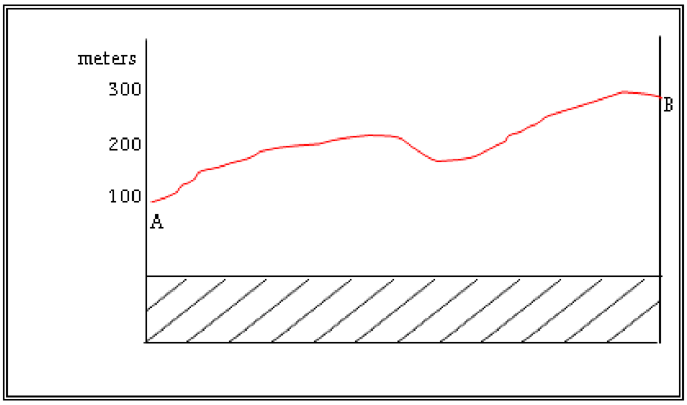
It can be used geographically to calculate the distribution of water in relation to earth, or any other mathematical geographical processes.

(10) The Concept of Slope:

It means the distance separating contour lines from other levels. Thus, the horizontal distance among contours is greater in relation to the vertical distance, or the rate of rise or fall of a quantity against horizontal distance that may be expressed as ratio, decimal, fraction, percentage, or the tangent of the angle of inclination which is contrasted with an aspect.

The slope between two points is measured by determining the differences in height between the two points (the vertical and interval) and dividing them by the horizontal distance. The slope is divided into many types such as the intensive type that has nearly attached contours, and the moderate or slight slope.

$$\text{The inclination of slope} = \frac{\text{Vertical interval (V I)}}{\text{Horizontal distance (H D)}}$$



Average inclination between A and B

$$\text{Inclination of slope} = \frac{\text{VI}}{\text{HD}} = \frac{150\text{m} - 50\text{m}}{20\text{m}} = \frac{100}{20{,}000} = \frac{1}{200}$$

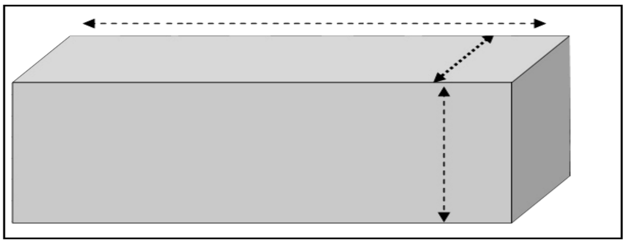
This means that for every 200 meters traveled, we go up 1 meter. The gradient is expressed as 1/200 or 1 in 200 or 1: 200.

(11) The Concept of Size:

It is signified by the symbol 'V', and is a part of space occupied by a solid material (that has a fixed form) compared to liquids whose size changes according to variation in pots containing them.

Example: Find the size of the cube whose lines are 5cm long
Solution: The size of the cube equals (V) = $5 \cdot 5 \cdot 5 = 125\ cm^3$.

In general, the size equals = length x width x height.



It can be also noted that, in order to find the size of liquids, we should recognize the size of the pot containing the liquid. Moreover, size is a standard quantity, which means that direction has no physical relevance with size. This concept is used geographically in recognizing the sizes of geographical shapes that are similar to geometrical figures such as cubes, cones ...etc.

(12) The Concept of Proportion:

It is the equality of two ratios or more. For example, if $\frac{A}{B} = \frac{C}{D}$, it is said that A, B, C, D, are in proportion. If A, B, C and D are in proportion, then, $\frac{A}{B} = \frac{C}{D}$. The two values A, D are called edges of proportion whereas the two values B, C are called medians of proportion:

A is the first proportionate.
B is the second proportionate.
C is the third proportionate.
D is the fourth proportionate.

Example 2: Find the fourth proportionate of the quantities 3, 4, 12.

Solution: It is hypothesized that the fourth proportionate is $\frac{3}{4} = \frac{?}{12}$

Then, the fourth proportionate is 9.

(13) The Concept of Equation:

The equation is composed of a dependent variable and an independent one, such as pressure and temperature. An equation has many types: It may be explicit, implicit, individual, dual, separate, or in sequence.

(14) The Concept of Arithmetic Means:

It is the sum of division between the number of frequencies of a certain incident and the total number. For example, the means of air temperature in a single day on three stations in a coastal city are 15°, 13°, 12°. What is the mean of temperature in the city?

$$\frac{15^\circ + 13^\circ + 12^\circ}{3} = 13{,}3^\circ$$

These means are usually used in climate maps in order to calculate the means of different climatic phenomena.

(15) The Concept of Numbers:

Numbers can be fractional, decimal, integral, or natural. Generally, there are characteristics that distinguish each type of numbers. For instance, we have subtraction, addition, multiplication, division, etc.

$1 + 3 = 4 = 3 + 1$

(16) The Concept of Power:

It is the change of state, from static into dynamic position. It is attributed to change in velocity of movement. Power = mass x acceleration. And the power unit is 'N=Newton'. The mass represents the material contained in a certain body. It is a standard quantity that can be measured by kg, ton, etc. The Power is a directed quantity since velocity is also a directed quantity.

(17) The Concept of Curve:

It is one of the statistical figures that represent the relationship among quantities regardless of place or position. It is represented in points, connected by straight lines that result in what is called frequency distribution or by curves to yield a frequency curve. It is used to provide a representation of the nature or behaviour of a certain phenomenon or phenomena to clarify them, or to demonstrate the relationship between two or more phenomena like the relationship between groups of crops and quantity of rain in a certain country.

(18) The Contour Mapping:

A topographic map indicates the features of the earth's surface, such as mountain, lakes, rivers, roads, and cities. Contour lines on a topographic map are irregular circles that connect points of equal elevation. Elevation is the altitude (height) or depth of the equal of the land above a reference point, usually sea level. The contour interval (change between the lines) represents grade (steepness); the closer the lines, the steeper the grade**.** A topographic map can combine colors, patterns, and contour lines to indicate location, shape, and elevation. The contour map is a bird's eye view of the same mountain. Both are topographic maps.

(19) The Concept of Graphs:

It is one of the geometrical figures that are used to illustrate statistical data. It interprets the numerical values, and raw scores into various forms such as lines, columns, circles, pyramids, or symbols on maps, and other illustrations that help to interpret numbers into live forms contributing to the learner's understanding in a simple and easy way.

Throughout this part of the study, a comprehensive investigation was conducted on the geographical mathematical concepts and the importance of learning them. This, of course, helps us to present part of the geographical mathematical skills in the same way used to present the previous illustration. This is evident in the third chapter of the study. This theoretical background contributed to a great extent in the preparation of the tools of the study so as to reach the desired objectives of the study.

3. Necessary Mathematical Skills for Learning Geography

Geography deals with man and his relationship with the environment in which he lives both as an individual and as a member of a group. It is also concerned with what results from these relationships, and what students acquire in their life as members of society and successful citizens.

Also geography is a science that consists of a connected set of facts, concepts, generalizations, theories, skills, and attitudes. Thus, it is formed in a hierarchical way beginning with a wide base of knowledge and facts that are combined and classified in the light of common standard qualities representing what we call concepts; such concepts are grouped in relationships to form generalizations, then theories are formed representing skills and concepts, attitudes, practical, cognitive, and other affective aspects [TIKUNOV, 1996, p 478].

Geography aims at making learners acquire various skills, whether they are cognitive or instrumental. This necessitates gaining awareness, on the part of teachers, of the difficulties associated with the subject that encounters students during their study; one distinguishing characteristic of geography that separates it from other disciplines is its focus on the spatial arrangement of people, places, phenomena, and processes around the earth. In addition to knowing the primary tools and national geography standards, geography informed person should have the knowledge and skills necessary to read and interpret the information portrayed on a map [GEOGRAPHY EDUCATION STANDARDS PROJECT, 1994, Pp 1-5].

Therefore, if a geography learner acquires such skills, this will be due to many factors, some of which come into play during preparation in the schools or in the schools of education represented in programs in the form of a group of syllabuses in the student's academic specialization, and another set that are in the form of general culture.

3.1. Definitions of skill

One of the important aims of learning any school subject is the learning of several skills, concepts, and attitudes since skills constitute a basic aspect of educational objectives which are sought by any subject.

Everyday usage of the world 'skill' implies some expertise in an activity developed as the result of training or experience that enable the learner to perform particular tasks, its defining attributes are generally held to be effective and flexible. There are many definitions dealing with the concept of 'skill':

WINFIELD defines a skill as "an organized and coordinated pattern of mental and physical activity in relation to an object or other display of information, usually involving both receptor and processes" [WINFIELD, 1979, p 22].

EVANS describes a skill as "any ability, generally assumed to have been learned, to perform a complex task involving psychomotor coordination with ease, speed and accuracy or constantly choosing and carrying out strategies which are efficient" [EVANS, 1978, p 13].

HOWARTH regards skill, in wider terms, as a set of strategic adaptations to the mechanical limitations of the brain and the body, which enable human purposes training or other experiences. It is built up gradually in the course of repeated training or other experience [HOWARTH, 1981, p 453].

SAVAGE & ARMSTRONG define a skill as "a practical knowledge in combination with ability; cleverness, experiences, to have discrimination or knowledge especially in a specified matter, or it can be defined as the power of discrimination" [SAVAGE & ARMSTRONG, 2000, p 21].

The Dictionary of Education defines a skill as "any series of mental or physical acts executed in such a way as to demonstrate complete control by the executor, complete control is based on the building up of coordinated activities that involve our different senses, our mental abilities and our muscles" [GOOD, 1973, p 558].

SHAFRITZ describes a skill as a mental and/or physical ability acquired by observation, study, or experience. It is considered basic to the mastery of schoolwork or other activities. Such abilities may include proficiency in planning and investigation, operational techniques, comprehension, organization, execution, remembrance, and the application of knowledge to acquire a desired result [SHAFRITZ, 1988, p 434].

FRED defines skills as "a behavior characterized by effectiveness, accuracy, and high speed of competence leading to a level close to the sub-conscious one, especially in motor skills" [FRED, 1993, p 27].

LARSON defines skills as "the competencies that are necessary for effective living, they are behaviors that are operational, repeatable, trainable, and predictable, within a delimited range of effects" [LARSON, 1984, p 4].

LOCKLEDGE regards a skill as "a kind of work characterized by accuracy and speed, and based on motor or mental skills, if the same conditions are repeated, a skill will approximate the mechanical behavior with some differences" [LOCKLEDGE, 1993, p 3].

PRICKETTE regards skill as "the ability to do something well as a result of practice, students learn skills in geography to carry out the broader processes that promote in depth understanding of a topic or issue" [PRICKETTE, 2001, p 49].

MUIR defines skills as "the individual's performance of a required task in the shortest possible time, the highest level of competence, and the least effort, on condition that he assures the safety and validity of the accomplished task" [MUIR, 1983, p 16].

According to the above-mentioned definitions, the present study defines a skill as the learner's ability to perform a certain task during the teaching process provided that that the performance is characterized by quickness, accuracy and competence.

Concerning a mathematical skill, it is defined as "a set of tasks performed by a student whether they are manual, like using geometrical tools, procedural, like dealing with and exploiting geometrical tools in solving algebraic and arithmetic problems, or mental like realizing concepts and solving mathematical problems, on condition that this is fulfilled at a high level of competence, consuming the least time and effort" [MATHEMATICS STANDARD STUDY GROUP, 2004, p 6].

In the International Conference for Mathematics, teachers concluded a set of bases and principles for learning mathematics through which the meaning of mathematical skill is reached based on their points of view on what a mathematical skill is. He also indicated in his study that a skill in mathematics is a mathematical behaviour, whether it is procedural, like arithmetic, algebraic, and geometrical processes, or mental, like realizing concepts, that may solve mathematical problems [NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, 1991, p 66].

The present study defines a mathematical skill as "the learner's performance during learning that is characterized by exploiting arithmetic or geometric processes in the process of drawing maps or graphs".

Concerning a geographical skill: The Council of Organizing Geographical Information defines a geographical skill as "a motor or mental performance followed by an individual while performing a certain work provided that accuracy, speed, and continuity of that performance are considered. Geographical skills also include explanation, and understanding of different geographical phenomena, in addition to the ability to perform some manual tasks designing models and graphs with a high degree of quickness and competence" [GEOGRAPHIC INFORMATION COORDINATING COUNCIL, 1999, p 2].

GERBER and LIDSTONE define a geographical skill as "the learner's participation in preparing schedules and graphs using the skills of analysis, synthesis, evaluation, and development of critical thinking skills, and the ways of acquiring information, and dealing with them, to make effective decisions in the future" [GERBER & LIDSTONE, 1988, p 67].

BARTLETT defines geographical skills as "those commonly used skills which are related to motor operation processes, probably which often occur concurrently, or those skills that are used to denote learning activities having a substantial motor component that draws a cross-section from a topographic map sheet" [BARTLETT, 1982, p 3].

THE AMERICAN ASSOCIATION OF GEOGRAPHERS (AAG) defines geographical skills as "instruments and techniques that are necessary for geographical thinking, or the techniques used by an individual when making important decisions concerning his future, like the place of renting a house, the way to find a job, the appropriate shopping methods, or the techniques of exploiting vacation" [ASSOCIATION OF AMERICAN GEOGRAPHERS, 2001, p 68].

THE NATIONAL COUNCIL FOR GEOGRAPHY EDUCATION (U.S.A) defines them as "the processes made by an individual to acquire the organization and use of information in dealing with natural phenomena on the surface of the earth [ALTERNATIVE ASSESSMENT IN GEOGRAPHY, 2005, p 1].

Throughout the previously mentioned definitions made by many educators, and their consensus on the fact that a skill is characterized by quickness of mental or manual performance with accuracy and competence of geographical and mathematical skills, the present study attempts to demonstrate the skills that require a mathematical base concerning the study of geographical skills that should be acquired by both the teacher and the learner.

Thus, the present study defines a geographical mathematical skill as performing geographical skills such as drawing, measuring, calculating, and specifying geographical figures and phenomena such as drawing maps, figures, and graphs using mathematical processes whether they are mental or procedural in the least possible time and effort and with the highest possible level of accuracy and competence.

Throughout the previous introduction that cared for presenting the different definitions of skill in general and the mathematical geographical skill in particular, we can introduce some theories that were interested in how the skill is developed and created in learners, according to what many educationalists tackled as follows.

3.2. The creation and growth of skills

Among the many theories accounting for the creation and growth of skills, the following have been found to be of particular relevance to the work of learning in the colleges of further education:

3.2.1. *GAGNÉ'S S-R (Stimulus-Reaction) chaining theory:* GAGNÉ considers skills as the result of connections between a set of individual associations (stimulus-reaction sequences). Part-skills should be taught, following instruction in the 'executive sub- routine', which controls their execution in the correct sequence. Stimulus-reaction associations are fixed and reinstated, as a result of guided practice; prompt, which ensures reinstatement, is used; chains, which result, are reinforced by further practice. Chains represent mastery of stimulus reaction units of activity, and result in the appearance of a 'skill'. GAGNÉ points out that those excusive subroutines often remain intact for many years even though, as a result of disuse, performance has become uneven. Thus a person who has learned the routine of setting and using a lathe has left the trade [CURZON, 1990, p 260].

3.2.2. *CROSSMAN'S selection theory:* CROSSMAN suggests that in acquiring skills the learner is refining the process of selecting the most appropriate methods from his repertoire. Practice involves exerting a 'selective effect' on the learner's behavior, favoring those patterns of selection and action which are quickest, at the expense of others. Hence, according to Crossman, trial and error are not as effective as processes by which the teacher guides the learner through the selection and utilization of the appropriate activity patterns. Speed is acquired as a result of practice based on a teacher's directions [CURZON, 1990, p 260].

3.2.3. *ADAMS' graded-movement theory:* ADAMS views the learning of graded movements as the essence of skill acquisition. The first stage of such learning involves the establishment of a 'perceptual trace' which the learner uses as the basis of successive movements; this is a verbal-motor phase in which the teacher provides verbal cues concerning the learner's action. In the second stage (the motor phase), verbal clues are not necessary since the perceptual trace is now firmly established. In practice, therefore, skills acquisition will grow from carefully directed teaching and practice [CURZON, 1990, p 260].

3.2.4. *ANNETT* and *KAY'S redundancy-appreciation theory:* ANNETT and KAY have suggested that skills are acquired as the learner is able to understand the redundancy in inputs of sensory information. In the first stages of his learning, a learner observes that signal x is apparently followed invariably by signals 'y' and 'z'. With intensified perceptual understanding he learns the probability of the signal 'x' being followed immediately by the signal 'z'. He is able to concentrate on useful cues, therefore, by learning to treat certain inputs as redundant. Skill acquisition will be determined by the selection and abstraction prior to its utilization in the activity [CURZON, 1990, p 261].

3.2.5. *FITTS' 'three-phase' theory:* FITTS believes that the acquisition of a complex skill necessitates the learner passing through three overlapping phases; the transition from phase to phase may take the form of a continuous rather than a sudden change. FITTS views complex skill learning in terms of the acquisition of a number of semi-independent sub-routines, which may go on concurrently or successively. Hence, he says, it is essential for success that the teacher should identify correctly the appropriate 'executive sub-routines' concerning sequence rules in a skill. The three phases in FITTS' model are:

3.2.5.1. The early cognitive phase: The beginner seeks to understand what has to be done and attempts to comprehend the background to the required sequence of action and builds on previously acquired part skills and the sub-routines. Frequently recurring errors are pointed out to the learner. As a result of this phase, he or she acquires in an 'executive routine' the required procedure.

3.2.5.2. The associative intermediate phase: Correct patterns of response are established in the learner's repertoire as the result of demonstrations, imitation and practice. Part skills are smoothed by the elimination of inadequate movement, and sub-skills are integrated into the required total skills.

3.2.5.3. The autonomous final phase: Skilled acts are now performed automatically, without the learner having to stop to think of 'what comes next'. Errors have been eliminated, speed of performance has been increased, resistance to the effects of stress is built up and improvement in skills continues (although in a decreasing manner) [CURZON, 1990, p 261].

3.2.6. *MILLER'S 'Hierarchical Structure Theory':* MILLER views the acquisition of skills as a progressive coordination of separate units of an activity into a hierarchical structure. He conducted research on "feedback loops" of an activity using the concept of 'TOTE' (Test-Operate-Test-Exit) unit. The first phase of an activity on which skill is based is a 'test', in which the learner assesses whether there is a difference between the actual state of the system and the required state of the same system. Any observed difference (of a significant nature) requires an 'operating' phase, followed by a further 'testing' phase. The cycle of 'test, operate and test again' will continue until the desired and required state is realized. After the realization of such a state, the activity ends (the 'exit' phase). The use of TOTE requires a plan, which is defined by MILLER as 'any hierarchical process in the organization that can control the order in which the sequence of operations related to some units of sensor motor activities occurs' [CURZON, 1990, p 262].

3.2.7. *KLAUSMEIER'S internal programmed theory:* KLAUSMEIER defines a skill in operational terms as "the level of proficiency attained in carrying out sequences of actions in a consistent way". He sets out five characteristics of a skilled performance:

3.2.7.1. The learner acquires a 'central motor program' (CMP) by practice as a result of which, his performance no longer depends on voluntary control or upon continuous attention to feedback; the CMP has been attained 'automatically'.

3.2.7.2. There is an increased freedom from reliance on external cues that has been internalized into the learner's CMP.

3.2.7.3. External 'visual feedback control' becomes internalized in the CMP.

3.2.7.4. Coordination movement patterns emerge under the control of the CMP i.e. the ability to perform the skill well under different types as changing conditions emerges [CURZON, 1990, p 262].

It is evident that skill development depends on many different foundations and basics as illustrated by the educational theories which were constructed on right bases. We can also show how skills are acquired based on those theories. This will be illustrated in the following pages:

3.3. Classification of geographical and mathematical skills

In this dimension, the study deals with the classification of skills in general, and their classification in mathematics and geography, in particular. There are many classifications of skills:

VICTOR emphasizes the fact that a skill is divided into several sub-skills such as: Functional skills and mental skills. Functional skills are concerned with the processes of observation, description, practice, measurement and recording, whereas mental skills are concerned with problem solving, critical thinking, creativity in deduction and induction. He classified skills into four main categories as follows [VICTOR, 1980, Pp 25-27., WILLIAM & NADER., 1992, p 267., JOHNSON, 2000, Pp 2-4]:

1. Social skills which are the skills that are developed through working in small or large groups at school;

2. Academic skills which are basic skills those enable the individual to continue studying in an effective way;
3. Mental skills which are concerned with valid practical thinking;
4. Manual skills which depend on manual work such as the use of drawing tools.

KINSHUK emphasizes that the skills based on competence embed two ingredients: physical skills, which constitute physical expertise of domain related to the procedural tasks; and cognitive skills, which are the skills to "carry out", procedural tasks of the domain, and thus have more to do with analysis, interpretation and decision making processes [KINSHUK, 2001, p 3].

Therefore, a skill can be classified into general skills associated with the actual surrounding reality such as social, academic, and manual skills, in addition to recording and measuring, and special skills, concerned with each individual's mental abilities and capabilities helping him in dealing with others easily and effectively.

Concerning mathematical skills, many researchers dealt with their classification such as:

(1) *Qualitative skills:* Such as using the language and style of mathematics in expression and explanation, as well as in realization of concepts that have qualitative characteristics. Examples of qualitative skills are:
- Accuracy in distinguishing symbols and mathematical concepts,
- Realizing the concepts of inclusion, variance, group, etc,
- Realizing the difference between mathematical terms like base and co-efficient,
- Recognizing the relationship between angles of a triangle of different types.

(2) *Instrumental (performance) skills:* They include connecting practical or mathematical situations concerning their transfer into relationships and mathematical models, or procedural processes. Examples of these skills are:
- Translating relationships into mathematical models,
- The relationship between angles of a triangle,
- Solving verbal problems.

(3) *Quantitative skills:* They include skills of reading numbers, and performing mathematical tasks such as:
- Reading and writing very small numbers,
- Dealing with integer numbers, fractions, or percentages,
- Mathematical problems like division and multiplication.

(4) *Practical skills:* They include the skill of using geometrical tools and performing measurement tasks using different tools and equipments such as:
- Drawing angles and geometrical figures,
- Drawing parallel lines,
- Performing direct measurement tasks using a ruler or a protractor,
- Performing direct measurement tasks through calculation, laws, and practical experiments.

(5) *Skills related to figure:* They are skills associated with recognizing the use of figures characteristics in general, and geometrical figures in particular, in addition to the ability to conceptualize figures to draw them graphically. Through this classification, we find that mathematical skills facilitate the performance of many tasks facing the learner during his daily life. They permit the direction of thinking, time, and effort in a better way to solve mathematical problems, and develop mathematical abilities [PATRICK, 1993, Pp 1-3., JORDON, 1985, Pp 31-32].

Also SAVISAAR assures that mathematical skills include the ability to perform calculations and manipulate data, occupations that require math skills at level one including pharmacists and dietitians and involve the use of algebra, geometry, and basic statistics. Level two occupations include those which require linear algebra, calculus or other higher levels of math. Operation research analyst and engineers must heave this level of skill [SAVISAAR, 1998, p 6].

Concerning geographical skills: Geography has many distinctive skills that educators have sought to classify, which include: mental skills, academic skills, intellectual skills, research skills, and practical skills. The study that was conducted by JORDON emphasized the fact that geographical skills include the explanation of figures, tables, and graphs, and the skill of recognizing symbols of graphical designs, terms, and titles, as well as understanding, analyzing, and explaining maps plans, using them effectively and accurately [JORDON, 1985, p 28].

It is evident from HOWARTH'S classification that skills can be further classified into:

(1) Social skills needed by the individual during his/her interaction with others and acquired throughout his/her interaction with them, especially those which are related to geography, such as dialogues, discussion and symposiums which are related to geographical issues;
(2) Hands-on skills which are related to drawings, models, charts, tables, or maps;
(3) Mental activities which are regarded as the most sophisticated that an individual may possess, while others may not possess them. There are many examples of mental activities, such as observations, interviews, data-recording, solving geographical problems or illustrating and clarifying maps [HOWARTH, 1981, Pp 462-465].

LIBEN and DOWNS classified these skills into many types:

(1) The observation skill including data gathering, organizing, and demonstration in maps, using certain symbols, and the ability to observe and gather information in an accurate way,
(2) Reading and understanding data shown on maps and globe models,
(3) Analyzing and explaining places and dimensions on maps, and globe models [LIBEN & DOWNS, 1993, Pp 739-752].

Success in dealing with issues and situations in life and work depends on the development and integration of a range of abilities, such as being able to:

(1) Comprehend basic concepts and terms, the areas of number, space, probability and statistics, and measurement,
(2) Extract, convert or translate information given in numerical forms, or as diagrams, maps, graphs or tables,
(3) Calculate and apply procedures,

(4) Use calculators and computers,
(5) Use skills or apply concepts from one problem or one subject domain to another.

Therefore, it can be observed that the previously mentioned skills are divided into two main types:
- The mental skills: those which are associated with explanation, analysis, calculation, estimation, and measurement;
- The instrumental skills: that depends on drawing and designing graphs or figures.

Thus, the types of skill dealt with in the present study can be divided into mental skills including those dealing with statistics and data, and translating them into meaningful information, and instrumental skills that appear through observable behavior which are the basis of preparing geography teachers who should be competent in these skills to transmit them easily and precisely to the students [DAVID, 1995, p 48].

From the previously mentioned skills in geography and math the students should have the following:

(1) ***Numbers and number sense***: Students will understand and demonstrate a sense of what numbers mean and how they are used, i.e. students will be able to:
  - (1.1) Use numbers in a variety of equivalent and interchangeable forms (e.g., integer, fraction, decimal, percent, exponential, and scientific notation) in problem solving,
  - (1.2) Demonstrate understanding of the relationships between the basic arithmetic operations on different types of numbers,
  - (1.3) Apply concepts of ratios, proportions, percents, and number theory (e.g., primes, factors, and multiples) in practical and other mathematical situations.

(2) ***Computation***: Students will understand and demonstrate computation skills. Students will be able to create, solve, and justify the solution for multi-step, real-life problems including those with ratio and proportion.

(3) ***Data analysis***: Students will understand and apply concepts of data analysis: i.e. students will be able to:
  - (3.1) Assemble data and use matrices to formulate and solve problems,
  - (3.2) Construct inferences and convincing arguments based on data.

(4) ***Geometry***: Students will understand and apply concepts from geometry. Students will be able to:
  - (4.1) Apply geometric properties to represent and solve real-life problems involving regular and irregular shapes,
  - (4.2) Use a coordinate system to define and locate position.

(5) ***Measurement***: Students will understand and demonstrate measurement skills, i.e. students will be able to:
  - (5.1) demonstrate the structure and use of systems of measurement,
  - (5.2) develop and use concepts that can be measured directly or indirectly (e.g., the concept of rate).

(6) ***Algebra concepts***: Students will understand and apply algebraic concepts, i.e. Students will be able to: analyze tables and graphs to identify properties and relationships in a practical context.

(7) ***Mathematical reasoning***: Students will understand and apply concepts of mathematical reasoning, i.e. students will be able to support reasoning by using models, known facts, properties, and relationships.

(8) ***Mathematical communication***: I.e. students will reflect upon and clarify their understanding of mathematical ideas and relationships. Students will be able to: use statistics, tables, and graphs to communicate ideas and information in convincing presentations and analyze presentations of others for bias.

3.4. The importance of acquiring geographical and mathematical skills

Reviewing some educational studies dealing with the importance of acquiring skills, the researcher finds out that there is a consensus on the fact that acquiring skills, whether they are simple or complex, is one of the main goals of learning different school subjects in different educational stages since the process of acquiring skills is greatly connected to acquiring and understanding the main bases of the target subject with its related facts, concepts, and relationships.

CASTELLS assures that the nature of change is an inevitable result of the influences of information and communication technology. These changes and their dimensions affect the nature of skills of geography learners, in addition to their being part of educational response through changes in describing and explaining what is going on, from the perspective of the academic subject, for example in learning skills, and emphasizing their importance in the learning process [CASTELLS, 1996, p 25].

Concerning the importance and functionalizing of the learned skills, CATLING states that fundamental to effective geographical learning is the development of geographical skills. A range of skills is vital in enabling students to undertake enquiries about places and environment fruitfully. The core skills providing access to so much information and data about the world within and beyond present experience are essential. Equally vital to enabling geographical understanding to develop in younger children are skills of reading and interpreting maps, of making maps, of reading and taking photographs and understanding and producing sketches. They involve the selection of a wide variety of maps, pictures, equipment and real environment, and examining the world outside at first and places fieldwork as a key source and inspiration for geographical learning for young children. Building both on children's fascination in exploring the world and on geography's study of the world here and now, sense, observing, investigating and responding to wildscape, landscapes and urbanscapes, the features, the daily round of lives, the events and the images of places and environments give geography the reality on which it is based and thrives. For younger children geographical ideas and concepts, attitudes and values will not begin to be understood or seen to be useful if not enabled to be appreciated through the skills and resources of geographical study [CATLING, 2000, p 4].

Thus, the importance of acquiring skills is considered important in most school subjects with a slight difference in each subject. Therefore, this search will indicate the importance of acquiring skills in general, especially the geographical and mathematical skills in one sequence as follows:

(1) Mastering a skill helps in realizing successful vocational, professional, manual, and hands-on work. In the academic or school aspect, it includes reading, writing, and work organization since the main purpose of teaching at school is to provide learners with the skills and intellectual situations which allow them to continue learning throughout their whole lives (long-life learning).
(2) Geographic skills help us to make reasoned political decisions. Whether the issues involve the evaluation of foreign affairs and international economic policy or local zoning and land use, skills enable us to collect and analyze information, come to an informed conclusion, and make reasoned decisions on a course of action. Geographic skills also aid in the development and presentation of effective, persuasive arguments for and against matters of public policy.
(3) The learner's competence of a skill helps him to deal easily and accurately with mathematics, and acquire further mathematical skills.
(4) Skills help the learners to perform an effective role in acquiring and developing skills among topics of learning.
(5) Competence of a certain skill leads to complete awareness of the relationship between science, and society, and clear understanding of social function of the learners, in addition to developing appropriate abilities to practice science application in society.
(6) Practicing the easiness of dealing with applications, meaning to create the ability to translate natural, biological, or social problems into mathematical problems through specifying mathematical statement, and recognizing the appropriate mathematical model.
(7) Skills help to acquire tendencies, and form desirable attitudes, as well as develop valid preferences [PALMER, 1994, Pp 37-40].

Also BEDNARZ adds the following to the importance of acquiring skills:

(1) Providing the individual with the ability to perform work easily and effectively,
(2) Raising the standard of competence,
(3) Creating a tendency towards work,
(4) Creating the ability to cope with scientific and technological developments,
(5) Developing the ability to maximize relationships with others,
(6) Helping to make valid judgments on the extent to which the individual is competent in knowledge, information, skills, and behaviors, leading to a kind of objectivity in making judgments [BEDNARZ, 2002, p 2].

This is what COLLEY & BEECH emphasized about the following to acquiring skills:

(1) Skills provide the necessary tools and techniques that enable us to think.
(2) They are essential to understanding physical and human patterns and processes in our world.
(3) Geographical skills are central to our ability to engage in geographic inquiry and to think critically about phenomena on earth.

(4) Math skills give students individualized, comprehensive coverage of fundamental mathematics, including skills such as number recognition, counting, numeration, place value, regrouping, and the use of variables.
(5) Skills help students make important decisions in their daily lives, such as how to get to work and where to shop, vacation, or go to school.
(6) They also help students make reasoned political decisions and aid in the development and presentation of effective, persuasive arguments for and against matters of public policy [COLLEY & BEECH, 1989, Pp 1-4., COMPUTER CURRICULUM CORPORATION, 2000, p 1].

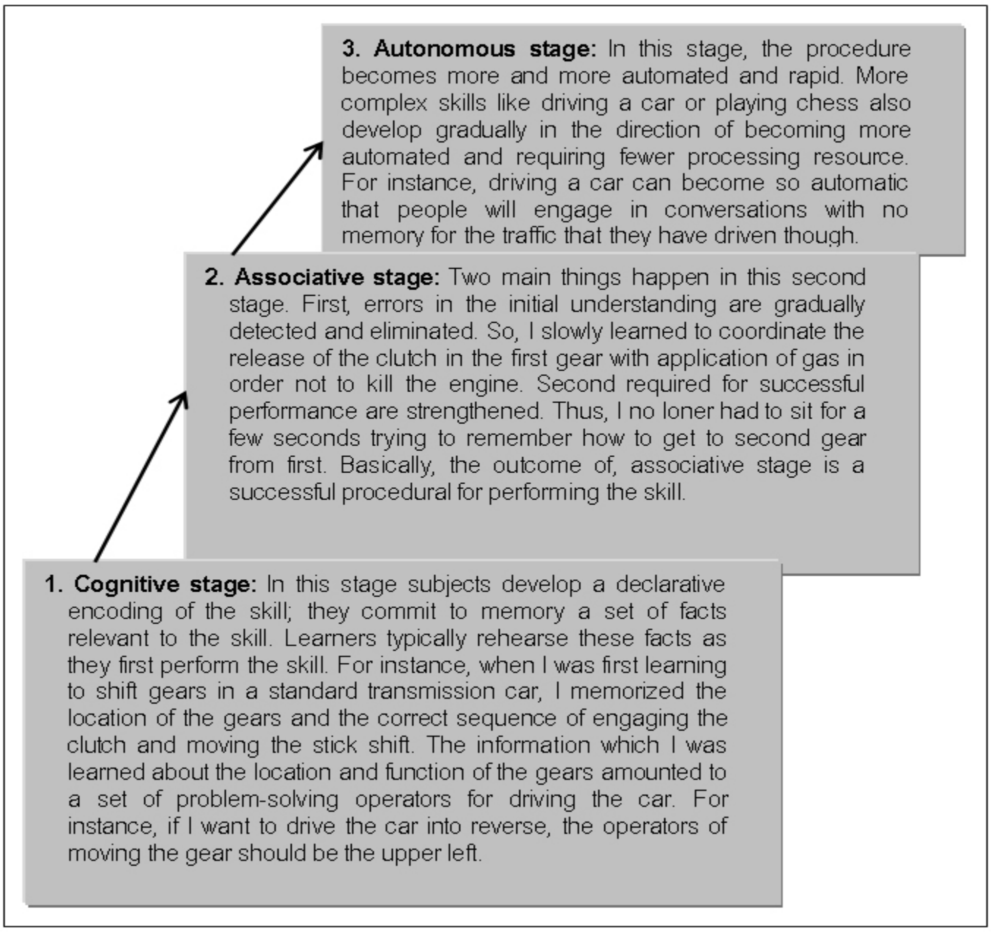
The importance of skills in the present study, especially those related to enhancing geographical skills are due to the emphasis on practical application of geographical skills connected to a mathematical basis. For example, reading and explaining graphs, as one of the skills that are associated with geography, require that learners should be competent in the basic principles that enable them to understand and explain such skills in a valid way. Thus, the use and explanation of graphs, tables, and caricatures add further opportunities to enrich geography learning.

3.5. Stages of geographical and mathematical skills acquisition

In order for the learner to acquire a certain skill, he/she should be completely aware of its value and effect on his/her daily life. After the learner acquires a skill, opportunities that allow him/her to practice it in natural situations should be provided. Therefore, learners should be fully aware of the details and components involved in a certain skill, and make the best use of such awareness in the proper way so as to enrich his/her learning.

3.5.1. ANDERSON specified three main aspects in the acquisition of the skill that are demonstrated in the following:

Figure (7)
ANDERSON Model to acquisition the skill [ANDERSON, 2000, Pp 273-274]



Two of the dimensions of improvement with practice are speed and accuracy. The procedures come to apply more rapidly and more appropriately [ANDERSON, 2000, Pp 273-275].

3.5.2. WINFIELD specified three main aspects in learning a skill that are demonstrated in the following:

3.5.2.1. *The mental (cognitive) aspect:* In order to perform a certain skill, there should be certain cognitive aspects prior to its performance since a skill requires two main aspects: The cognitive aspect and performance aspect. The ratio of these two aspects varies from a task to another because a skill necessitates a considerable deal of knowledge and information leading to concentrating on the cognitive aspect of the skill to perform it easily and effectively.

3.5.2.2. *Performance (behavioral) aspect:* This aspect can be observed by the analyst in the form of steps of behavioral instruments composing a single practical skill, distinguishing between skillful and unskillful performance concerning accuracy and speed.

3.5.2.3. *Emotional aspect:* It is connected with the individual's sensations and emotions. It is one of the main aspects involved in the process of learning a skill, since the affective aspect is closely connected to the cognitive and performance aspects of skills. It is also changeable and can be developed within longer periods [WINFIELD, 2000, Pp 22-28].

3.5.3. BARTLETT adds some important basic components of acquiring skills:

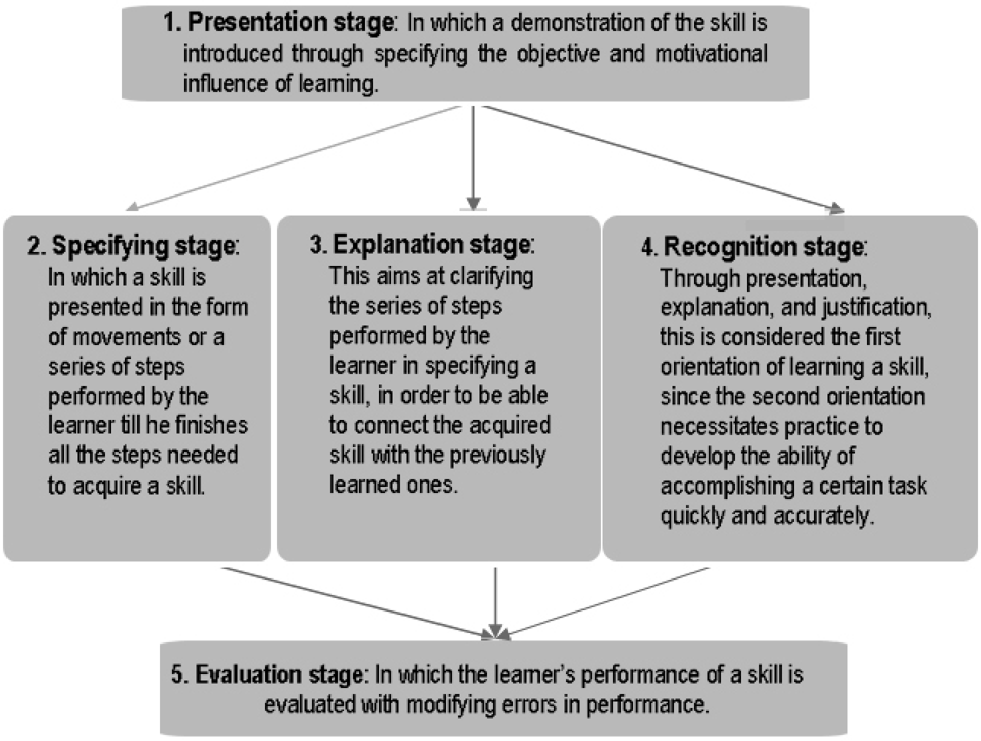
3.5.3.1. *Understanding:* Pupils should understand what the skill involves. This may be achieved by observing, discovering, reading about and listening to a lesson on or watching a film about the skill. For example, students need to understand the uses of scale, projection and map symbolism in learning to draw a map.

3.5.3.2. *Organization:* Students should be given opportunities to practice the skill so that their speed and coordination improve to the point where the skill is almost automatic. There is more emphasis on motor dexterity than on understanding in this phase.

3.5.3.3. *Perfecting:* Students should be given opportunities for continuing use of the skill in addition to coaching aimed at improving the understanding and organization components of the skill. Specific skills may be joined into composite skills [BARTLETT, 1982, p 83].

The most important stages of learning a skill were also specified as follows [CARY & PHILIP, 1991, Pp 206-209]:

Figure (8)
Stages of learning a skill according to CARY and PHILIP [CARY & PHILIP, 1991, p 206]



3.5.4. *Some educators* demonstrate another form of the stages of learning a skill as follows [JOHNSON, 2000, Pp 1-5., HEDLEY, 1990, Pp 167-188]:

3.5.4.1. *Analyzing the skill:* Analyzing a skill means specifying the physiological and psychological characteristics of skilled performance, recording them, specifying the source, future, and processes of decision-making. In other words, analyzing a skill is concerned with the study of all features of a skill, whether they are visible or not. Hence, it is considered a profound analysis of skilled performance.

3.5.4.2. *Estimating the initial behavior:* The degree of efficiency of the performance behavior in initial stages is specified in three forms:

(1) Analyzing the skill into units composed of series and sub-units which should be acquired by the student in order to learn the new skill,

(2) If an analysis of a certain skill is conducted in the form of simple components that are necessary for learning a complex skill, we should make sure that the students have already learned all the preliminary components required,

(3) In analyzing the initial behavior, the physical, manual, and motor abilities of the student should be measured.

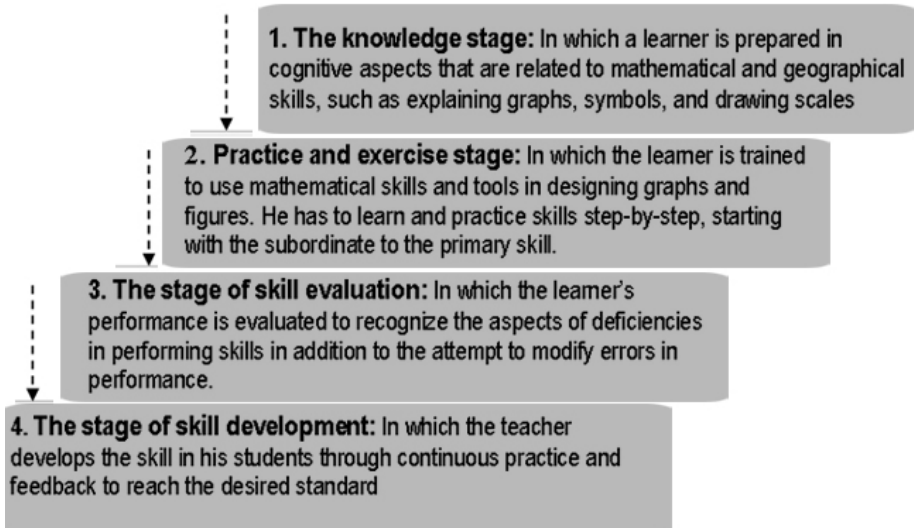
3.5.4.3. *Describing and demonstrating a skill to students:* The demonstration of a skill to students is considered a criterion for judging a student's specific performance. Thus, it allows him/her to specify a suitable objective. Therefore, dividing work into easily-performed tasks, each of which has its specific clear objective, is a necessity. This includes the gradual connection of the different parts of this work, and then, concentrating on continuous performance.

3.5.4.4. *Practicing the units of the skill elements:* This aims at providing the opportunity for a student to learn steps of the skill in which he made mistakes concerning the selection of behavior, and the development of mental and scientific abilities. This is based on the good performance aspects.

3.5.4.5. *The student's practice of the skill:* Practice is one of the essential conditions of learning a skill in addition to comparison and feedback. Practice should be fulfilled through appropriate direction.

The present study is concerned, in this dimension, with the stages of learning a skill, which can be detailed as follows:

Figure (9)
The stages of learning a skill by JOHNSON CAROLYN [JOHNSON, 2000, p 5]



3.5.5. JOYCE adds some characteristics to develop the skills:

3.5.5.1. *Specific responding:* We want our students to recognize basic information about nations: their names, where they are, demographic information such as indicators of wealth (gross national product), population (size, fertility rates), health (health care facilities, longevity) and culture (linguistic data, religious heritage, culture groups). For these we might use mnemonics and the inductive model; teaching the names and asking the students to classify the countries with respect to the basic demographic information.

3.5.5.2. *Chaining:* We might ask students to collect information about the kinds of life that are lived within the nations and begin to develop pictures about how the demographic information might relate to the quality of life.

3.5.5.3. *Multiple discrimination:* We might ask students to develop matrices that allow countries to be classified on multiple variables, such as how types of government are related to the rights of women.

3.5.5.4. *Classifying:* We might ask students to develop typologies of nations and generate maps, such as those in the state of the world atlas, that permit sets of variables to use to generate pictures that lead to correlations, such as whether educational levels, industrial capacity, commercial activity, and family structure are associated with one another.

3.5.5.5. *Rule using:* We might ask the students to create predictions about how the nations of the world can be expected to respond to various types of conditions, such as population growth, ecological crises, and natural disasters.

3.5.5.6. *Problem solving:* We might present students with sets of problems that can only be dealt with from an international perspective, such as cooperation to solve ecological problems and conflicts of various sorts. We might ask them to apply the jurisprudential model to analyze the values that underline decisions about international cooperation. We might also ask them to categorize changing the international situation such as population and trade changes and to predict the types of problems that are escalating to be solved by the international community [JOYCE, 2002, Pp 367-374].

As an application of skills classification and the stages of acquiring skills in general, and mathematical geographical skills in particular, the Geographical Educational Standards Project cites an example of organizing and acquiring the geographical knowledge and skills, which can be illustrated as follows.

The geographic skills that a geographically informed person should have consist of five sets adapted from the Guidelines for Geographical Education, the Association of American Geographers and the National Council for Geographic Education; Following is a brief discussion of the principles underlying the five skill sets, followed by the presentation of skills [GEOGRAPHY EDUCATION STANDARDS PROJECT, 1994, Pp 42-45]:

(1) *Asking Geographical Questions*: Successful geographic inquiry involves the ability and willingness to ask, speculate on, and answer questions about why things are where they are, and how they got there. Students need to be able to pose questions about their surroundings: Where is something located? Why is it there? With what is it associated? What are the consequences of its location and associations? Students should be asked to speculate about possible answers to questions because speculation leads to the development of hypotheses that link the asking and answering stages of the process. Hypotheses guide the search for information.

Geography is distinguished by the kinds of questions it asks; the 'where' and 'why there' of a problem. It is important that students develop and practice the skills of asking such questions to themselves. The task can be approached by giving students practice in distinguishing geographical from non-geographical questions and by presenting students with issues and asking them to develop geographic questions. At higher-grade levels students can identify geographic problems and ways in which an application of geography can help solve problems or resolve issues.

(2) *Acquiring Geographic Information:* Geographic information is information about locations, the physical and human characteristics of those locations, and the geographical activities and conditions of the people who live in those places. To answer geographic questions, students should start by gathering information from a variety of sources in a variety of ways. They should read and interpret all kinds of maps. They should compile and use primary and secondary information to prepare quantitative and qualitative descriptions. They should collect data from interviews, fieldwork, reference material, and library research. The skills involved in acquiring geographic information include locating and collecting data, observing and systematically recording information, reading and interpreting maps and other graphic representations of spaces and places, interviewing, and using statistical methods.

Primary sources of information, especially the result of fieldwork performed by the students, are important in geographic inquiry. Fieldwork involves students conducting research in the community by distributing questionnaires, taking photographs, recording observations, interviewing citizens, and collecting samples. Fieldwork helps arouse the students' curiosity and makes the study of geography more enjoyable and relevant. It fosters active learning by enabling students to observe, ask questions, identify problems, and hone their perceptions of physical features and human activities. Fieldwork connects students' school activities with the world in which they live.

(3) *Organizing Geographical Information:* Once collected, the geographic information should be organized and displayed in ways that help conduct analysis and interpretation. Data should be arranged systematically. Different types of data should be separated and classified in visual, graphic forms: photographs, aerial photos, graphs, cross sections, climagraphs, diagrams, tables, cartograms, and maps. Written information from documents or interviews should be organized into pertinent quotes or tabular form.

There are many ways to organize geographic information. Maps play a central role in geographic inquiry, but there are other ways to translate data into visual form, such as by using graphs of all kinds, tables, spreadsheets, and time lines. Such visuals are especially useful when accompanied by clear oral or written summaries. Creativity and skill are needed to arrange geographic information effectively. Decisions about design, color, graphics, scale, and clarity are important in developing the kinds of maps, graphs, and charts that best reflect the data.

Geography has been called “the art of the map”. Making maps should be a common activity for all students. They should read (decode) maps to collect information and analyze geographical patterns and make (encode) maps to organize information. Making maps can mean using sketch maps to make a point in an essay or record field observations. It can mean using symbols to map data on the location of world resources or producing a county-level map of income in a state. It can even mean mapping the distribution of fire-ant mounds in a field or trash on a school playground. For students, making maps should become as common, natural and easy as writing a paragraph. They should be skilled in interpreting and creating map symbols, finding locations on maps using a variety of reference systems, orienting maps and finding directions, using scales to determine distance, and thinking critically about information on maps.

(4) *Analyzing Geographical Information:* Analyzing geographical information involves seeking patterns, relationships, and connections. As students analyze and interpret information, meaningful patterns or processes emerge. Students can then synthesize their observations into a coherent explanation. Students should note associations and similarities between areas, recognize patterns, and draw inferences from maps, graphs, diagrams, tables, and other sources. Through using simple statistics, students can identify trends, relationships, and sequences.

Geographical analysis involves a variety of activities. It is sometimes difficult to separate the processes involved in organizing geographical information from the procedures used in analyzing it. The two processes go on simultaneously in many cases. But in other instances, analysis follows the manipulation of raw data into an easily understood and usable form. Students should scrutinize maps to discover and compare spatial patterns and relationships; study tables and graphs to determine trends and relationships between and among items; probe data through statistical methods to identify trends, sequences, correlations, and relationships; examine texts and documents to interpret, explain, and synthesize characteristics. Together these analytic processes lead to answers to the questions that first prompted an inquiry and to the development of geographical models and generalizations. These are the analytical skills that all students need to develop.

(5) *Answering Geographical Questions:* Successful geographical inquiry culminates in the development of generalizations and conclusions based on the data collected, organized, and analyzed. Skills associated with answering geographical questions include the ability to make inferences based on information organized in graphic form (maps, tables, and graphs) and in oral and written narratives. These skills involve the ability to distinguish generalizations that apply at the local level from those that apply at the global level (issues of scale are important in developing answers to geographical questions).

Generalizations are the culmination of the process of inquiry, and they help to codify understanding. Developing generalizations requires that students use the information they have collected, processed, and analyzed to make general statements about geography. At other times, however, students use the evidence they have acquired to make decisions, solve problems, or form judgments about a question, issue, or problem. Geographic generalizations can be made using inductive reasoning or deductive reasoning. Inductive reasoning requires students to synthesize geographical information to answer questions and reach conclusions. Deductive reasoning requires students to identify relevant questions, collect and assess evidence, and decide whether the generalizations are appropriate by testing them against the real world. Students should have experience in both approaches to learning.

Students should also be able to communicate clearly and effectively, especially as they learn to answer geographical questions. It is a skill linked closely to good citizenship. Students can develop a sense of civic responsibility by disseminating the answers they have discovered in geographical inquiry. They can display geographic information in many engaging and effective ways - for example, by using multimedia, such as combinations of pictures, maps, graphs, and narratives, to present a story or illuminate a generalization. Geographic information can also be presented through the use of poems, collages, plays, journals, and essays. Each medium chosen to present geographic information to answer a question or address an issue or problem should stimulate inquiry and communicate clearly. Choosing the best means of presenting answers to geographical questions is an important skill.

Students should also understand that there are alternative ways to reach generalizations and conclusions. There are many types of knowledge, and many levels of reality and meaning. Teachers should encourage students to develop multiple points of view and to seek multiple outcomes to problems. This process should include collecting many kinds of data, including personal, subjective information, from a variety of sources.

The fifth skill set represents the last step in the process of geographical skills inquiry. But it is not really the final step, because the process usually begins again with new questions suggested by the conclusions and generalizations that have been developed. These questions, often posed as hypotheses to be tested, provide a way to review generalizations. Each question answered, decision reached, or problem solved leads to new issues and new problems. Geographical learning is a continuous process that is both empowering and fascinating.

Based on the above illustration of the learning skills and how to deal with them, we can conclude that skills are distinguished by special characteristics that should be available to both the teacher and the learner. Losing one aspect of a skill means missing an important aspect of learning. This is evident in the following characteristics which distinguish skills.

3.6. Characteristics of geographical and mathematical skills

Skills have several characteristics. Some psychologists state that the main characteristics of skills are [SHEPARD, 2000, Pp 4-14., AMES, 1992, p 221]:

(1) *Series of responses:* A skill represents a series of motor responses that differ from verbal responses in that they are mental movements.

(2) *Sensory-motor coordination:* A skilled behavior is characterized by coordination among sensory organs like eye and ear, and the motor organs like hand and foot. A motor or cognitive skill is the label often given to such skills that include the meaning of coordination.

(3) *Patterns of response:* Human behavior can be considered an organization series of stimuli and responses in larger patterns.

Any analysis of the motor skill facilitates their description on that basis. It can be said that motor responses are mental movements. The practical skill can be developed through usage and practice. Motor skills contain subordinate skills. An individual seeking to develop them has to start with subordinate skills .There are some characteristics of skills that can be emphasized as follows [EISENBERG, 2002, Pp 1-2]:

(1) *Understanding:* It is a complex process with different levels. It means the realization of the situation as a whole, then realizing the extent of relationship among constituting elements, as well as selecting appropriate elements, excluding the inappropriate ones, with the ability to explain and justify, and organize elements to reach a certain solution.

(2) *Accuracy:* It aims at reaching correct answers or practicing the correct style that necessitates direct supervision, time, and practice, in addition to accuracy in the different stages of conducting a skill, which is an important process to reach the correct answer.

(3) *Speed:* It is considered a basic element in acquiring a skill. Efficiency in performance of any task requires accomplishing it in the shortest possible time.

KELLY emphasized giving skills some qualities that distinguish them from other knowledge, such as their physical aspects, and their reliance on the mental aspects during learning them. Also they improve through application and usage, and they require information and knowledge on which they can be based. Each skill is divided into other sub-skills that can be used for different purposes and in different instructional situations [KELLY, 2000, p 5].

CURZON adds some characteristics of a skill such as the following:

(1) The skill ought to be demonstrated initially in its entirety as a fully integration set and cycle of operations and it should be stressed from the very beginning that mastery can be acquired by those who are willing to learn.

(2) The skill must then be broken down into its component and subordinate activities. Each action should be demonstrated, explained, analyzed and demonstrated again so as to emphasize its particular importance and significance for the skill as a whole.

(3) Skills acquisition requires supervised, reinforced, and carefully spaced practice by students.

(4) Continuous, swift and accurate feedback must be provided for the learner and he must be taught to interpret such information correctly.

(5) Tests in realistic conditions ought to be administered regularly; insight and retention ought to be evaluated along with the capacity to transfer acquired skills to novel and demanding situations.

(6) Achievement of competence at one level ought to be accepted as a necessary preparation for movement to a higher level of skills.

(7) The development of perceptual skills, those depending largely on the mechanisms underlying perception, requires discrimination exercise backed up by practice. The testing of perceptual skills requires a variety of test settings [CURZON, 1990, Pp 263-266].

Through the previous demonstration, the characteristics of skills can be concluded as follows:

(1) A skill is a process requiring coordination among knowledge, motivation, and performance.

(2) A skill is a complex process that is composed of a number of subs-skills that should be initially acquired.

(3) A skill is developed through comprehension and practice, including aspects of usage through drawings, graphs, models, tables, globes, and maps.

(4) Repetition of a skill reduces the chances of oblivion through different activities like interviews, observation, recording data, reading and explaining maps, and solving geographical problems.

In spite of the previously mentioned views concerning skills and their characteristics, the present study is limited to evaluating mathematical skills that are related to learning geography, which are complex skills including many behavioral steps such as using graphs, drawing scales, relative circles and other mathematical geographical skills in addition to a proposed integration program to learn these skills.

3.7. Conditions of learning geographical and mathematical skills

Learning a skill involves several conditions that should be recognized by the learner.

3.7.1. Many studies were concerned with indicating these conditions that require a student to [MOORE, 1997, Pp 123-165., HARRISON, 2006, Pp 1-10., BURK, 1996, Pp 89-94]:

1. Be aware of the importance of the skill that he learns, its value, and effect on his scientific and practical life.
2. Practice a skill actually on real life situations or similar ones.
3. Be aware of the steps included in the required skill, the valid scientific methods of its performance, and the way to connect them.
4. Recognize the form of activity and the required movements and the excluded ones, not only the ultimate form of the skill.
5. Teach in a functional way connected to the academic subject.
6. Being subjected to a careful supervision by the teacher during his/her initial attempts of implementing a skill in order to form the right habits from the beginning.
7. Practice in a continuous way in order to assure accuracy and quality of performance.
8. Imitate the learner as a live model in practicing work skillfully, in order to acquire the skill through the best ways and techniques.
9. Be flexible in programming learning, and permitting the learning of skills according to the learner's needs.
10. Compare the student's level of performance through the pursuit of stages of development, or the comparison of his performance to the correct procedures.

3.7.2. Thereupon, the present study may adopt the conditions of learning skills identified by BRADBEER:

1. *Synchronism:* It is one of the most important conditions of learning skills. This means that acquiring skills is integrated in time, coordination, arrangement, and the use of body muscles in a certain succession. In other words, a skill requires a great deal of time succession without delay. Concerning the mathematical skills that are necessary for learning geography, there should be synchronism and succession during learning to complete the learning of the skills. In the present study, the researcher attempts to analyze the skill in the form of

successive units or steps that are combined to compose the behavioral parts of the skill.

2. *Practice:* It is the selection of appropriate method and technique for teaching skills in a complete way. In other words, if a situation is repeated in the existence of suitable supervision, it will cause a change in performance. Thus, it is the condition associated with learning a skill or not. A geographical skill requires chances for practice through scientific training in which a student repeats the tasks with the learner's observation, step by step, to make a change in performance.

3. *Feedback:* It means providing evaluative data for the learner concerning his performance. It is considered a self-evaluation technique. In learning a skill, feedback helps the learner to receive information about frequency of success and points of weaknesses. Thus, the student becomes able to modify and improve his performance. Feedback is considered one of the main conditions of learning a skill, since it is used more frequently than the term "reinforcement" and it is concerned with the description and learning of a skill. It emphasizes the information aspect of the learner, and makes the individual compare his actual performance with the standard performance of the skill.

4. *Mental training:* It contributes to learning a skill by setting an intellectual conception of the skill required to be learned, and the appropriate methods of performance. A skill is connected to valid comprehension, speed and accuracy, as well as economy in time and effort [BRADBEER, 1996, Pp 11-18., PRIMARY NATIONAL STRATEGY, 2004, Pp 6-11].

Throughout the previous examples related to the methods used in learning skills in general, and mathematical geographical skills in particular, we cite an example taken from Florida Geographical Center that provides some important points related to what learners may use during the study of geography. This is similarly applied to the mathematical skills studied by learners in general, and by geography learners in particular [THE FLORIDA GEOGRAPHIC ALLIANCE, 2005, Pp 1-5]:

1. *Perception*: "Experience is the best teacher" is an old phrase, but it conveys the idea of perception very adequately. Perceptive learning occurs through the senses and it is the most long-lasting and most basic form of learning. We learn perceptually from the cradle to the grave. Teachers should identify the level of perceptive learning which each student brings to the classroom. Of course, it is impossible to do this for each student for every learning experience, but it is important to know as much as possible about the background the student brings to the lesson.

Generally, teachers identify the perception level of students by questions and answers and by pretesting. A more time-consuming method is by discussion. To develop perceptual understandings the instructor may use pictures, records, models, or other media. For the geographer, the use of maps is an important example of perceptual learning. These tools are necessary because first-hand experience is not usually possible in the classroom. When possible, a field trip is an ideal way to develop perceptive learning. However, to be successful, a field trip must be well organized, causing the learning process to be more focused on specific experiences and observations, not just on a random experience out of the classroom. Perceptual learning may give the student knowledge of a specific river, a pollution source, a sinkhole, or a field of celery. Too many times we teach about Florida assuming the student knows what the Suwannee or St. Johns River looks like. If the hometown of the student is Miami, he or she may only "know" perceptually the Miami River. For the student to think about the Miami River of his experience when the teacher is discussing the idea of a "wild river" would be a hindrance to learning.

2. *Concepts*: There are many definitions of the term concepts. A concept may be considered the image, or response, that comes to mind when the learner is confronted with a stimulus. For example, the concept "river" should elicit responses such as water flowing from higher to lower levels, banks, mouth, source and any other associated ideas stored up about rivers, usually from perceptual learning. The level of the response is, of course, broader in the more educated person. Concepts may be rather simple, such as sunshine, or more complex, such as environmental quality. Complex concepts are developed as more and more cognitive data and perceptual learning is generalized into useful learning building blocks. For example, urbanization is a very complex concept that requires at least a general understanding of many terms, such as, population concentration, economic activity, various aspects of transportation, and even another complex concept, such as social and physical infrastructure. In developing lesson plans a teacher needs to be aware of all those simple and complex concepts used to reach the teaching objective.

3. *Generalization*: Much discussion has occurred about teaching, or having students develop, generalizations. It is more easily said than done. However, we can understand a generalization as a rational process by which one makes a judgement or a statement which applies to a whole class of items, often on the basis of experience with a limited number of the class. Simple generalizations are that Florida has a tourist-based economy and Florida has sandy, well- drained soils. Of course, neither statement describes all of the state.

An example of a more complex generalization is that the physical environment suggests and limits human activities but does not dictate them. Or the significance of the physical environment is a function of people's objectives, their attitudes and perceptions, and their level of technology. These two generalizations are just examples of how teachers can use this type of learning to develop curriculum. Students should be encouraged to develop generalizations inductively from the observation of data and to deductively test generalizations by gathering and analyzing data to support the general truth and to identify exceptions.

4. *Memorization*: On too many occasions, it has been said that teachers should not have their students memorize. This statement should be qualified to mean that memorization should not be used as an end result of learning. It is actually a legitimate way to learn but it is too often misused. On occasion, it is desirable to learn something by rote to facilitate a planned, higher level of learning or application. To have a student memorize something in order to recall it for test purposes is the lowest level of learning and generally a poor teaching strategy.

5. *Comparison:* The consideration of two things with regard to some characteristic that is common to both such as the likening of one nations resource base to that of another. Comparison allows a student to increase his/her level of understanding by analyzing relative values. Geographers compare the benefits of the relative size or shape of two nations or their location in the high or low latitudes. Many activities can be developed involving the comparison of physical, population, or economic factors to increase the geographic understanding of places.

6. *Experimentation*: This way of learning entails the carrying out of an exercise under controlled conditions. It helps to verify known or suspected knowledge and introduces new learning in a defined area of investigation. It may be used in the application of general ideas to the local area and in the testing of hypotheses. The class might discuss the economic and recreation value of various types of vacation resorts. Pictures might be given of seven different resorts from which students would select their favourite. The next activity in the experiment would be to analyze why different students chose different types of resorts.

7. *Categorization*: This way to learn step allows students to gain the ability to group data into classes according to common characteristics, such as soil, climate, landform, etc., under natural or physical factors, religion, occupations, health and under cultural phenomena. To think critically students must be able to categorize land uses, economic activities, ecosystems, types of wastes, etc.

8. *Association*: This process helps students learn by connecting phenomena in their temporal or spatial contexts. For example, the teacher is encouraged to help the learner associate various aspects of the physical environment with factors that influence the location of an industrial site such as water and raw materials. The association of low education levels, low technical skills, and low wages might be made in regard to jobs in the service sector of our economy.

9. *Relationship*: Very closely connected to association is relationship. The difference is that relationship entails understanding of the effect that various things have on one another. Recognizing and postulating relationships in the physical and cultural environment are encouraged as an important part of analysis and synthesis. Students can be encouraged to see the relationships between large successful regional shopping malls and good transportation access and the proximity of a minimum number of people with high disposable incomes. Another relationship might be made between the historical development of industry, the Piedmont area of the Appalachian Mountains, and the existence of water power.

10. *Transfer*: Transfer is a very important mental skill to develop. It allows people to focus their previous learning experiences on the job of understanding new experiences. The importance of any model is not only its use in a specific instance, but also its application to the analysis and solution of new problems. One example of transfer would be the application of the model presented in this paper to the understanding of places at different scales, or the transfer of the student's understanding of the location factors of land, taxes, labour, raw materials, and market to various economic activities.

11. *Analysis:* Life is full of complex structures and events. It is specifically the duty of the teacher to help students identify and separate the various parts of a complex structure. Analysis also includes the establishment of relationships and the organization of the various parts of a structure or event. One of the goals of analysis is extraction of generalizations that may have some universal validity; therefore, transfer value.

12. *Synthesis*: This is, generally, moving from the simple to the complex. It is the construction or reconstruction of the various parts into a whole, after comparison and evaluation. Students should be led to understand that the character of any place is the total sum of the existence of each of the subheads in the model provided in this paper. The unique synthesis of cultural and physical phenomena makes every place different. Geographers call this differentiation.

13. *Creativity*: It is sometimes given as the highest form of learning; however, creativity is often missing from the classroom. This is a mistake: creativity is not an activity only for the art, music, or industrial arts class. It is the act of invention, or exploring new or unique ways to understand or solve old problems. It is the new arrangement of old data into a useful or pleasing original structure. Usually, creativity is divided into three stages: incubation, illumination, and evaluation. One factor or part of a familiar complex whole can be changed so that students have the opportunity to project a new or creative result. This is one way the teacher can have students utilize known material in a creative exercise. For example, the teacher might obtain, from the local planning department, a traffic map including trip counts and have students reorganize traffic patterns to achieve better flow, or they might speculate on the impact a zoning change would have in their community. Some teachers have had students utilize the generalized systematic maps of the world to have students locate an imaginary island and describe its physical and cultural characteristics using known patterns and processes.

Teachers and learners should think through this list of learning ways and keep them in mind as they develop every lesson plan and activity. Too many teachers and learners are not cognizant of the importance of perceptual understandings brought to a class. They are unaware of the importance of concept-and-generalization development, and they lean much too heavily on memorization both in learning and in the evaluation of teaching. Often the other ways are not used at all or they are used by the teacher without knowledge of what he or she is doing. Students should understand that learning in school is not accomplished just to pass a test, but that it has a transfer value to appreciation and problem solving in later life.

Throughout the previous example, we can come to how to evaluate the skills, what we want to evaluate in this study, and how to provide the ideal solutions for the problems that we encounter during the learning of skills. This is what will be presented in the following paragraphs.

3.8. Evaluation of geographical and mathematical skills

The process of evaluation is defined as a diagnostic preventive and remedial process aiming at discovering points of strength and weakness meaning to improve the teaching and learning processes according to the desired objectives [PARKES, 2003, p 152].

A skill can be measured through parts of general achievement tests. The best ways for evaluating mathematical skills are performance tests in which the learner's behavior can be directly observed, in addition to recording the aspects of activity, the experience, emotions, and skills in an accurate way. Evaluation in the present study means "judging the standard of learners of geography in mathematical skills in order to recognize the skills that have a high standard of performance and those connected to low ones. Moreover, evaluation aims at recognizing the causes that hamper the achievement of desired standard of learners, and suggesting the suitable solutions to raise the standard of performance and develop high standard performance". Therefore, measuring a skill requires specifying the desired level of competence, and the appropriate time of performance [THE PROGRAM EVALUATION STANDARDS, 1995, Pp 1-4].

This means that mathematical skills are measured by achievement tests in which the students are required to fulfil a certain task. A skill, though depending on knowledge, is considered behaviour in the ultimate analysis. The present study aims at determining the most important mathematical skills required for learning geography, and the proposed program helps the students to acquire mathematical skills and concepts for geography learning. There are certain approaches for evaluating a skill from the total approach. It is based on judging the extent of validity of the results attained by the student, or the quality of his work products. It requires students to fulfil certain tasks, then wait to achieve the end of their work, and attain the final result. Finally, the student's skills are evaluated in the light of the results he reached and the time taken to accomplish his work [CULLINGFORD, 1997, Pp 256-277].

Out of the following example on evaluation, we can use skills in industry and other fields, and this is what we may use in the study according to the nature of each skill and the ideal method by which the skill is measured and evaluated:

(1) The non-measurement approach:

This approach simply equates occupation groups such as professional, managerial, white-collar or blue-collar with implicit skill levels. It has substantial validity problems. For example, the traditional white-collar/blue-collar distinction may obscure rather than help ascertain skill levels in jobs or study. With this approach it is difficult to make precise judgments about content, composition shifts, or quantities of change. The approach is used in a recent research paper for the productivity commission, the increasing demand for skilled workers in Australia and for adaptation to technical change. The paper divides employed persons into high skilled persons and other workers. High skilled workers are defined as managers and administrators, professionals and semi-professionals. This approach is not very useful in thinking about education and training needs since the specific dimensions are unclear.

(2) The indirect approach:

This approach takes qualifications or wage levels of an occupational group as an indication of the skill level. However, the dimensions of skill also remain unclear with this indirect approach. Simply using qualifications as a proxy for skill can be problematic. The average increase in the level of qualifications in an occupation may be an indication of excess supply over demand and may not mean a rise in the skill level for jobs in that occupation. Conversely, a drop in the average level of qualifications may be an indication of skill shortage. Thus care needs to be taken in interpreting results from such analyses. Employers often screen potential employees by the qualifications they hold. Qualifications can be taken to indicate a number of desirable characteristics in employees including their capacity to be trained for skills required in a job, but may not necessarily measure the true level of skills required to perform in the job. The use of wage rates as an indicator of skill levels in jobs has problems too. It requires complex assumptions about constancy in the supply of and demand for labor. In general, the higher the wages are, the higher the skill requirements for the job will be. However other factors, such as a skill shortage, geographical location, private or public sector employment, industrial award and non-economic factors, such as social prestige or history, can be a cause of levels of, and variations in, wage rates.

(3) Direct measurement:

Third suggestion of direct measurement has the most advantages. It allows more precise comparisons of change across studies, and investigation of issues of validity and reliability are more straightforward. The approach is often adopted for commercial job analysis, and in determining training needs, competencies. For example, a job from a host of historical and social influences evaluation systems, however, is not based on consistent criteria regarding skill definition. Consensus does not even exist on the dimensions of skill or how it should be measured for jobs. There is paucity of data available at the system level, especially time series data. Nevertheless data on the explicit assessment of skills in jobs from even small sectors or case studies are important complements to analyses based on indirect assessment. Given that skill is a social construct, it is difficult to look at it in isolation [SHAH, 2001, Pp 1-5].

The present study is concerned with evaluating the students in the following aspects of each skill:

(1) *The cognitive aspect:* This is evaluated through an objective test including a set of questions of the multiple-choice type. The cognitive aspect includes the facts, concepts, and tools connected to mathematical skills that are necessary for learning geography.

(2) *The performance aspect:* It includes the evaluation of students in the following sub-aspects:

(2.1) Speed which is evaluated through calculating the time taken to perform skills, and comparing it to the standard time of performance.

(2.2) Accuracy in which is evaluated through the ratio of correct or faulty performance for each step of the skill, and we can note these two aspects in the mathematical tests in the present study.

3.9. Mathematical skills and their relationship with learning geography

Our entry is about how mathematics is used in geography. Studying and understanding geography requires knowledge of certain mathematical skills. We give examples of situations in which math and geography are used together. Our entry has a problem solving section. Students can solve real and creative geography problems using mathematics. Topics which we cover are longitude and latitude, continental drift, time zones, scale and the four-color theorem of map coloring. It is our educational objective to teach other kids how one subject does not stand by itself and how we need all subjects to understand one. It is also our objective to teach other kids that our entry is map skills included as the following: longitude, latitude, symbols, political maps, thematic maps, locator maps, physical maps, political maps, scale, equator, Tropic of Cancer, Tropic of Capricorn, Arctic Circle, Antarctic Circle, and Prime Meridian [SHOGREN & STAMLAND, 2002, Pp 1-15].

HARTE and DUNBAR added that some geographical skills which are linked with mathematical processing are:

(1) Geographic techniques that include: direction, longitudes, latitudes, map references, scale, and vertical exaggeration.

(2) Mapping skills such as: Chorophleth maps, Cross-sections, Dot maps, Flow-line, Gradient, and Isoline maps.

(3) Collecting data: likert scales, line drawing, precise maps, questioners, statistics.

(4) Processing data such as: index numbers, circular graphs, issue analysis, paragraph response, photographs, picture graphs, ray diagrams, triangular diagrams.
(5) Presenting data: Bar/column graphs, climatic graphs, lands, images, line graphs, logarithmic scales/graphs, population pyramids, proportional symbols, scatter graphs, sector graphs, synoptic charts, transect diagram [HARTE & DUNBAR, 1994, p 1].

Mathematical skills have an important role in learning different subjects, since learning or acquiring skills helps the learner understand ideas and mathematical concepts. It also increases his understanding of mathematical systems, and facilitates the performance of many tasks facing the learner in his daily life. In addition, it provides the opportunity to direct the learner's thinking, time, and effort in a better way, concerning mathematical problems, and to develop the learner's ability to solve these mathematical problems.

To learn mathematics effectively, an individual should develop the effective and cognitive abilities related to accepting given information (input), preparing this input for mental processing, and preparing the processed information to come out as an output. Each step of this learning process requires various levels of thinking, but the entire procedure should not require a constant awareness of the total series of steps if we must keep using the procedure to learn new information. The procedure must be followed step by step and must be automatic (like driving an automatic after you have acquired the necessary skills). If we accept this conclusion, then we must acknowledge the fact that training is required [THORNTON, 1994, Pp 1-5].

The technological age in which the learner lives requires the use of certain skills by the learner such as estimation, problem-solving, data explanation, organizing information, measuring, predicting, and applying mathematics to daily situations. With the change in the needs of society, and the quantitative breakthrough of information, priorities concerned with basic mathematical skills should be restated, especially those that are required for preparing the learner to play an effective role in different specialization like geography [CULLINGFORD, 1997, p 120].

It was not a matter of chance that specialists in geography were more concerned than others with mathematics, to be able to gather facts and spatial relationships, indicate disparities among places and regions all over the world, and apply the mathematical techniques, whether in maps and areas, or in drawing scales, and analyzing temperature, then comparing these results with each other to deduce the rules or systems governing the globe, with emphasis on the role of man who lives on it [FISHER & BINNS, 1996, p 41].

The national council of teacher's of mathematics emphasizes the fact that individuals need a considerable deal of mathematical skills that differ according to their age. Nevertheless, there are basic indispensable skills for each cultured learner. The National Scientific Council for Mathematics in the United States has specified a number of skills that are useful to the learners in particular. Such skills were included in ten mathematical topics (digits, numbers, mathematical processes and their characteristics, geometrical and mathematical statements and formulas, measurement, relationship, synchronism, statistics, probabilities, drawing and mathematical analysis). These skills are considered a mathematical translation that emphasizes the importance of awareness among teachers and students of such skills in order to be able to read graphs, and explain and generalize relevant information [NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, 1991, p 66].

The National Council of Supervisors of Mathematics emphasized the importance of learners acquiring the skills of explaining and designing tables and graphs as basic mathematical skills that are closely related to geographical skills necessary for learning geography. The existence of mathematical skills is very important due to the fact that they help the learners to deal easily, quickly, and accurately with mathematics, and to acquire further mathematical skills; mathematical skills also help learners to develop these skills and apply them to daily life. There is also a set of mathematical skills that should exist within the learner such as:

(1) Application skills: such as using mathematical concepts, and previously studied relationships in conducting algebraic and geometrical processes, as well as solving new unfamiliar problems.
(2) Transformational skills: These skills are represented in expressing mathematical information and transforming them from one form into another.
(3) Practical skills: such as using geometrical tools in implementing certain drawings and graphs.
(4) Interpretation skills: such as the ability to interpret verbal forms into geometrical ones and vice versa, in addition to explaining graphs [JAMES, 1995, p 163].

Mathematics like other academic subjects is integrated with different sciences. This integration that appeared as a curricular organization was a result of many researches and studies that were conducted in the fields of education and psychology leading to significant results. The most important results were transformation of aims of education from conserving heritage into educating the individual, and preparing him for life in a way that facilitates adjustment and integration with the environment, and then transmitting this learning from a generation to another. Studying geography in any educational stage requires a reasonable degree of mathematical knowledge that should be mastered by the student. This mastery varies according to the content and quality of processing mathematical skills to facilitate studying geography.

Therefore, in order to learn mathematical geography through problem solving or the analytical and the discussion methods, a student must possess the ability to remember rules and generalizations to make use of them in a new learning situation. A learner should remember such information before or after facing a mathematical problem. Thus, he needs to depend on the processes of analyzing the educational situation before starting. Learning may occur at first in a simultaneous way. So, simultaneous thinking is necessary for achieving learning, and being creative in solving problems.

POST emphasized the fact that developing mathematical skills is considered an important objective in learning geography in all educational stages. It is necessary for learning. However, good understanding of basic elements constituting the procedures conducted by the student should precede it. Learning mathematics serves the field of geography since many basic concepts, and mathematical skills are necessary for solving geographical problems. Thus, the role of students' understanding cannot be ignored; those basic facts, concepts, and skills are necessary for a student's geographical topics [POST, 1988, Pp 2-4].

Therefore, geographical skills require mathematical skills to help understand and master them. It can be said that studying geography is very difficult without understanding and mastering some mathematical concepts and skills whether they are theoretical or practical. The increasing interest in the present age of abstraction in mathematics involves the concern for raising the standard of effective application in different fields.

In Geography, students are to be encouraged to develop their understanding and to learn through the integration of mathematical strategies and approaches to tasks which are appropriate to the subject. Similarly, students should be presented with experiences that stimulate their mathematical interest and hone those quantitative skills that contribute to operating successfully within each of their subject domains.

Geographers use a variety of numerical and other mathematical concepts and skills, especially those relating to graphs and tables, statistics, maps, diagrams and measurement. Geographers also make extensive use of computer databases and software packages to manipulate and represent geographical data and concepts.

The characteristic nature of geography may require that new mathematical concepts and skills should be introduced and new skills developed for some students. All students need opportunities to practice the quantitative skills and understand what they have developed previously. Within appropriate learning contexts and experiences in geography, opportunities are to be provided for the revision, maintenance, and extension of such skills and understandings.

WENDY'S study emphasized that the presented activity design improves student's basic mathematics, reading, and reasoning skills while involving them in the application and understanding of human geography concepts, describes the activity background, place in the curriculum, development, implementation, and learning outcomes and provides the activity in a form ready for classroom use [WENDY, 1998, Pp 253-260].

FRED'S study emphasized the importance of providing students majoring in geography with the necessary means of analysis and deduction, such as statistics, computers, and climatic graphs, in addition to other aids, such as economics and sociology. These subjects should be ended in an obligatory way before a student majors in geography. The study also concentrated on the importance of including these subjects in the preparation program of learning geography at the colleges of Education [FRED, 1993, p 227].

BYRNES'S emphasized that the consultative committee that is responsible for specifying the essential skills related to history, geography, and social sciences, be of the same mind on several important skills such as reading and explaining maps, globes, models, shapes, graphs, schedules, and caricatures which help to select and organize information derived from books, encyclopedias, or dictionaries. They also help to understand and realize terms related to geography, history, and social sciences, which in turn help to develop different aspects of thinking [BYRNES, 2003, Pp 67-74].

Through the previous demonstration, we can extract an example of mathematical skills related to geography like drawing, which includes:
(1) Drawing things in a certain drawing scale to specify the real dimensions.
(2) Designing a drawing representing the relationship among variables of given data.
(3) Reading drawings and analyzing results.

This is usually exploited in geographical distribution of natural phenomena through mathematical data. The importance of mathematical skills in the present study is derived from concentration on continuous training on geographical skills related to a mathematical basis. For example, reading and explaining graphs as one of the skills associated with geography require that a teacher should be aware of the main principles that enable him to understand that skill, in addition to the ability to design, and explain it correctly. Learners' competence in these mathematical skills is important in order to be able to learn easily and accurately.

The present study is concerned with the student's competence in geographical mathematical skills [AMERICAN EDUCATIONAL RESEARCH ASSOCIATION, 1999, Pp 5-13., DOWSON & MCINERNEY, 2001, Pp 35-42]:

(1) *The Analysis:* In which a student can analyze a skill into elements and parts, in addition to evaluating and judging each part correctly, like mathematical geographical skills that require accurate analysis using logical arithmetic processes to solve problems correctly.

(2) *The Explanation:* It helps a student with understanding geographical-mathematical analyses and reading them easily. For example, a student can explain arithmetic processes, and describe the logical structure of the mathematical skills related to explaining graphs as a geographical skill.

(3) *The Realization:* Is among the different phenomena, and the methods that deal with geography mathematically. A student should be able to estimate length, distance, weight and other mathematical processes in explaining geographical phenomena. He should also be able to realize the inverse relationship between length and distance on the map, as well as their counterparts in reality.

(4) *The Measurements:* They refer to using different types of measurements, such as centimeter, meter, or inch, in finding areas and transforming them.

(5) *The Prediction:* That often encounters a student with probabilities of occurrence of certain events. So, he should depend on the mathematical basis. A specialist in geography, in order to predict the increase in temperature within several future days, should conduct processes related to probability and statistics, and be able to explain tables and graphs.

Therefore, through the integration between mathematics and geography, we can conclude the most important mathematical skills that are necessary for learning geography that are summarized as follows:

(1) The skill of using drawing scale in transforming distances, transforming areas, specifying geographical position on maps, magnifying and minimizing maps.
(2) The skills of using length or width circles through specifying astrological position, calculating time distance, specifying directions.
(3) The skill of using plans in explaining topographic maps, using a drawing level surface map, and specifying plans of the map.
(4) The skill of using arithmetic processes in explaining climatic maps using calculation of temperature means, calculation of the ratio of barometric pressure.
(5) The skills of reading and explaining graphs that are divided into drawing graphic curves for teaching phenomena, problems, and production, and comparing different phenomena by using graphs.
(6) The skill of using arithmetic skills in explaining contour maps which are represented in specifying the shape of relief, specifying knolls or slopes.
(7) The skill of finding the relationship among distance, time, and speed, calculating time based on distance and speed, calculating distance based on speed and time, and calculating speed based on distance and time.
(8) The skill of using degrees in quantitative distributions concerning drawing quantities in the form of circles, rectangles, or triangles according to ratio of production.
(9) The skill of using curves in explaining geographical data and drawing simple curves on topographic maps.
(10) The skills of calculating different degrees of regression, and the skill of using sectors in explaining geographical phenomena drawing a broad sector for valleys, drawing a longitudinal sector for rivers, drawing an interrelated sector for groups of other sectors.
(11) The skill of explaining similarity among mathematical shapes and some geographical phenomena such as a cone and a volcano, a pyramid and a mountain, an oval figure and a knoll…etc.

Based on the theoretical background presented in the second and third chapters of the study, in which the mathematical concepts and skills needed for learning geography were illustrated, concepts and skills were selected, and achievement tests, for measuring to what extent these concepts and skills were available, were designed. Consequently, the program was built in the light of scientific methods that were rooted in some educational theories and foundations suggested by educationalists in order to deal with the educational topics and problems in the proper way. This is clearly evident in the fourth chapter which presents the tools of the study, how they were designed, and the statistical procedures and techniques utilized. The fifth chapter shows in details the study results, their interpretations, and concluding the suggestions and solutions required for treating the problem of the study. This is clearly demonstrated in the section below.

4. Instruments of the Study

In this chapter, the study introduces a detailed demonstration of mathematical concepts and skills that are necessary for learning geography in order to recognize the most important concepts and skills described by the present study. It also includes the construction and description of the study instruments, in addition to the main difficulties that encountered the researcher and the statistical techniques used in analyzing the results of the pilot study.

4.1. Designing the study instruments

4.1.1. Specifying a list of necessary mathematical concepts and skills for learning geography:

The researcher reviewed many previous studies and researches which specify some necessary mathematical concepts and skills for learning geography. He also reviewed the most important books and scientific references dealing with the importance of concepts, and methods of teaching them whether in geography or in any other branch of knowledge.

Through reviewing related studies[1], books, academic references, and math teacher's guides for secondary schools in Bavaria, the main mathematical concepts and skills which students should learn every year were concluded. The researcher estimated certain concepts and skills that are important for studying geography. In this regard, he designed an achievement test for the students to find out the degree of importance of each skill from the curricula, and the extent to which each of the selected concepts existed among the students.

4.1.2. The achievement tests of some necessary mathematical concepts and mathematical skills for learning geography:

4.1.2.1. *Specifying the aim of the tests:*

This test aims at evaluating the performance and cognitive aspects of the students, and some necessary mathematical concepts and skills for studying geography, in addition to the extent to which these concepts and skills exist among the students, and the aspects of deficiency (if there are any). Besides, this test aims at giving the percent for these mathematical concepts and skills, and helps the research to mathematical concepts and skills for studying geography.

4.1.2.2. *Specifying the relative importance of each of the mathematical concepts and skills included in the tests:*

The researcher specified the relative importance of mathematical concepts and the skills included in the study through analyzing the content of those concepts and those skills. In determining the number of questions, the researcher considered certain factors, like the time taken for studying each

[1] See the study references pages (130-140)

concept and each skill through the study plan, and the scientific content studied, as well as the relative importance of each concept and skill. The questions ranged from one to two for each concept and skill. The researcher approximated fractions to assign two questions for each concept and skill.

4.1.2.3. *Sources of the tests:*

The researcher used some references, researches, and studies in the field that are closely related to geography. The researcher also reviewed the tests that were designed in the field of concepts or skills in previous studies in order to recognize the types of questions they contain and their methods of statement, in addition to what they measure in different educational situations. The researcher avoided repeating the questions included in previous books or tests.

4.1.2.4. *Preparing the tests items:*

The questions connected to each concept and skills stated in the test were previously specified. The questions were of the multiple choice and completion types. The study depended on that kind of objective tests because it avoids subjectivity, allows easiness of correction, and covers many parts of the subject. In addition, it is able to measure various levels of behaviour, and is easy to administer decreasing the ratio of guessing. The concepts test included (40) items, divided into different levels. The skills test included (36) items, divided into different levels. Therefore, the concepts and skills, which students must have learnt at secondary schools in Germany, are important for defining the curriculum items for mathematics and for geography at secondary schools. Therefore, they were analyzed, especially in the curricula of Bavaria secondary schools.

4.1.2.5. *Statement of tests items:*

There were many considerations in stating the test items as follows:

1. The number of alternatives was four, among which, only one was correct
2. The alternatives were as equal as possible concerning length of statement.
3. The alternatives were connected to the stem of the question.
4. The wrong alternatives were uniform.
5. The linguistic statement was simple to suit the students' levels.
6. The alternatives were arranged in such a way that enables the respondent to conclude the correct answer.
7. The math concepts test included (40) questions of the multiple-choice type, two questions for each concept, and four alternatives for each question.
8. The math skills test included (36) questions of the multiple-choice type, two questions for each skill, and four alternatives for each question.

Table (1) [2]

Geo-Math concepts test items divided the concepts and the question numbers.

No.	The Concept	Question number	Numbers in the test
1	Scale	2	1, 13
2	Distance	2	2, 17
3	Surveying	2	3, 31
4	Magnifying and minimizing	2	4, 14
5	Longitudes	2	8, 18
6	Direction	2	5, 20
7	Time	2	9, 28
8	Speed	2	10, 33
9	Slope	2	11, 15
10	Curves	2	7, 35
11	Size of circle, cylinder, cube, triangle and rectangle	4	16, 21, 27, 36
12	Portion	2	22, 23
13	Proportion	2	24, 19
14	Average	2	25,26
15	Diameter and volume	2	29,37
16	Correct numbers	2	30,32
17	Parallel and vertically	2	34,40
18	Drawing graphics	2	6, 39
19	Percentage	2	12, 38

[2] See appendix pages (141-156)

Table (2) [3]
Geo-Math skills test items divided the skills and the question numbers.

No.	The Name of Skill	Numbers of Question	Numbers of Question in Test
1	Transforming distance	2	1,2
2	Transforming areas	2	3,4
3	Specifying distance between places on the map	2	5,6
4	Magnifying and minimizing maps	2	7,8
5	Specifying the astrological position	2	9,10
6	Determining directions	2	12,13
7	Calculating the time spent between different places	2	11,21
8	Determining the projections of the map	2	18,19
9	Using degrees in drawing sectors	2	33,34
10	Using curves in interpreting geographical data.	2	24,28
11	Calculating the different degrees of regression among places	2	28,29
12	Calculating the means of temperature and pressure	2	15,20
13	Graphic designs	2	31,32
14	Using scores in quantitative distributions on maps	2	23,30
15	Air-photographic maps	2	25,26
16	Determining the relation among distance and speed to reach time	2	14,16
17	Calculate speed via distance and time	2	17,22
18	Similarity between mathematical figures and geographical phenomena	2	27,36
19	Contour maps	2	35,36

[3] See appendix pages (157-178)

4.1.2.6. *Specifying the learning levels involved in the tests:*

1. Comprehension:

   It represents the second rank of cognitive levels in which an individual can understand what goes on around him, the pictures and information presented, and the relationships involved in such topics. He can also recognize the existence of certain phenomena, and distinguish some factors affecting them. The student's comprehension is estimated according to his response towards relevant questions.

2. Application:

   It is the extent to which a learner can use and exploit concepts, skills and information that were previously learned, in addition to the ability to apply them in new learning situations which is a distinctive quality between mere understanding and creative ability to make advanced mental processes such as analysis, synthesis, and evaluation, as represented in tables number (3) and (4).

Table (3)
Geo-math concepts test items divided into levels of comprehension and application

Level	Comprehension	Application	Total
Items	12	28	40
Relative Importance	30%	70%	100%

Table (4)
Geo-math skills test items divided into levels of comprehension and application

Level	Comprehension	Application	Total
Items	6	30	36
Relative Importance	16,3%	83,7%	100%

4.1.3. Tests instructions:

After the test items were written down, a group of instructions to be used by students in answering the test questions were included. Those instructions were regarded as a guide to help the student answer questions and identify the nature and objectives of the test as well as the rules that should be considered to achieve the best possible desired results. Therefore, the researcher prepared test instructions before the preliminary experiment to be able to score these instructions in the light of this preliminary experiment. The researcher was careful about the following:

(1) Clarity and accuracy of vocabulary used in the instructions and their appropriateness to the student's linguistic level.
(2) The inclusion of demonstrative examples to guide the students to recognize the suitable method for answering questions of the test.
(3) Brevity of instructions for fear of embarrassing the students.
(4) Specifying the test objective to make the student aware of what he has to do.
(5) Assuring that all the students start answering at the same time.

4.1.4: Pilot experiment:

After designing the tests and judging their validity by expert jury members, the tests were administered on a randomly selected group of geography learners including (21) individuals from Augsburg University as a pilot group in order to:

4.1.4.1. *Calculate the time of the tests:*

The time taken to administer the math concepts test and math skills test was specified through determining the time taken for answering the tests questions in the pilot experiment. The quickest students finished the tests within 20 minutes, while the slowest students finished the same tests within 40 minutes. The average time was, then, calculated. It was 30 minutes. Thus, the test became valid for evaluating the desired objectives in its final form.

4.1.4.2. *Assure the clarity of instructions and questions:*

The researcher observed the student's behaviour during answering the test questions. He found out that learners had only a few questions about the test content signifying its clarity concerning both questions and instructions.

4.1.4.3. *Calculate the tests reliability:*

Test reliability means obtaining the same results if the test is administered on the same group in two different occasions. It may also refer to the correlation between the test and itself. Reliability was obtained from the following formula [HOWITT & DUNCAN, 1997, Pp 62- 69]:

$$\text{Regression Coefficient } r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{sqrt[n(\Sigma x^2) - (\Sigma x)^2] * sqrt[n(\Sigma y^2) - (\Sigma y)^2]}$$

Where:
N = number of students
Σx = total score of the single question
Σy = total pair question score
Σx^2 = the square of the single question score

The researcher administered the test on the group of learners which included (21) students. He used the split-half method in calculating the reliability coefficient. For the math concepts test the study found out that the value of

"R"[4] was (0.79) which refers to a good correlation. The reliability coefficient was (0.62) demonstrating a high reliability degree. For the Math skills test the study found out that the value of "R" was (0.83) which refers to a strong correlation. The reliability coefficient was (0.68) demonstrating a high reliability degree.

4.1.4.4. *Calculating the coefficients of easiness and difficulty:*

The researcher calculated the coefficients of easiness and difficulty for each of the test items in order to delete the questions which are too easy or too difficult. He also:

(1) Calculated facility value for test degrees from the following formula, [HOWITT & DUNCAN, 1997, Pp 62-69]:

$$\text{Coefficient of easiness} = \frac{\text{Correct answers}}{\text{Correct answers} + \text{incorrect answers}}$$

(2) Calculated facility value tests degree of the guess value by the following formula

$$\text{Coefficient of diffiecult} = \frac{\text{Correct answers} \ \dfrac{\text{Incorrect answers}}{1-\ \text{Alternative}}}{\text{Correct answers} + \text{incorrect answers}}$$

(The value of the coefficient of difficulty is negative. The larger the amount of the coefficient of difficulty the more difficult is the question). The researcher found out that question (5) in math skills test had an easiness coefficient of (0.93) indicating a high degree of easiness. Thus, it was restated, whereas the rest of questions had a coefficient ranging from (0.58) to (0.88) indicating the approximation in ratio of easiness and difficulty concerning test items.

The researcher found out that question (22) in the math concepts test had an easiness coefficient of (0.95) indicating a high degree of easiness. Thus, it was restated, whereas the rest of questions had a coefficient ranging from (0.60) to (0.92) indicating the approximation in ratio of easiness and difficulty concerning test items.

4.1.4.5. *The final form of the test:*

It is the last step in test design after calculating difficulty and easiness coefficients, validity, reliability, and time of the test. The ultimate form of the math concepts test includes a test notebook consisting of a cover and (40) questions. The final form of the math skills test includes also a test notebook consisting of a cover, and (36) questions. Thus, the test is in its final form and is applicable to the research group.

4.1.5. Statistical techniques used for analyzing results:

The researcher used some statistical techniques to attain the valid results. This study is considered one of the experimental studies which depend on comparing the

[4] $R = r^2$ $(0{,}79^2 = 0{,}62)$

mean scores of learners to realize the relative importance of skills, the correlation coefficient of skills, the validity and reliability of the achievement test and to specify the existing standard of the students' performance in those mathematical concepts and skills that were previously determined.

4.2. Constructing the suggested program of some mathematical concepts and skills that are necessary for learning geography

The following steps were adopted [5]:

4.2.1. Specifying the aim of the program:

The aim of the program was represented in making students suggest some suitable innovative solutions associated with some geographical issues. Those solutions should contain many mathematical concepts and skills which help them to solve and face several learning problems in the course of studying geography, especially those connected with mathematical topics.

The aims of the program were represented in developing some mathematical concepts and skills necessary for studying geography which were emphasized through achievement tests whose results indicated the necessity of constructing a suggested program containing these concepts and skills. This is done to enable teachers and students to deal with such problems encountered in studying mathematical geography.

4.2.2. Principles of the suggested program:

They were represented in reviewing previous studies and the theoretical framework of the research, including a theoretical study about concepts and skills in general, especially those associated with mathematical methods in geography, in addition to the way of acquiring certain geographical facts, concepts, terms, and laws.

This step resulted in demonstrating a set of principles that were taken into consideration when constructing the proposed program such as:

(1) The necessity of providing comprehensiveness and integration, in addition to combining all aspects of experience in the aims of the program in order to achieve coordination among students concerning the topics of the program and the awareness of problems. This emphasizes the necessity of including the behavioral aspects in the aims of the program to clarify the relationship between geography and mathematics so as to develop the coordinated concepts and skills between them.

(2) Considering the tendencies, abilities, aptitudes, and problems of the students, since instructional programs are based on psychological principles of students at each academic stage or grade.

(3) Taking care of implementing the program inside or outside the college, since this program allows many opportunities for the students to recognize and deal

[5] See appendix pages (179-294)

with mathematical concepts and skills that are necessary for learning geography.

4.2.3. Specifying the instructional activities, teaching techniques, and instructional aids:

4.2.3.1. *Specifying instructional activities:*

They are behaviors performed by the students inside the classroom or inside and outside the school in order to achieve the best possible standard in learning and acquiring concepts and skills that are taught. There are some suggested activities that the teacher may assign to students during studying concepts and skills in the proposed program. These are:

1. Preparing statistical schedules about population phenomena concerning high and low population density in the world and illustrating them in the form of population graphs and maps.
2. Studying and using raw scores in drawing various graphic designs such as curves, circles, and the like.
3. Using numbers in forming geographic maps with the aid of contours to demonstrate differences in the height of geographic reliefs.
4. Using mathematical calculations to demonstrate different forms of drawing scales in relation to maps.
5. Drawing climate maps for various places in the world.
6. Gathering information and primary data from a variety of sources including:

(6.1) Maps (topographic, orthophoto, thematic, geological),
(6.2) Statistics and graphs,
(6.3) Databases and geographical information systems,
(6.4) Websites,
(6.5) Photographs: horizontal, aerial (both vertical and oblique) and satellite,
(6.6) Diagrammatic representation, e.g. flow, block diagram,
(6.7) Books, periodicals and reports,
(6.8) Audiovisual materials,
(6.9) Field work (observation and surveys),
(6.10) Field equipment,
(6.11) Community personnel.

Gathering information from such learning resources and settings is an integral part of the learning experiences of Geography students. The techniques used in the effective gathering of information should be incorporated into teaching programs in a systematic way. Skills to be developed include:

(1) Developing a research plan,
(2) Selecting and organizing relevant information,
(3) Observing,
(4) Summarizing and note making,
(5) Recording measurements,
(6) Sketching, mapping and surveying,
(7) Interviewing,
(8) Listening,

(9) Recording relevant bibliographical and referencing information,
(10) Communicating and presenting information in a variety of ways appropriate to the experiences of students, such as:
(11) Maps (land use, choropleth, isoline, dot, flow).
(12) Tables of data.
(13) Graphs (column, line, scatter, population pyramid).
(14) Photographs.
(15) Diagrams/sketches (cross section, systems diagrams, flow diagram).
(16) Observation schedules.
(17) Written reports.
(18) Written essays.
(19) Seminars (oral and written).
(20) Audiovisual formats.
(21) Computer presentations.

4.2.3.2. *Teaching methods:*

Teaching methods means the steps adopted by the teacher to teach mathematical skills and concepts in geography. This program provides specific steps for teaching different topics. There are different teaching techniques according to the nature of teaching topics. The method of deductive models may be used in teaching concepts and skills such as GAGNÉ'S model for teaching abstract concepts, KLAUSMEIER'S model, and MERRILL & TENNYSON'S model that is based on deduction, or models of teaching inductive concepts and skills according to the educational situation of the teaching model. The Math skills and concepts require communicating and presenting information to students effectively in a way that guarantees their incorporation into the teaching program in a systematic way.

4.2.3.3. *Instructional aids:*

Instructional aids are instruments used by the teacher and are selected in the light of the nature, limits, and aims of the subject to be achieved by the suggested program such as:

(1) Statistical tables.
(2) Illustrative pictures for different drawing scales.
(3) Geographical maps and contour maps.
(4) Graphic shapes.
(5) Different kinds of Atlas.
(6) A group of guiding books to be borrowed from the school library in order to help the teacher identify and explain some meaning of mathematical skills and concepts through certain paragraphs that are read and summarized by the students.

4.2.3.4. *Evaluation:*

Evaluation is a diagnostic remedial process that is performed by the teacher in order to recognize the extent of success achieved by a certain method to reach the desired objectives. The evaluation techniques suggested in the program are various. There are partial evaluation techniques at the end of each part of the lesson, remedial a technique representing what is called ‘feedback’; and final evaluation techniques that indicate the achieved aims out of the whole lesson. The researcher adopted different techniques that can cope with the nature of students and the suggested programs. These techniques can be summed as follows:

1. Oral questions:

   Oral questions are necessary in this study. The teacher used them during the training process in order to make sure that the students realize the meanings of mathematical concepts and measure skills, and their ability to apply them in other educational situations.

2. Essay questions:

   Essay questions are questions that the teacher assigns to students so as to give an answer in a few lines. The present study depended on these questions within the lesson tasks assigned to the students during the lessons to answer them. The aim of providing such kind of questions is to realize the extent to which the students interpret the topics through what goes on in their minds about these concepts and skills.

3. Objective questions:

   Objective questions are questions that the teacher suggests in order to recognize the extent of the students’ knowledge and their understanding of the mathematical concepts and skills that are related to studying geography. This is done through the student’s achievement of correct answers. These questions vary; they may be true/false questions, multiple-choice questions, and completion. These questions were introduced at the end of each lesson in the units of the proposed program.

4.2.3.5. *Specifying the content of the program:*

Since the suggested program in mathematical geography aims at developing some mathematical concepts and skills that are necessary for studying geography at the secondary stage level, certain program units that are closely related to mathematical processes were selected. These units combine the topics including concepts which are associated with skills. The units of the suggested program were as follows:

Lesson One: Drawing scales & their types.
Lesson Two: Magnifying and minimizing maps.
Lesson Three: Specifying the astrological position.
Lesson Four: The directions.
Lesson Five: The curves.
Lesson Six: Geological sectors and relief sectors.
Lesson Seven: Climate maps and their explanation methods of distribution on climate maps.
Lesson Eight: Regressions and their measurement.
Lesson Nine: Using degrees in graphic designs.
Lesson Ten: Air-photographic maps.
Lesson Eleven: The contour maps & their types.

Lesson Twelve: Similarity between mathematical figures and geographical phenomena.

Justifications of selecting the program lessons:

(1) They contain mathematical processes that are needed in studying geography.
(2) Some students do not learn any mathematical tendencies. Thus, the program bridges this gap in the students' knowledge.
(3) Studying the program units contributes in developing the patterns of thinking since they contain many problems that represent a challenge to the students' thinking.
(4) Studying the program units contributes in the students' learning of primary principles that are used in mathematical processes after their graduation and work at schools.
(5) Teaching these units using multiple concepts methodology helps the students in achieving some knowledge and mathematical geographical concepts and skills.

4.2.3.6. *Sources of the program:*

The students, when necessary, specified some main sources in order to refer to them during studying the suggested program (See the study references pages 138-140).

4.3. The Experimental procedures of the study

It was necessary to make sure of the degree of effectiveness of the proposed program in mathematical geography in order to develop some concepts and skills that are necessary for learning geography. Therefore, a field study was required.

4.3.1. The aim of the study experiment:

The study experiment aims at teaching mathematical concepts and skills that are necessary for studying geography and their effects on the student's achievement. Thus, a teacher's guide was prepared for teaching the units of the suggested program including the aims of teaching the units, the objectives of each lesson, instructional aids, methods of demonstrating geographical concepts and skills, the evaluation of each lesson, and the evaluation of students after studying the program units through re-administering the achievement tests of concepts and skills. This was done to identify the effectiveness of the proposed program in teaching and to measure its effect on developing these concepts and skills among geography students.

4.3.2. Steps of the study experiment:

4.3.2.1. *Testing the group of the study:*

The group of the study was selected from among the geography students of all universities in Bavaria in Germany. The group of the study consists of several semesters. The tests were administered after controlling the various variables that affect the results of the study. The sample of the study was randomly selected. The following table shows search tests by the random sample and name of universities in Germany. We can note that in the following table:

Table (5)
The universities and group of the study and their numbers

The Geo-Math concepts and skills test										
University	Implementation date	Students numbers	Semester							
			1	2	3	4	5	6	7	8
Uni. Regensburg	15.05.04	40	2	7	9	20	-	-	2	-
Uni. Passau	19.10.04	20	3	4	2	5	-	3	-	3
Uni. Erlangen-Nürnberg	19.06.04	25	3	-	5	7	-	4	2	4
Uni. Bayreuth	30.06.04	20	3	5	-	5	4	3	-	-
Uni. Bamberg	30.11.04	22	-	4	2	10	-	4	-	2
Uni. Augsburg	19.10.04	125	110	-	9	-	3	2	1	-
Uni. Würzburg	19.10.04	14	-	2	4	3	-	2	3	-
Uni. Augsburg	13.07.05	20	-	-	-	15	-	1	1	3
Uni. München	29.04.05	25	-	18	1	3	-	-	-	3

4.3.2.2. *Variables of the study and controlling methods:*

1. The independent variable:

   The independent variable of this study is the suggested program in mathematical methods in geography that includes some concepts and skills that are necessary for studying geography. A sample was selected for the experimentation of the suggested program.

2. The dependent variable:

   The dependent variable of the study is represented in developing some mathematical concepts and skills that are necessary for studying geography and their applications in new situations through administering the test of concepts and skills to the group of the study to assure the students' acquisition of these concepts and skills.

4.3.3. The pre-application of the tests of geographical-mathematical concepts and skills and program test:

The pre-test was conducted for testing of concepts and skills before starting teaching the proposed program so as to recognize the initial level of the study group before teaching the units using the suggested program and its various teaching techniques.

4.3.4. Correcting and recording the scores of the pre-test of mathematical concepts and skills and the program test: The test was corrected and the scores were recorded according to the following procedures:

1. Examining the answer sheets and excluding the questions which carry more than one answer signifying the student's hesitation.
2. Correcting the answers of the study group according to the answer model designed for this purpose.
3. Recording the scores of the individuals' samples in tables. The maximum score was (40) for the concept test divided as one score for each of the test question. The maximum was (36) for the skills test divided as one score for each of the test question. And the maximum was (51) for the program test divided as one score for each of the test question.
4. Applying the equation of excluding the guessing effect on the test scores.
5. Through correcting and recording the scores of the study group, the significance of differences among means was calculated using the U test for the efficient group. The one group of the study was found to be low in the level of mathematical concepts and skills before teaching the program.

4.3.5. Teaching the units of the suggested program to develop some mathematical concepts and skills that are necessary for learning geography:

After the pre-test of concepts and skills and program test and recording the results, the teaching of the program units began considering the following:

1. The teacher taught the program units that were designed according to the teacher's guide of the study, along with the use of instructional aids, activities that were previously specified, and applying the workbook for each lesson.
2. In each period, a paper was handed to each student including various questions in order to conduct the investigative training. The teacher collected the papers at the end of each period, and corrected them in order to monitor the standard of the students in acquiring concepts and skills that were previously studied.
3. In the course of the teaching of the units, the teacher was relating the taught concepts and skills to the current events, such as the different contemporary issues dealt with in the newspapers and magazines.

At the end of each period, the teacher gave the study group some application questions on each lesson and asked the students to answer them in a separate notebook under his supervision. He also assigned some activities to them that were associated with lessons, concepts, and skills. Teaching the study units had taken twelve periods divided on six weeks, with the rate of two periods per week.

4.3.6. Conducting the Re-test on the study group:

After finishing the teaching of the program using the techniques designed for the study, the test of concepts, and mathematical skills were administered to the group of the study.

Chapter Five illustrates the study tools regarding how they were designed and how they were experimented with the various samples of the study, the geographical mathematical concepts and skills tests required for learning geography or for the program and its design, the topics tackled in the program, its objectives and the possibility of experimenting it, and the study results obtained.

5. Results of the Study and their Interpretations

This section deals with the statistical analysis of the study results, and their discussion in the light of the study questions which aimed at recognizing the extent of existence of some mathematical concepts and skills that are necessary for studying geography. In addition, the study aimed at identifying the effectiveness of an integrated program based on the integration between geography and mathematics in developing some mathematical concepts and skills that are necessary for studying geography.

The statistical treatment depended on calculating the arithmetic means and the standard deviation, as well as the differences among the means of the study groups. The researcher used the U test in order to identify the significance of the differences between means of scores of the study group in the pre-test and those of the post-test [JÜRGEN, 1993, Pp 144-145., LIPSEY, 1990, Pp 54-58., GREENE AND D'OLIVEIRA, 1999, Pp 111-113]. Moreover, CARL'S effect equation [CARL, 1994, p 467] was also calculated to recognize the effect of the program on acquiring concepts and skills.

Demonstration of the Most Important Results of the Study

5.1. Answering the First Question

To answer the first question, *"To what extent do some mathematical concepts and skills that are necessary for learning geography exist among geography students?"* the researcher followed the following steps:

Through reviewing previous studies and skills and their mutual relationship, the following conclusions were reached:

1. There is as integrated relationship between both mathematics and geography as two educational disciplines.
2. There are many studies that deal with the mathematical concepts and skills included in some academic syllabuses, especially geography, in different stages of public education.
3. Some skills related to mathematics were not dealt with by previous studies, such as the skill of using curves in explaining geographical phenomena and the skill of using sectors in explaining similarities between mathematical figures and geographical figures.
4. There is integration between geography and mathematics; this was exposed through the theoretical aspect of the study.
5. The content of some syllabuses studied by students in different academic stages was analyzed in order to recognize the concepts and skills that are necessary and important. Therefore, a preliminary list was introduced including the main mathematical skills and sub-skills, in addition to a list of the main important concepts.

We can note this in the table below which demonstrates the geo-math concepts and skills:

Table (6)
Some Geo-Math concepts and skills which are very important for learning geography

No.	The Concept
1	Scale
2	Distance
3	Surveying
4	Magnifying & Minimizing
5	Longitudes
6	Direction
7	Time
8	Speed
9	Slope
10	Curves
11	Size of circle, cube, triangle and rectangle
12	Portion
13	Proportion
14	Average
15	Diameter & volume
16	Numbers integration
17	Parallel & vertical
18	Drawing graphics
19	Percentage

No.	The Skill
1	Measuring distances
2	Measuring areas
3	Specifying distances on a map
4	Magnifying & minimizing maps
5	Specifying geographical positions
6	Specifying directions
7	Calculating time between places
8	Drawing maps and their types
9	Using degrees in drawing sectors
10	Drawing graphic curves for different phenomena
11	Calculating different degrees of regression among places
12	Calculating the means of temperature & pressure
13	Graphic designs
14	Drawing quantities in several graphic designs
15	Air-photographic maps
16	Calculating distance, speed and time on the map
17	Similarity between mathematical figures and geographical phenomena
18	Contour maps

The main list of concepts and skills was determined through the preliminary application of an achievement test. Thus the first question of the study was answered.

5.2. Answering the Second Question

To answer the second question: *"What is the degree to which certain mathematical concepts and skills necessary for learning geography exist among geography students?"*, the results of administering the achievement tests of concepts and skills were as follows:

5.2.1. The selection of some mathematical concepts necessary for learning geography

Table (7)
The percentages of questions and students' scores in the math concepts test

Question number	Student numbers	Student scores	Percent -age	Question number	Student numbers	Student scores	Percet -age
1	311	276	88%	**21**	311	139	44%
2	311	268	86%	**22**	311	198	63%
3	311	260	83%	**23**	311	226	72%
4	311	277	72%	**24**	311	169	54%
5	311	159	51%	**25**	311	232	74%
6	311	265	85%	**26**	311	221	71%
7	311	149	47%	**27**	311	252	81%
8	311	274	88%	**28**	311	218	70%
9	311	166	53%	**29**	311	203	65%
10	311	206	66%	**30**	311	113	42%
11	311	210	67%	**31**	311	186	59%
12	311	245	78%	**32**	311	202	64%
13	311	274	88%	**33**	311	244	72%
14	311	158	55%	**34**	311	136	43%
15	311	214	68%	**35**	311	275	88%
16	311	247	79%	**36**	311	269	86%
17	311	282	90%	**37**	311	265	85%
18	311	254	81%	**38**	311	209	67%
19	311	173	55%	**39**	311	298	95%
20	311	226	72%	**40**	311	125	40%

From the above table, it has become obvious that:

1. All the scores of the questions ranged close to 90%, which is a high percentage, indicating the students' possession of the cognitive aspects related to this question. Of course this does not mean easiness of the question, whether in the verbal phrasing or in the scientific content. Rather it was obvious that the subjects of the study possessed the knowledge related to this kind of questions. The researcher was so fascinated with the students of the study group because

they possessed the knowledge related to these concepts which is considered a fundamental element required for learning and studying geography.

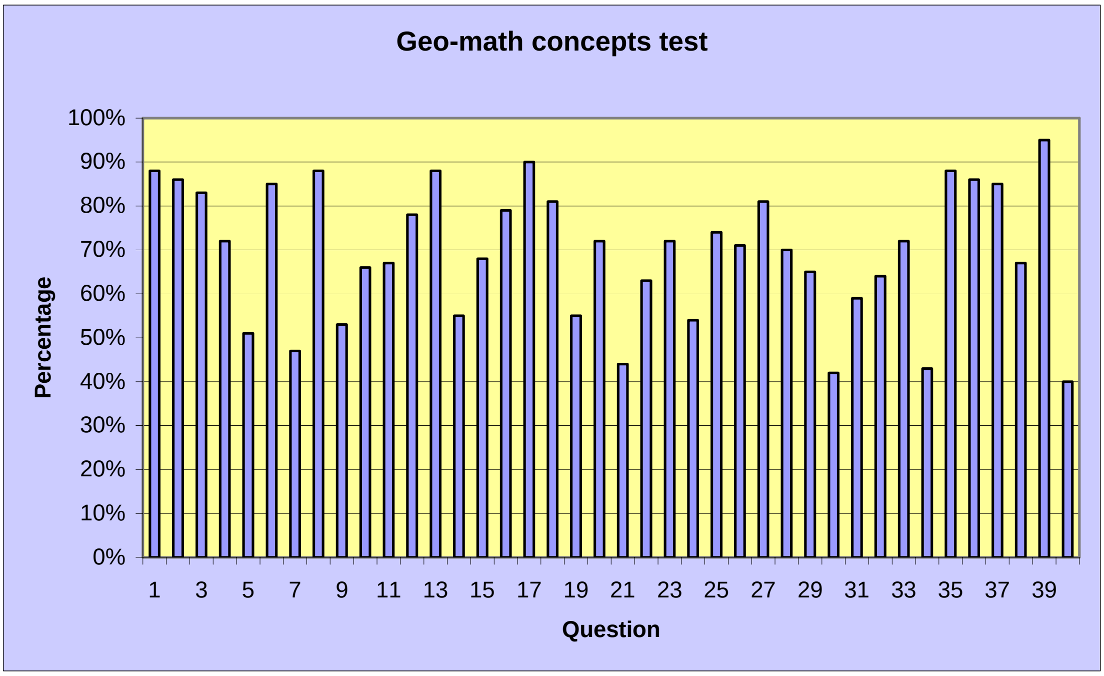
2. Percents of the students' scores in some questions ranged between 80% and 85%. Of course this indicates that the students composing the study sample master the information and knowledge related to these questions. The students' answers reflect the existence of the concepts related to these questions in the students.

3. The students' answers of some questions ranged between 70% and 79% which was relatively low since the percent of 85% was considered as an indication level of concept existence. This shows the relatively low level of performance as indicated by the students' answers. This emphasizes the existence of a low level knowledge related to those questions. The study considered the questions in which the student gets less than 80% an indication of the lack or shortage of knowledge for the group of the study.

4. The answers for some questions which ranged between 60% to 69% and little more demonstrate the low level of knowledge and information that help students to deal with the concepts. This indicates a low general indicator of the correct answers of these questions throughout the students in the group of the study. This emphasizes the fact that the students in the study group do not possess the information, knowledge and concepts which are related to those questions as the percentage of those questions out of the total general questions reached 17% which is considered a huge percentage.

5. The student answers for some questions reached the percentage of 40% to 59% indicating the inability to deal with the concepts correctly, as indicated in the figure below. Here we find that the level continues to be lower and lower and this is clear from the students' answers. This emphasizes the fact that the students in the study group do not possess the knowledge and information related to the questions, whose percent, out of the total questions is not less than 27%. This is a great percent, which emphasizes the unavailability of the concepts related to these questions for the students in the group of the study.

Figure (10)
The student answers for the question included in the test of mathematical geographical concepts



From the previous diagram, it can be concluded that there is some conceptual information for some mathematical geographical concepts that is relevant (and closely related) to geography, and which is reflected in the students' answers of the test questions. The graphic curve classifies students into several levels that indicate the existence of a great gap between the presence and absence of conceptual knowledge. However, most of the concepts ranged between 55% and 85%, which are relatively low percents for judging the mathematical concepts that are necessary for studying geography. The low percent reached 40% which also indicates the students' need for a sufficient conceptual awareness.

5.2.2. Concerning the selection of some mathematical concepts which are necessary for learning geography

The table below demonstrates the ratios of the concepts specified in the present study among the students of the study group:

Table (8)
The ratios of the concepts specified in the present study among the students constituting the study group

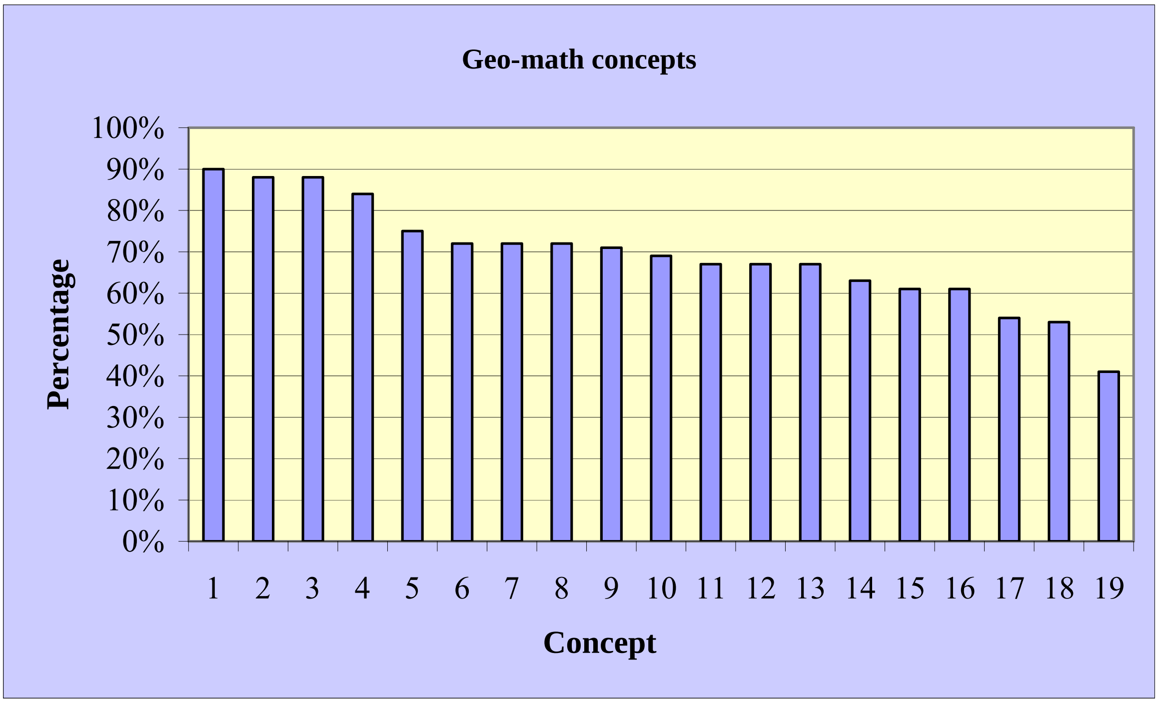
No.	The Concept	Number of the questions	The Existing Ratio
1	Drawing graphics	6,39	90%
2	Scale	1,13	88%
3	Distance	2,17	88%
4	Longitudes & Latitudes	8,18	84%
5	Diameter & volume	29,37	75%
6	Average	26,25	72%
7	Size of circle, Cube, Triangle & Rectangle	16,21,27,36	72%
8	Percentage	12,38	72%
9	Surveying	3,31	71%
10	Speed	10,33	69%
11	Slope	11,15	67%
12	Curves	7,35	67%
13	Portion	22,23	67%
14	Magnifying & Minimizing	4,14	63%
15	Direction	5,20	61%
16	Time	9,28	61%
17	Proportion	23,24	54%
18	Numbers integration	30,32	53%
19	Parallel & vertical	34,40	41%

Form the above table, it can be noted that:

1. The mathematical geographical concepts, such as drawing graphic and diagrams existed among the students of the study group with a percentage of 90%; indicating a high level of knowledge.
2. The mathematical geographical concepts, such as longitudes and latitudes, scale, distance, ranged from 80% to 88%, which is a high percentage that refers to the existence of such concepts.
3. The mathematical geographical concepts such as surveying, size, circle, cylinder, cube, triangle, rectangle, average, diameter, volume and percentage decreased relatively among the students to 70%; a percentage below the acceptable level specified by the study 80%.

4. The mathematical geographical concepts, such as magnifying, minimizing, direction, time, speed, curves, slope, and portion, existed of a percentage of 60% to 69%, which is relatively low and insufficient.
5. The mathematical geographical concepts such as proportion and integral numbers existed in percentages of 54%.
6. Finally the mathematical geographical concepts, such as parallel & vertical, decreased to 41%, which is an extremely low percentage that refers to the absence of the relevant knowledge of this mathematical concept.

Figure (11)
The Geo-Math concepts and the available percentages



According to the above diagram, it can be said that the total test scores were calculated for each individual student in the study group in the test. A student is considered competent in concepts if he/she gets 80 percent or more out of the total maximum score. The highest ratio ranged between 41% and 90%, and this indicates variance in the achievement standard level among the students composing the sample of the study. From table (7), and diagram (8), it can be said that the students were different in their cognitive performance concerning certain concepts such as: magnifying, minimizing, curves, time, speed, portion, and direction, since this standard reached a degree between 60% and 70%, compared with the students' cognitive performance in the test and their inability to use or remember these concepts included in the test. However, application remained as a difficult task for students to do. This was clearly indicated by the mathematical behavior accompanying the test, and also by the students' positive performance, which ranged between the cognitive and the application levels.

5.2.3. Concerning the selection of certain mathematical skills that are necessary for learning geography: The results indicated the existence of ratios as seen in the table below:

Table (9)

Question percentage and students' scores in the mathematical skills test

Question number	Student numbers	Student scores	Percent-age	Question number	Student numbers	Student scores	Percent-age
1	311	286	91%	**19**	311	218	70%
2	311	272	87%	**20**	311	234	75%
3	311	233	74%	**21**	311	176	56%
4	311	164	52%	**22**	311	214	68%
5	311	289	92%	**23**	311	235	75%
6	311	291	93%	**24**	311	120	38%
7	311	286	91%	**25**	311	138	44%
8	311	264	84%	**26**	311	122	39%
9	311	138	44%	**27**	311	87	27%
10	311	110	35%	**28**	311	85	27%
11	311	193	62%	**29**	311	101	32%
12	311	268	86%	**30**	311	176	56%
13	311	279	89%	**31**	311	203	65%
14	311	224	72%	**32**	311	201	64%
15	311	91	29%	**33**	311	125	40%
16	311	276	88%	**34**	311	178	57%
17	311	227	72%	**35**	311	204	65%
18	311	242	77%	**36**	311	109	36%

Based on the above table, it can be noted that:

1. The students' answers to some questions ranged between 80% and 95% which is a high percentage indicating the existence of information and relative knowledge. Of course this indicates the easiness which the students found in performing the correct answers in relation to the questions. This is clearly represented in the performance of the students of the study group and it indicates their possession of the information and knowledge related to these questions. This was one of the primary interests of the researcher who cared for identifying the extent to which those students possess the knowledge and information related to these questions and the subsequent skills which are considered essential foundations for learning and studying geography.

   The high percents of the students' correct answers that ranged between 80% and 95% in the skills test may be attributed to the fact that the study courses in the different stages of study covered the skills addressed by the questions that were put to measure these skills. Besides, these questions measured skills considered essential for learning geography that should be mastered by learners.

2. Students' answers to some questions ranged between 70% and 77%; a percentage indicating a reasonable level of knowledge. This shows the relative reduction in performance throughout the study group. This emphasizes the reduction of the cognitive level related to these questions as it was assumed in the study that the questions in which students get more than 80% of the correct answers were considered to be among the knowledge aspects and skills which were not available to the students in the study group. This is clearly illustrated in the previous table as well as the results of the study group students.

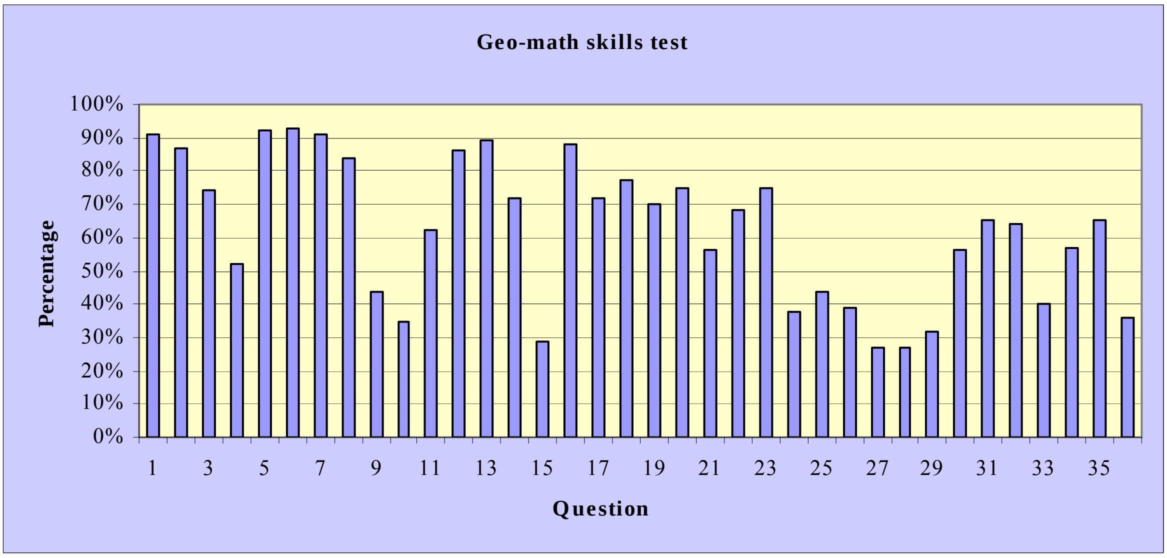
3. The answers to some questions ranged between 60% and 69% and this indicates a low standard of knowledge. This indicates the reduction of the general indicator of the correct answers to these questions. This emphasizes the fact that the study group students do not possess the information, knowledge and concepts which are related to the skills of these questions as the percentage of these questions out of the total general questions of the test reached 13% which is considered a very high percentage.

4. The answers to some questions were very relatively low (50%) referring to a low standard of knowledge. This indicates reduction in the general indicator of the correct answers to these questions. This emphasizes the fact that the study group students do not possess the information, knowledge and concepts related to these questions as the percentage of these questions out of the total general questions reached 11%, which is considered a very high percent.

5. The answers to some questions were extremely low (40%) indicating a deteriorating low level of knowledge. Here we notice that the level of the study group students continued to be lower and lower. This emphasizes the idea that those students do not possess the knowledge and information related to the skills involved in those questions whose percent is not less than 33% out of the total general questions. This reinforces the unavailability of the skills related to these questions to the study group students.

Figure (12)

Questions percentages and students scores in the mathematical skills test



Based on Figure (12), it can be noted that the students' standards fluctuated as their percents ranged from 0.92 to 0.29 (or rather from a high level to an extremely low one).

5.2.4. The results which indicated the existing ratios for the Geo-math skills. Available as shown in the following table:

Table (10)
The Geo-Math skills and their degree of existence

No.	Skill	Questions Numbers	Existing Ratio
1	Specifying distances on a map	5,6	93%
2	Measuring distances	1,2	89%
3	Magnifying & minimizing of maps	7,8	88%
4	Specifying directions	12,13	87%
5	Calculating distance, speed and time on the map	14,16,17,22	75%
6	Drawing maps and their types	18,19	73%
7	Drawing quantities in several graphic designs	23,30	66%
8	Graphic designs	31,32	64%
9	Measuring areas	3,4	63%
10	Calculating time between places	11,21	59%
11	Calculating the means of temperature & pressure	15,20	52%
12	Contour maps	35,36	50%
13	Using degrees in drawing sectors	33,34	48%
14	Air-photographic maps	25,26	41%
15	Specifying geographical positions	9,10	39%
16	Drawing graphic curves for different phenomena	24,28	32%
17	Similarity between mathematical figures and geographical phenomena	27,36	31%
18	Calculating different degrees of regression among places	28,29	29%

Throughout the above table, it can be noted that:

1. The mathematical geographical skills, such as measuring distances, specifying distances, magnifying & minimizing maps, and specifying directions, percentages of answers ranged from 80% to 93% which is considered to be a high percentage that indicates the existence of skills and relevant knowledge among the study group students.

2. The percentages of the geographical mathematical skills, such as using degrees in drawing sectors, and calculating distance, speed and time on the

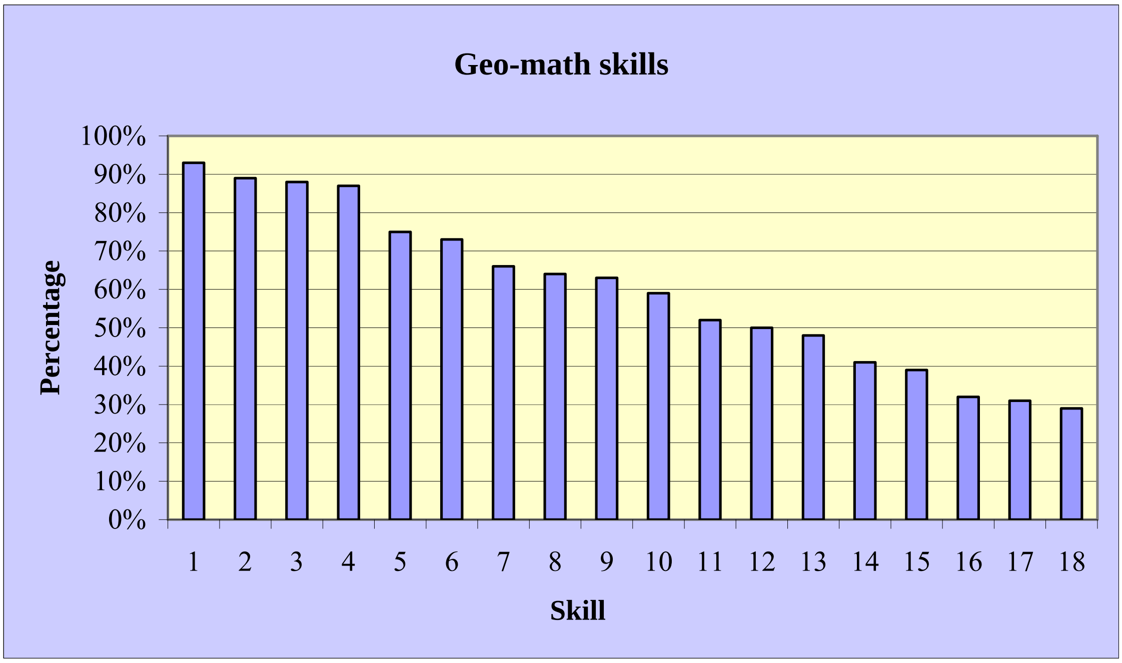
map ranged between 70% and 75% which is a moderate ratio signifying the lack of cognitive aspects that are relevant to these skills.

3. The geographical mathematical skills, such as measuring areas, calculating the means of temperature and pressure and drawing quantities in several graphic designs percentages ranged between 60% and 69%, which is considered to be a low ratio that indicates the lack of knowledge among students of the study group.

4. The percentages of the geographical mathematical skills, such as calculating time between places, calculating the means of temperature & pressure and contour maps, ranged between 50% and 59% which is a very low ratio referring to the absence of sufficient knowledge in students.

5. The percentages of the geographical mathematical skills, such as specifying geographical positions, using degrees in drawing sectors, drawing graphic curves for different phenomena, calculating different degrees of regression between places, air-photographic maps and the similarity between mathematical figures and geographical phenomena, ranged from 29% to 50%, indicating an extreme lack of knowledge among students. Thus, the following figure illustrates the judgment on the extent of the existence of the mentioned skills, whose percentages ranged from 29% to 93% as follows:

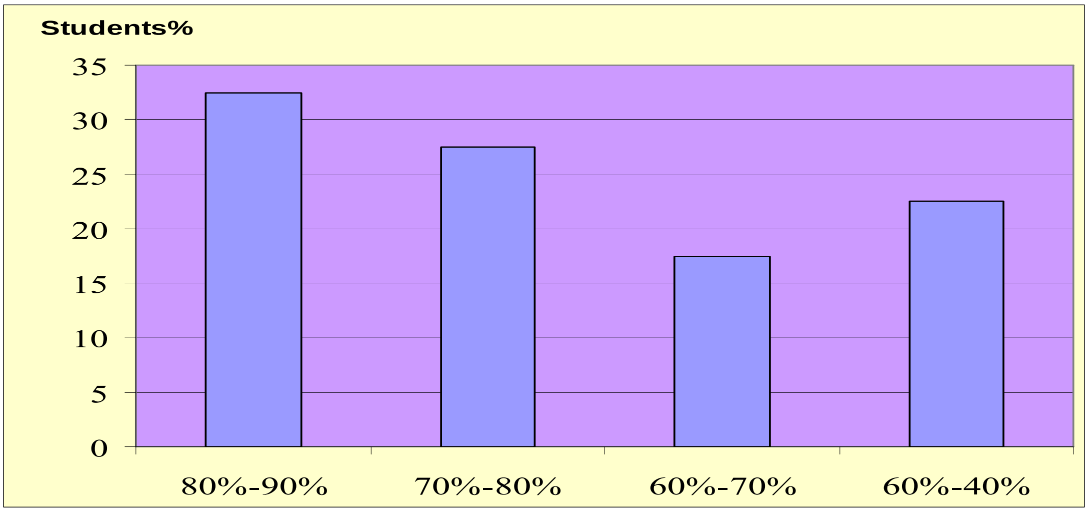
Figure (13)
The Geo-Math skills and their degree of existence



The previous figure indicted the ratio of distribution of each skill that illustrates the closeness of low ratios. This may be due to exploiting the information and data correctly during studying. Such defects can be dealt with through special study and care on the part of those who are interested in educational affairs. This necessitates a special remedial program for developing these mathematical concepts and skills that are necessary for studying geography. Through the previous illustrations, the following results can be concluded:

(1) In the light of the mathematical-geographical concepts test, it was evident that the students demonstrated an excellent level of understanding some concepts with a percent that ranged between 80% and 90% indicating that they had the cognitive and achievement aspects, relevant to these concepts with a moderate level of (32.5) of all the concepts of the study. However, the students demonstrated a moderate level in performing some aspects of the concepts test with a percent ranging between 70% to 80%, indicating a relative decrease in performance with a moderate level of (22.5) of all the concepts of the study, whereas the students continued their low performance in other concepts with a percent ranging between 60% to 50%, which was (17.5) of all the concepts of the study. The other percents in the study were about 40% to 50% indicating an extreme decrease in performance and a very low performance level and this part was (27.5) of all concepts in the study. The following figure exhibits the percent of existence for each group in relation to the total existence percent.

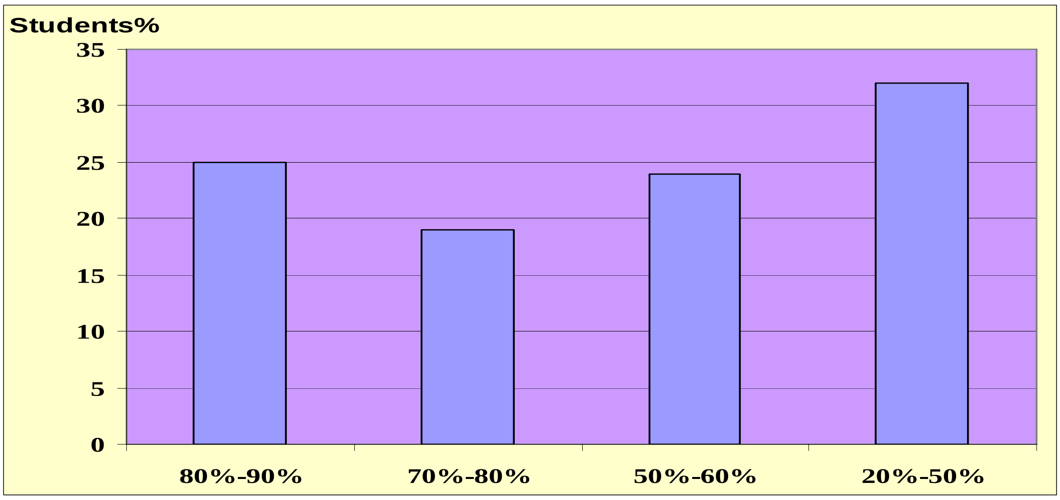
Figure (14)
The percentage of concepts and their existence



(2) Through calculating the average of existence for each concept, it was found that the total existence percentage for those concepts was 69% which is a moderate one. The results of a considerable part of the concepts were in the moderate level (45% of the concepts), while 55% of the concepts were low. In general, there was a low standard of existence of concepts indicating the students' need for a remedial program.

(3) Concerning the skills test, 25% of the students were ranked in the high level 80% to 90%, whereas the moderate performance was represented by 19% of the students' answers which ranged between 70% to 80%, the low-standard answers were represented by 24% of the answers which ranged between 50% to 60%, while the other percents in the study were ranging between 20% to 50%, indicating an extreme decrease in performance or a very low performance level, and this part was 32% of all skills in this study as shown in the figure below:

Figure (15)
The skills percentage and their existence



(4) The average of existence or availability for the skills included in the study was 59% which is a low percentage. However, the students were shown to own a relative excellence in some geographical mathematical skills, but they lost this advantage during the skill performance of the concepts and skills included in the study.

(5) The general average of availability of these concepts and skills included in the study was 64%, which indicates a low level that requires a remedial program to help the students understand and perform these concepts and skills correctly. In addition, it has become evident that the students require an increase in teaching the mathematical aspects that are related to geography according to the age group of the learners.

5.3. Answering the Third Question

"What would a suggested integrated program of mathematical concepts and skills with geography be like? What is the degree of effectiveness of such an integrated program in developing these concepts and skills?"

To answer this question, the following steps were done:

1. Administering the program based on the results of the tests of geographical mathematical concepts and skills that are necessary for studying geography. It consists of twelve lessons and their appendices including all the study skills and concepts demonstrated in different techniques.

2. Conducting the program on two experimental groups of geography students randomly selected (20 students in summer 2005 and 20 students in summer 2006) from different study levels. The program was taught according to the lesson plans presented in the teacher guide and exercises book during teaching.

3. The tests of geographical mathematical skills and concepts that are necessary for studying geography were administered in order to recognize the level of

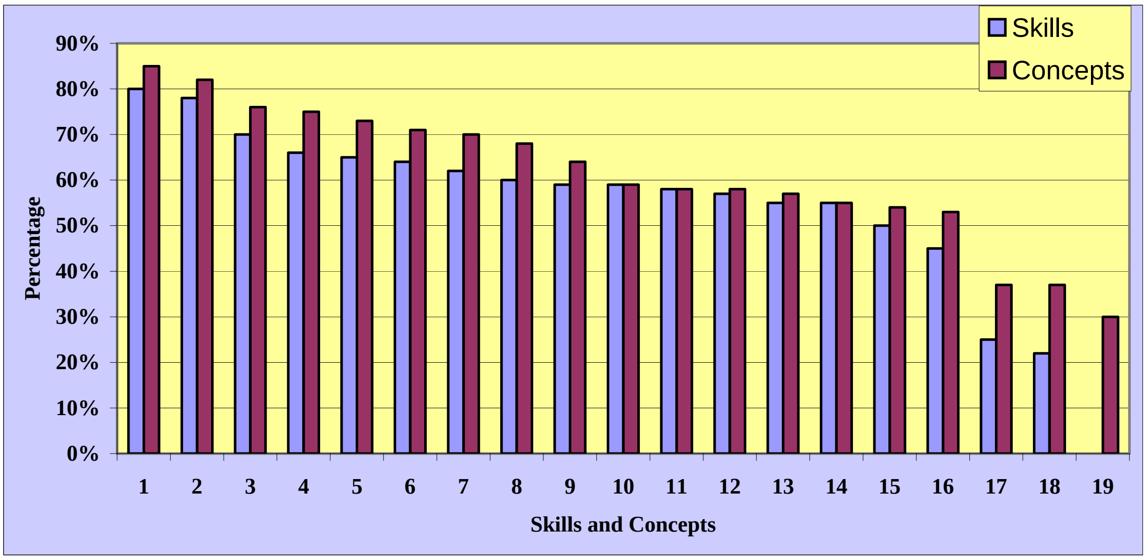
availability of skills and concepts, which was found to be 59%, indicating a low standard that can be represented through table (11) and figure (16):

Table (11)
The ratios of the skills and concepts specified in the present study among the students (experimental group)

No.	The Skill	Existing Ratio
1	Measuring distances	80%
2	Measuring areas	78%
3	Calculating time between places	70%
4	Drawing quantities in several graphic designs	66%
5	Specifying geographical position	65%
6	Calculating the means of temperature & pressure	64%
7	Magnifying & minimizing of maps	62%
8	Specifying distances on a map	60%
9	Using degrees in drawing sectors	59%
10	Calculating different degrees of regression among places	59%
11	Calculating distance, speed and time on the map	58%
12	Graphic designs	57%
13	Specifying directions	55%
14	Contour maps	55%
15	Drawing maps and their types	50%
16	Drawing graphic curves for different phenomena	45%
17	Air-photographic maps	25%
18	Similarity between mathematical figures and geographical phenomena	22%
Average existing ratio for all skills 57%		

No.	The Concept	Existing Ratio
1	Distance	85%
2	Scale	82%
3	Drawing graphics	76%
4	Speed	75%
5	Surveying	73%
6	Longitudes	71%
7	Average	70%
8	Percentage	68%
9	Direction	64%
10	Curves	59%
11	Diameter & volume	58%
12	Curve	58%
13	Time	57%
14	Slope	55%
15	Magnifying & Minimizing	54%
16	Portion	53%
17	Parallel & vertical	37%
18	Proportion	37%
19	Numbers integration	30%
Average existing ratio for all concepts 61%		

Figure (16)
The Geo-Math concepts and skills and their degree of existence
(Experimental groups)



4. Before teaching the program the pre-test was applied to the groups of the study. The results were analyzed to identify the extent of the students' competences in the skills and concepts that are related to the designed program.

5. The pre-test was administered to the study groups so as to identify their cognitive and psychomotor levels. It was also administered to two experimental groups with long intervals between the testing and retesting so as to guarantee the validity of the prepared program and the extent to which it is able to lead to nearly similar results if implemented for so many times.

6. The tables and drawings below illustrate the results of the experimental sample of the present study in the pre-test and post-test which are represented in two experimental groups across various stages of education.

The First Experiment in 2005

The program was administered to a group of students in the Geography Education Department of the Institute of Geography in Augsburg University. In the first experiment, the program was administered to (20) students. The table below illustrates the students' scores as well as the differences between the pre-test and the post-test for the study group so as to identify the extent to which the suggested program was effective.

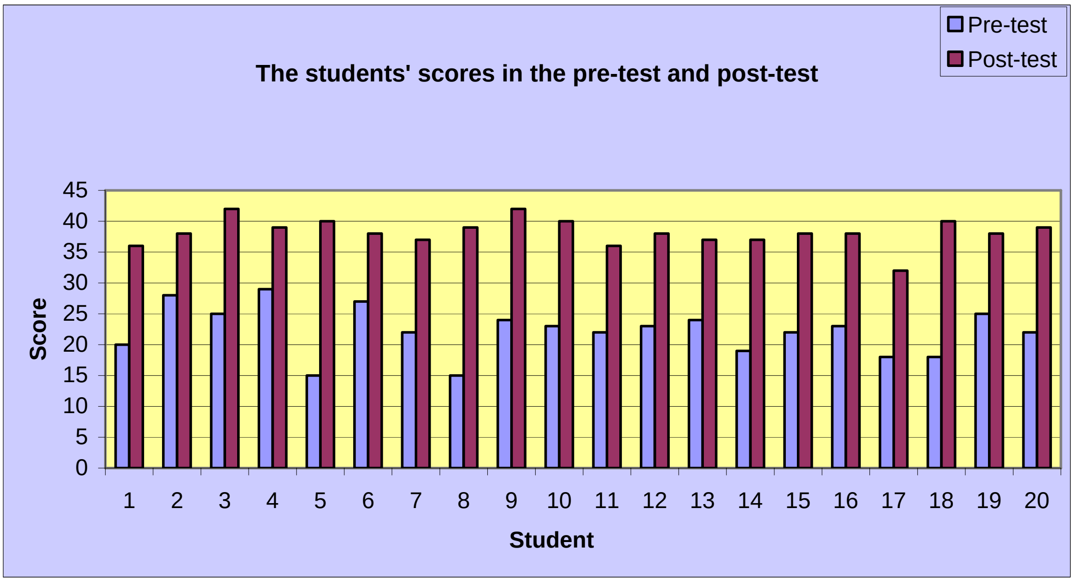
Table (12)
The student's scores in the pre-test and post-test of the program

The implementation date summer 2005							
No.	**Total Scores**	**Pre-Test**	**percents**	**No.**	**Total Scores**	**Post Test**	**percents**
1	51	20	39%	**1**	51	36	70%
2	51	28	54%	**2**	51	38	74%
3	51	25	49%	**3**	51	42	82%
4	51	29	56%	**4**	51	39	76%
5	51	15	29%	**5**	51	40	78%
6	51	27	52%	**6**	51	38	74%
7	51	22	43%	**7**	51	37	72%
8	51	15	29%	**8**	51	39	76%
9	51	24	47%	**9**	51	42	82%
10	51	23	45%	**10**	51	40	78%
11	51	22	43%	**11**	51	36	70%
12	51	23	45%	**12**	51	38	74%
13	51	24	47%	**13**	51	37	72%
14	51	19	37%	**14**	51	37	72%
15	51	22	43%	**15**	51	38	74%
16	51	23	45%	**16**	51	38	74%
17	51	18	35%	**17**	51	32	62%
18	51	18	35%	**18**	51	40	78%
19	51	25	49%	**19**	51	38	74%
20	51	22	43%	**20**	51	39	76%

Throughout the above tables and the following drawings (table 12 and figure 17), which illustrate the results of the pre-test that was administered to the study group, we can notice that the students' levels appear to be low. They always ranged between 29% and 56%. This indicates the relative decrease in the subjects' cognitive and psychomotor levels, as their levels of existence always tended to be low. This is illustrated by the following drawing level of the first experimental group.

Thus the standard of the students was found to be fluctuating, were most scores ranged in the low level indicating the lack of geographical mathematical skills and concepts included in the program and the test. It is also illustrated by the following graphic figure:

Figure (17)
The students' scores in the pre-test and post-test of the program



But we can notice from the above table and drawing (table 12, figure 17), which illustrate the results of the post-test, that the students' levels appear to be high. Their levels ranged between 70.5% and 84%. This indicates the high increase in students' levels after the program was administered to them.

Throughout the previous drawing, we can easily compare between the students' level of the first experimental group in the pre-test and the post-test. It shows the preeminence of the group in the post-test and this emphasizes the effectiveness of the proposed program in developing these mathematical concepts and skills which are needed to learn geography.

During implementation, the researcher observed the following:

(1) There is a difficulty in performing simple and easy calculations so as to transfer the types of drawing scales into their parallels in reality.
(2) There is a difficulty in connecting the map drawing scale and specifying distances and areas.
(3) There is a difficulty in understanding maps and their types and applications.
(4) The students found easiness in understanding and recognizing graphs and their explanations and in comparing the geographical phenomena to each others, in addition to drawing curves that represent such phenomena.
(5) The students had great difficulty in reading and explaining the climate maps and specifying average temperatures.
(6) The students performed drawings of different sectors specifying their types.
(7) Some students found difficulties in understanding the air-photographing maps, their explanations and relevant concepts.
(8) The students found no difficulty in drawing contour maps specifying heights and proportions among geographical figures, and using calculations, in addition to determining different forms of topography.
(9) The instability of scientific content during the students’ preparation phase and the differences among teachers in the teaching of the content of the subject may be attributed to their concentration on some aspects and ignoring others.

(10) Lacking a perfect contact between the practical aspect and the theoretical one. Now that much care is devoted to measuring the students' academic achievement only through achievement tests without giving much focus to the practical aspect, students are unable to apply the information and knowledge they have already learned in the right way.

Throughout the first experiment and the comparison between the students' scores in the pre and post test, the U-test can be calculated using the WILCOXON Test [JÜRGEN, 1993, Pp 144-145] for pairs when the observations in two equal groups of data are matched. This test is characterized by revealing the differences between the pairs of observations and the size of these differences. Based on this the U-test for the experimental group in the first experiment, the results indicated that calculated T is bigger than the tabular T at the level of 0.01. This means that the error rate is very little for the post-test. This indicates a high correlation since the calculated T is 122.5 and the tabular T is 39, which means a high correlation and high differences between the pre and post test as the statistical significance is at the level of 0.01 which is a high level. This emphasizes the effectiveness of the proposed program and its ability to develop the mathematical concepts and skills which are required for teaching geography to the study group.

The Second Experiment in 2006

The test was administered to a sample consisting of 20 students of different educational levels so as to guarantee the validity of the proposed program and its effectiveness in developing some mathematical concepts and skills which were required for learning geography. This is evident in the following table which illustrates the differences in scores between the pre-test and the post-test for the study sample in the second experiment.

Table (13)
The students' scores in the pre-test and post-test of the program

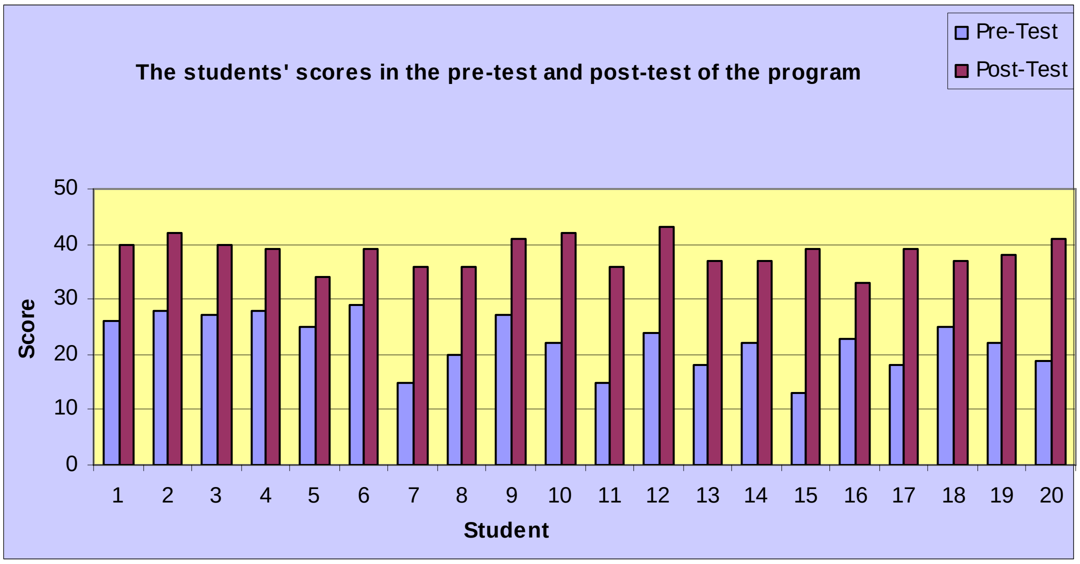
The implementation date summer 2006							
No.	**Total Scores**	**Pre-Test**	**percents**	**No.**	**Total Scores**	**Post-Test**	**percents**
1	51	26	50%	**1**	51	40	78%
2	51	28	54%	**2**	51	42	82%
3	51	27	52%	**3**	51	40	78%
4	51	28	54%	**4**	51	39	76%
5	51	25	49%	**5**	51	34	66%
6	51	29	56%	**6**	51	39	76%
7	51	15	29%	**7**	51	36	70%
8	51	20	39%	**8**	51	36	70%
9	51	27	52%	**9**	51	41	80%
10	51	22	43%	**10**	51	42	82%
11	51	15	29%	**11**	51	36	70%
12	51	24	47%	**12**	51	43	84%

Table (13)
The students' scores in the pre-test and post-test of the program

13	51	18	35%	**13**	51	37	72%
14	51	22	43%	**14**	51	37	72%
15	51	13	25%	**15**	51	39	76%
16	51	23	45%	**16**	51	33	64%
17	51	18	35%	**17**	51	39	76%
18	51	25	49%	**18**	51	37	72%
19	51	22	43%	**19**	51	38	74%
20	51	19	37%	**20**	51	41	80%

-This was also illustrated by the following graphic:

Figure (18)
The students' scores in the pre-test and post-test of the program



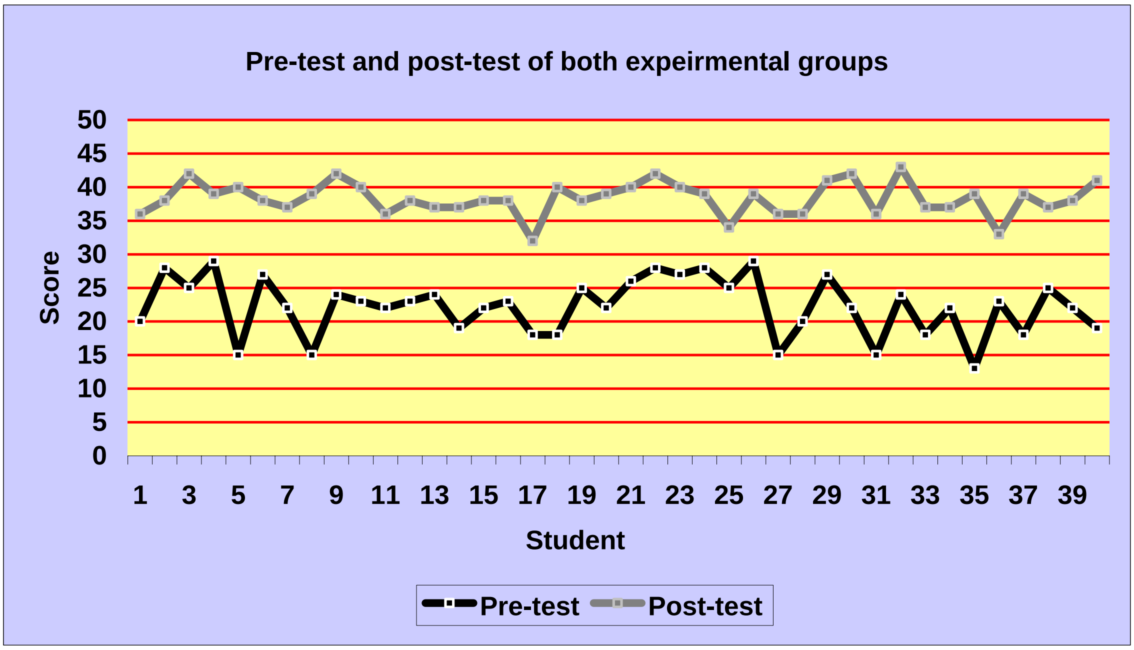
The results indicated that calculated T is bigger than the tabular T at the level of 0.01. This means that the error rate is very little for the post-test. This indicates a high correlation level since the calculated T is 105 and the tabular T is 39, which means a high correlation and a high direction of the differences towards the post-test as the statistical significance is at the level of 0.01 which is a high level. This emphasizes the effectiveness of the proposed program in developing the mathematical concepts and skills which are required for teaching geography to the study group.

Results analysis

(1) The difference in the students' scores in the two experimental groups was obvious in the total scores of the students and their ability to answer the questions correctly. The curve provided high values for most answers between 70% and 85% included in the program, a high percentage signifying its effectiveness.

(2) From the above difference in the students' scores, we can note the difference between pre-test groups and post-test groups in the following curves.

Figure (19)
The difference between the pre-test and the post-test



Throughout the above drawing, we can easily compare between the students' levels in both experimental groups in the pre-test and the post-test. It shows the great performance and excellence of the groups in the post-test and emphasizes the effectiveness of the proposed program in developing these mathematical concepts and skills which are needed to learn geography.

Through the previous tables, U value was estimated and it was found to be (102,5) in the first experiment and (105,5) in the second experiment, which is higher than tabular U indicating the existence of statistically significant differences between scores of the students in the experimental groups in favor of the post test; this indicates that the proposed program helped the students increase the level of acquiring mathematical skills and concepts that are necessary for studying geography.

5.4. Measuring the effectiveness of the proposed program in developing mathematical concepts and skills that are necessary for studying geography

In order to know the degree of effect of the proposed program on developing mathematical concepts and skills, the researcher used the following formula [CARL, 1994, p 467., LIPSEY, 1990, Pp 54-58]:

$$\text{Effect size} = \frac{Mx1 - Mx2}{\delta}$$

Where:
Mx_1 is the mean of post-test,
Mx_2 is the mean of the pre-test and
δ is the standard deviation between the pre-test and post-test.

Since the ratio of effect size of the proposed program was lower than (0.5), the effect size was weak, whereas in the case of having a ratio between (0.5-0.7) the effects are considered moderate, but if the ratio exceeds (0.8) this indicates that the effect was high.

The effect size for each group in the study (i.e. the first experimental group and the second one) was calculated. The ratio of effect size was (1,00) which is a high ratio exceeding (1,00) and indicating the very high effect size of the proposed program on developing mathematical concepts and skills of the students in studying geography. This means that using the proposed program is effective in teaching mathematical concepts and skills.

The previous indicates the following:

(1) There are no statistically significant differences between the groups (experimental) concerning the increase of concepts and skills of the students caused by the taught program.
(2) There are statistically significant differences between the mean scores of the study groups (pre-test & post-test) in the test of the program at the level of (0.01). These differences were in favour of the experimental groups and emphasized the effectiveness of the proposed program. The effect size of using the proposed program was (1,00) which is a very high value.
(3) Using the proposed program was effective in teaching mathematical concepts and skills that are specified in the study.

5.5. Recommendations

The researcher can provide the following recommendations:

(1) Relating the scientific or the theoretical aspect to the practical one during studying in order to achieve integration between the two aspects.

(2) Caring for the integration between different school subjects in order to achieve the main goal of the teaching process which is represented in developing the integrated aspects of personality.

(3) Specifying the desired learning goals in an objective and non- biased way.

(4) Caring for variation in the teaching content for the students to achieve integration of knowledge.

(5) Paying attention to effective evaluation techniques concerning the measurement of the learner’s standard.

(6) Paying attention to modern teaching techniques and strategies that suit the nature of geography as a school subject.

(7) Introducing new techniques that develop thought and are based on scientific principles.

(8) Increasing learning activities that help to achieve cooperative learning and positive interaction with the subject.

(9) The necessity of providing practical exercises that can increase students' in achievements as well as raising the performance level.

(10) The necessity of connecting different learning aspects and caring for modern theories of learning.

(11) Pre evaluation is required to specify the skills and conceptual level of the students according to their needs for different skills and concepts.

(12) The necessity of using the suitable evaluation instruments in order to recognize the weaknesses and strengths in the studied concepts and skills.

(13) The necessity of providing the appropriate conditions that are based on a valid scientific basis in using the instruments during the evaluation process.

(14) Using suitable remedial techniques in order to deal with the weak learning aspects among the students.

(15) The necessity of continuing the evaluation process during the study and after graduation in order to recognize the weaknesses and remedying them within the professional preparation of programs teachers.

(16) The study indicated the existence of some deficiencies and shortcomings in the students related to having some mathematical concepts and skills. Thus, it is recommended that there should be an increase in the specified hours for the syllabus of teaching methodology at schools to train students in how to use concepts and skills in effective real-life situations.

(17) The study found out that it was a necessity to integrate different subjects and provide a link between mathematical skills and geographical skills. Therefore, it is recommended that remedial programs for teachers should be designed in order to link mathematics with geography.

(18) It is necessary that geographic schools should occupy a basic position in the geography teacher preparation program. This can be achieved through preparing syllabuses at the college level dealing with academic geography in schools.

(19) Providing mathematical concepts and skills in the school textbooks and in actual life in proportion to the age and standard of learners so that the students can realize the meaning of these mathematical concepts and apply them in new situations.

(20) The study recommends the necessity of preparing teachers guides and demonstrating the methods of teaching according to the designed models and programs, as well as the new teaching approaches.

5.6. Suggestions

To complete the aspects of the present study, it can be recommended that there are certain important future studies as follows:

1. The study of the effect of a suggested program on the mathematical abilities that is necessary for the geography teachers through the different teaching models.

2. A suggested program for specific competences which are required of geography teachers, and recognizing the extent to which these competences are mastered by geography section students.

3. Studying the relationship between the level of achievement of natural geography among students and their level of achievement in other geographical subjects.

4. The effect of using the teaching models on teaching the topics of maps and area on developing mathematical concepts and skills among geography section students.

5. Investigating the effectiveness of using the mathematical processes in the achievement of economic geography for student-teachers majoring in geography.

6. Measuring the effect of mathematical imagination of the preparatory stage students on geographical achievement and the attitudes towards the subject.

7. Measuring the effect of using the constructivist theory on the achievement of the students concerning geographical skills in the geography section.

8. Measuring the effect of mathematical imagination of the preparatory stage students on the geographical achievement and the attitudes towards the subject.

9. Measuring the effect of using the constructivist theory in the achievement of the students concerning geographical skills in the geography section.

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Appendix (1)
Achievements Test for Geo-Math Concepts

Important Note:
Please read this part before you begin answering the test

Name: ....

Term: ...., Diploma.........., LA.................

Date: ....

Time duration: 30 minutes

Dear geography students
This test is for students of geography. It aims at knowing how far they possess the mathematical concepts that are necessary for studying and mastering geography.

Please consider the following:
- There is only one correct answer for each item.
- Consider the test as a real test that measures how far you possess the following mathematical skills.
- There is no question which has no correct answer.

Please take your time before deciding upon the most appropriate choice

For example:

If the temperature is -13°C at noon in Munich and on the next day it is 5°C, how big is the temperature difference?

a. 5°C.	□	b. 8°C.	□
c. -8°C.	□	d. 18°C.	□

(Applicable mark)

And now: Good luck!!

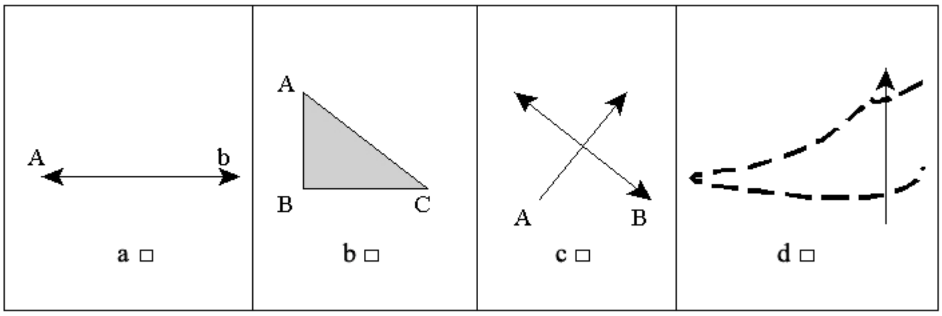
1. The relation between distances on the map and distances in reality is defined by:

a. the triangle.	□	b. the circle.	□
c. the direction.	□	d. the scale.	□

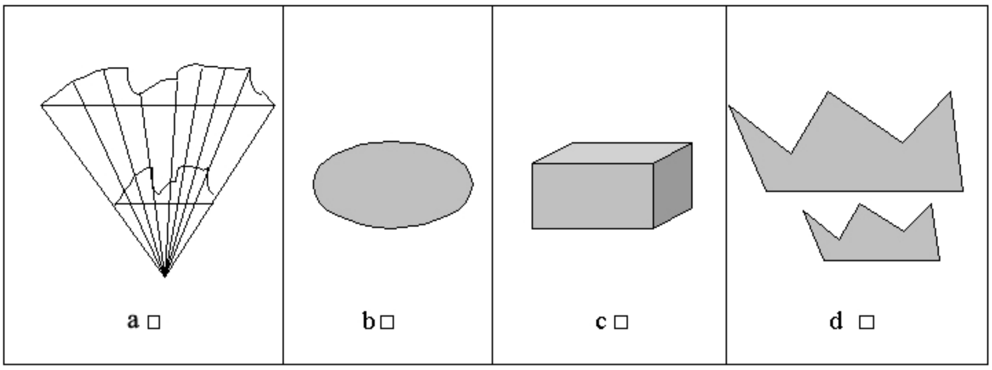
2. The space between two a point (A and B) is in reality or on the map:

a. the distance.	□	b. the line.	□
c. the points.	□	d. the streak.	□

3. Which of the figures represents the measurement area?



4. Which diagram explains magnifying and minimizing on the map?



5. We are located in a site and can see two salient points, which are also represented on the map. How do we determine our location on the map?

a. by triangle construction (angle, side, angle).	□
b. by forward cutting.	□
c. by two crossed points before determining their direction.	□
d. by vector addition.	□

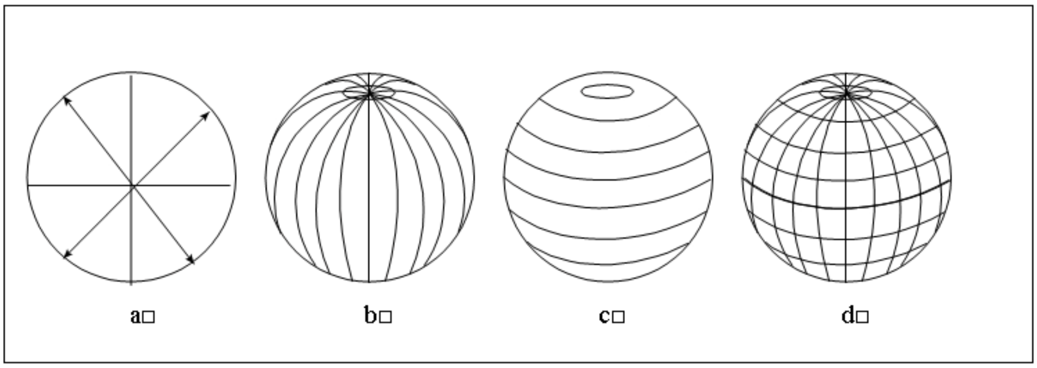
6. How does one visualize data best?

a. by a diagram.	□	b. by statistics.	□
c. by a text.	□	d. by pictures.	□

7. A representation shows the line which runs exactly between two contours, how can one designate this line?

a. contour.	□	b. curve.	□
c. fall line.	□	d. distance direction.	□

8. Which figure shows the degrees of longitude?



9. If we only know the degree of longitude for the comparison between two locations on the map or in reality, what can we compare?

a. the distance. □ b. convergence of the meridians. □
c. the time. □ d. the situation. □

10. How can we indicate the kinetic energy of a body?

a. by speed. □ b. by mass. □
c. by mass and speed. □ d. by mass and acceleration. □

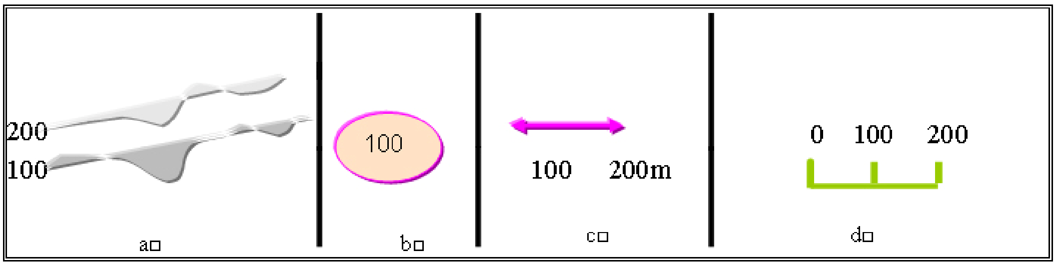
11. How does one call the variable size between the vertical straight line and the slope gradient line?

a. the slope gradient. □ b. the slope inclination. □
c. the vertical deviation. □ d. the striking direction. □

12. How much percent of points a student may obtain if he gets 18 out of 20 possible points in a geography exam?

a. 0.09%. □ b. 9%. □
c. 0.90%. □ d. 90%. □

13. The scale is the relationship between the distance of two points on the map and the distance of two points in reality. Which diagram shows the scale?

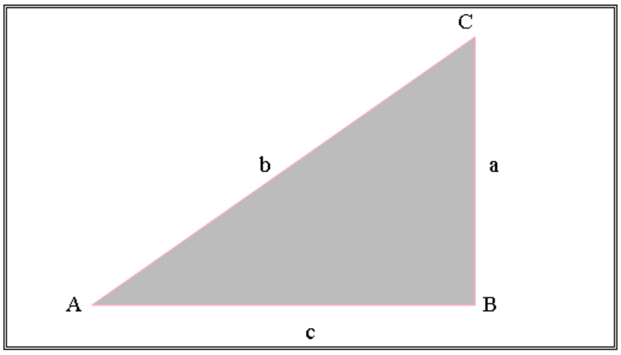


14. Which designation corresponds to the relationship of different scales of two maps?

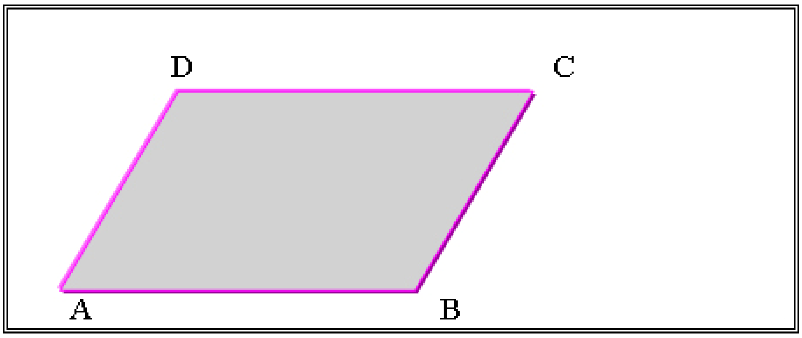
a. enlargement factor. □ b. reduction. □
c. distortion. □ d. projection. □

15. The downward inclination of the line b is

a. b/a. ☐ b. a/b. ☐
c. a/c. ☐ d. b/c. ☐



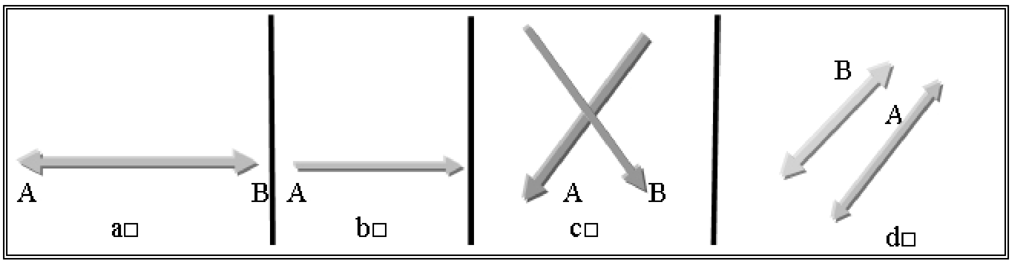
16. How does one determine the area of the parallelogram?



a. $\overline{DC} \bullet \overline{AC}$. ☐ b. height • baseline. ☐

c. $\overline{AD} \bullet \overline{BC}$. ☐ d. all answers are correct. ☐

17. Which diagram shows the distance between two points?



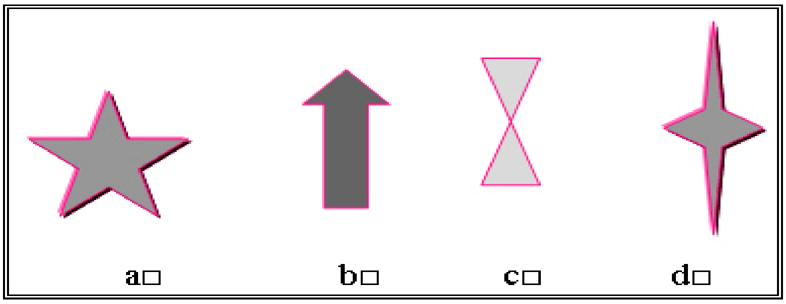
18. What do we call the line between the North Pole and the South Pole?

a. the degree of longitude. ☐ b. the degree of latitude. ☐
c. the parallelogram. ☐ d. the map scale. ☐

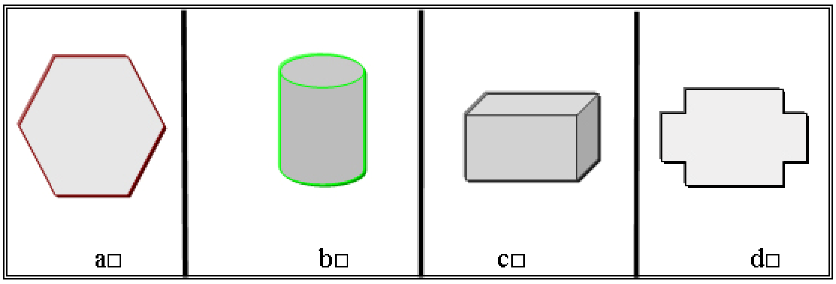
19. The relation of water-land distribution on earth is ....

a. 2:1. ☐ b. 7:1. ☐
c. 7:3. ☐ d. 3:1. ☐

20. Which diagram shows the point of the compass?



21. Which geometrical figure represents a cube?



22. How can the difference between two average values be represented?

a. by relation.	□	b. by proportionality.	□
c. by priority.	□	d. by size.	□

23. The equality is ....

a. the identity.	□	b. the proportionality.	□
c. the validity.	□	d. the equivalence.	□

24. What is the proportion of the following numbers: ¾ and 12?

a. 12.	□	b. 15.	□
c. 16.	□	d. 18.	□

25. If you measure the temperature at a climatological station on 21 March during successive years, what is represented?

a. the average of temperature.	□	b. the temperature sum.	□
c. the temperature rise.	□	d. the proportions.	□

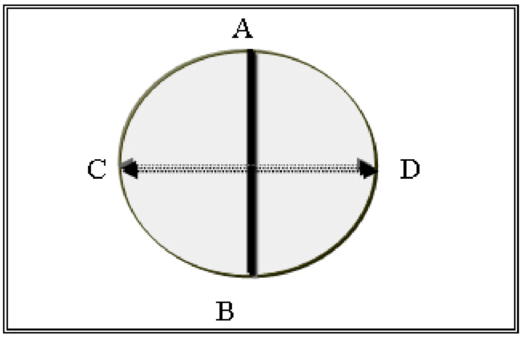
26. The mean of the following sequence of 6 monthly average temperatures, 16°C, 17°C, 18°C, 19°C, 20°C, and 25°C is

a. 19,16°.	□	b. 20,15°.	□
c. 16,3°.	□	d. 17,8°.	□

27. Which parameter has to be measured for fast calculation of the circle area?

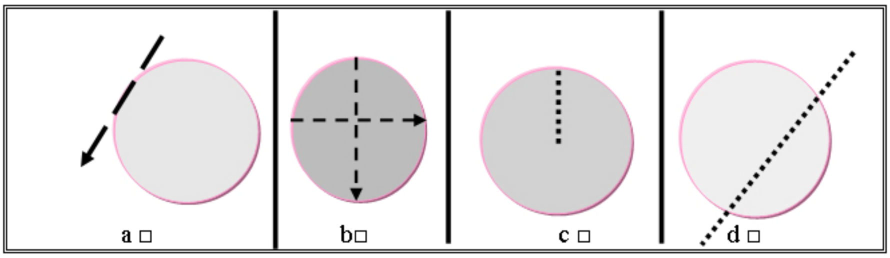
a. $\overline{AB}$. □ b. $\overline{AB}$ and $\overline{CD}$. □

c. half $\overline{AB}$. □ d. $(\overline{AB})^2$. □



28. The time is
a. proportional to speed. □ b. distance/speed. □
c. distance • speed. □ d. speed/distance. □

29. Which diagram shows a secant?



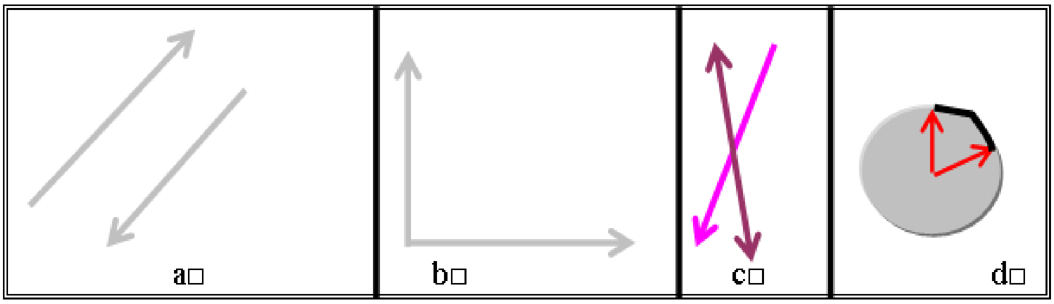
30. What is the volume of the earth, if it is $1{,}08 \bullet 10^{21} m^3$?
a. $1{,}08 \bullet 10^8$ km³. □ b. $1{,}08 \bullet 10^{12}$ km³. □
c. $1{,}080 \bullet 10^6$ km³. □ d. $1{,}08 \bullet 10^{15}$ km³. □

31. What does it mean if one determines the surface area?
a. surveying. □ b. distance. □
c. line. □ d. triangulation. □

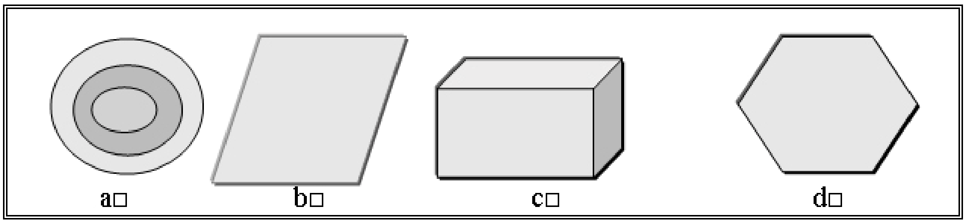
32. On which number systems does the computer work?
a. binary. □ b. decimal. □
d. octal. □ c. hexadecimal. □

33. How is speed measured?
a. by time. □ b. by distance. □
c. by time and distance. □ d. by average time. □

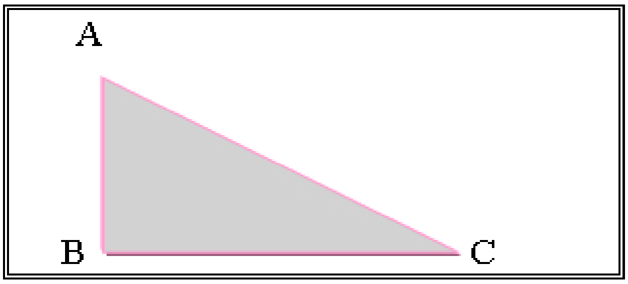
34. Which diagram shows two equal vectors?



35. Which figure can be a contour representation on the map?



36. How can one determine the area of the triangle?

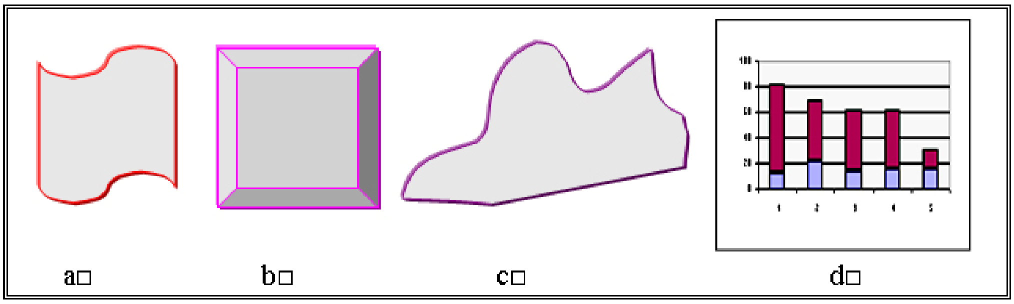


a. ½ • $\overline{BC}$ • $\overline{BA}$. □ b. $\overline{AB}$ • $\overline{BC}$ • sin∢CAB. □
c. $\overline{AB}$ • $\overline{BA}$ • cos ∢ BAC. □ d. the baseline • the height. □

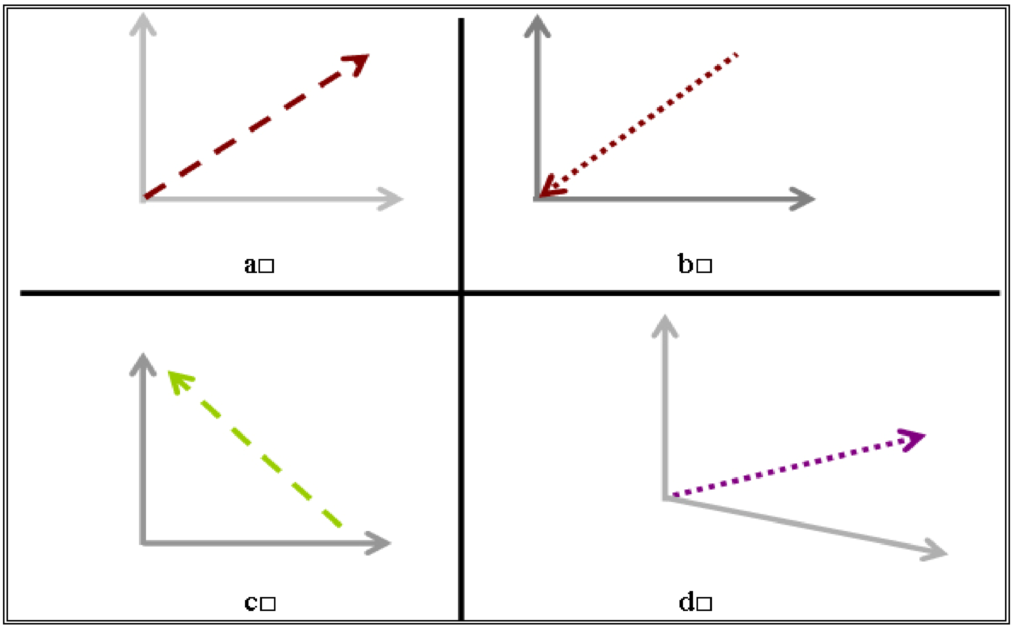
37. What is the name of the line between the central point of a circle and each point on this circle?
a. the radius. □ b. the degree of longitude. □
c. the chord. □ d. the secant. □

38. What do we call the % indication in the equation (3€ = 100€ • 3%):
a. percentage. □ b. basic value. □
c. proportion. □ d. frequency. □

39. Which of the following figures represent graphical diagram?



40. Which design shows the difference of the two vectors?



Wichtiger Hinweis:

Bitte lesen Sie diese Seite, bevor Sie mit dem Test beginnen

Name:..

Semester: ...., Diplom.........., LA..........., Fächerverbindung...........

Datum: ....

Testdauer: 30 Minuten

Liebe Studierende des Faches Geographie:

Dieser Test ist für Studenten der Geographie, um ihre Fähigkeiten zu testen, einfache mathematische Fertigkeiten und Kenntnisse anzuwenden, sowie räumliche Vorstellungen zu prüfen.

Bitte beachten Sie Folgendes:

- Es gibt jeweils eine richtige Antwort pro Aufgabe.
- Die Aufgaben sollen wie in einer echten Prüfungssituation abgelegt werden.

Überlegen Sie sich bitte, bevor sie weiterlesen, für welche Möglichkeiten Sie sich entscheiden.

Sehr einfaches Beispiel:

Wenn die Temperatur in München zur Mittagszeit -13°C und am nächsten Tag 5°C ist, wie groß ist die Temperaturdifferenz?

a. 5°C.	□	b. 8°C.	□
c. -8°C.	□	d. 18°C.	□

(Zutreffendes ankreuzen)

Und nun: Viel Spaß und Erfolg bei Ihrem Test!

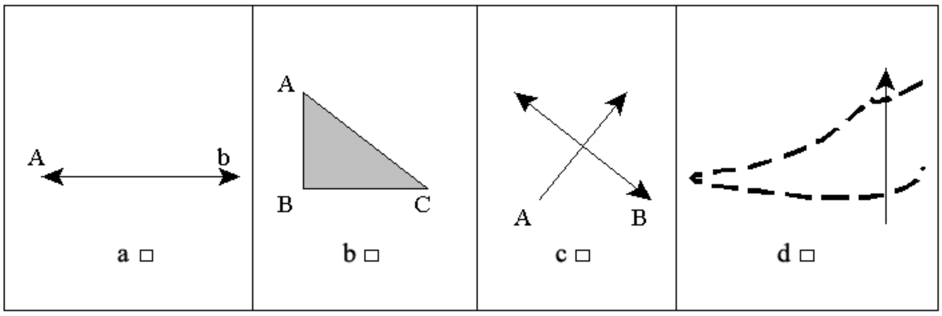
1. Was stellt beim Messen in der Karte den Bezug zur Realität in Kilometer, Meile oder Zentimeter her?

a. das Dreieck.	□	b. der Kreis.	□
c. die Richtung.	□	d. der Maßstab.	□

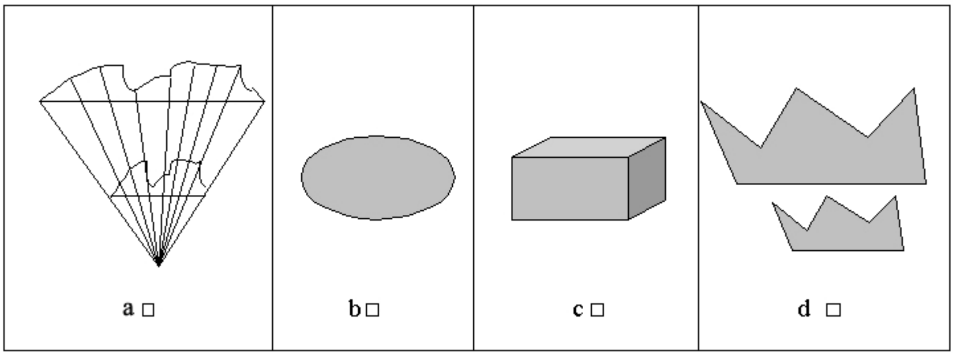
2. Der Abstand zwischen zwei Punkten A und B ist in der Realität oder auf der Karte:

a. der Strahl.	□	b. die Distanz.	□
c. die Linie.	□	d. die Punkte.	□

3. Welche Figur zeigt eine vermessene Fläche?



4. Welches Diagramm erklärt den Vergrößerungsfaktor und die Verkleinerung in der Karte?



5. Wir stehen im Gelände und sehen zwei markante Punkte, die auch in der Karte dargestellt sind. Wie bestimmen wir unseren Standort in der Karte?

a. durch Dreieckskonstruktion (Winkel, Seite, Winkel).	□
b. durch Vorwärtseinschneiden.	□
c. durch Verschneidung zweier vorher in ihrer Richtung bestimmten Geraden.	□
d. durch Vektoraddition.	□

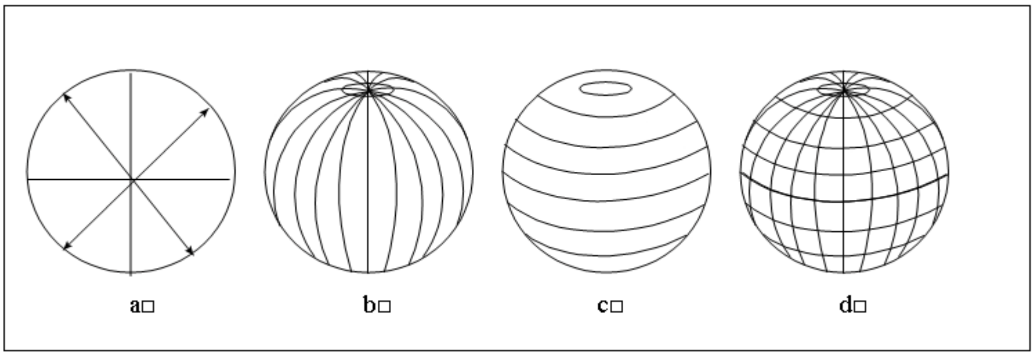
6. Wie visualisiert man Daten am besten?

a. durch ein Diagramm.	□	b. durch eine Statistik.	□
c. durch einen Text.	□	d. durch Bilder.	□

7. Eine Darstellung zeigt die Linie, die genau zwischen zwei Höhenlinien verläuft. Wie kann man diese Linie bezeichnen?

a. Höhenlinie.	□	b. Kurve.	□
c. Falllinie.	□	d. Streckenzug.	□

8. Welche Figur zeigt die Längengrade



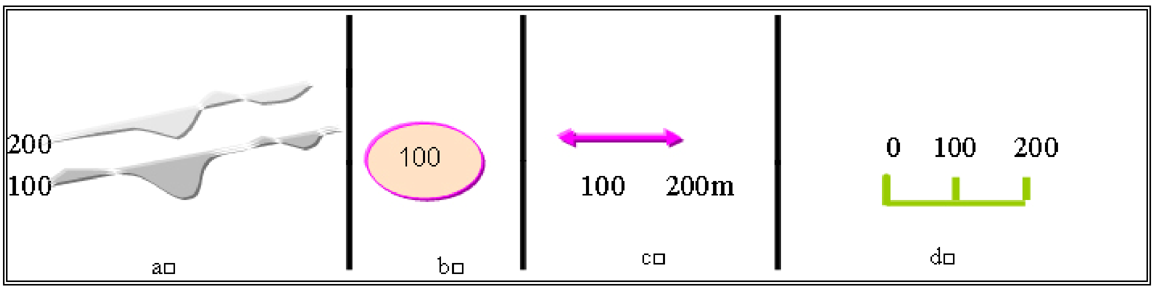
9. Wenn wir nur den Längengrad für den Vergleich zwischen zwei Orten in der Karte oder in der Wirklichkeit benutzen wollen, können wir vergleichen:
   - a. die Distanz. □ b. die Meridiankonvergenz. □
   - c. die Uhrzeit. □ d. die Lage. □

10. Wie können wir die Bewegungsenergie für einen Körper bestimmen?
   - a. durch die Geschwindigkeit. □
   - b. durch die Masse. □
   - c. durch Masse und Geschwindigkeit. □
   - d. durch Masse und Beschleunigung. □

11. Wie kennt man die Winkelgröße zwischen der vertikalen Geraden und der Gefällelinie?
   - a. das Gefälle. □ b. die Hangneigung. □
   - c. die Vertikalabweichung. □ d. die Streichrichtung. □

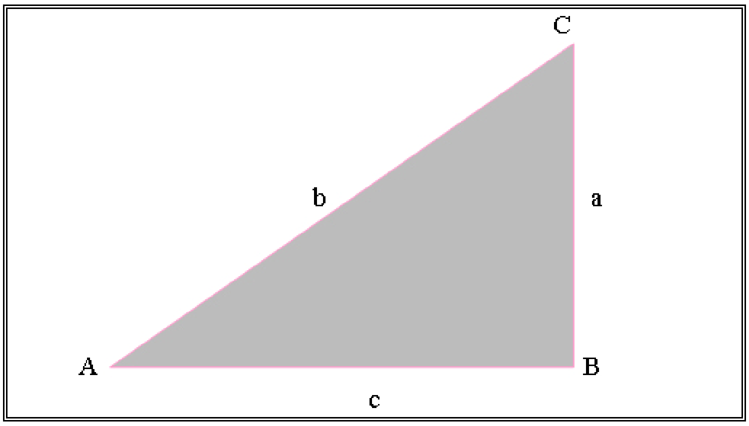
12. Wie viel Prozent bekommt ein Student, wenn er 18 von 20 möglichen Punkten in einer Geographieprüfung hat?
   - a. 0.09%. □ b. 9%. □
   - c. 0,90%. □ d. 90%. □

13. Der Maßstab ist das Verhältnis der Distanz zwischen zwei Punkten in der Karte und der Realität. Welches Diagramm zeigt den Maßstab?



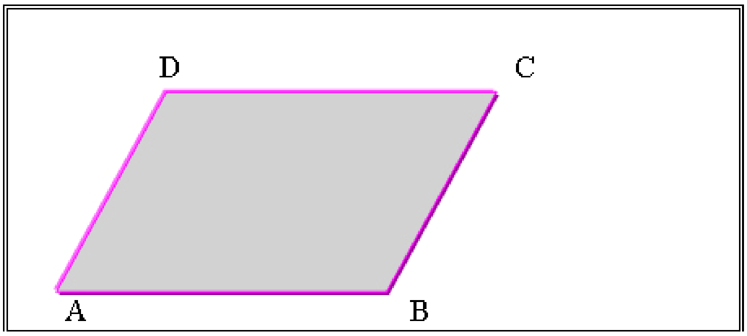
14. Welche Bezeichnung entspricht dem Verhältnis verschiedener Maßstäbe zweier Karten?
   - a. Vergrößerungsfaktor. □ b. Verkleinerung. □
   - c. Verzerrung. □ d. Projektion. □

15. Das Gefälle der Linie b:



a. b/a. ☐ b. a/b. ☐
c. a/c. ☐ d. b/c. ☐

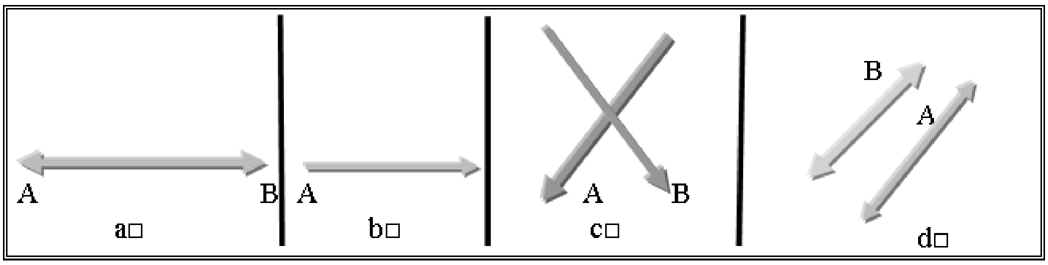
16. Wie bestimmt man die Fläche des Parallelogramms?



a. $\overline{DC} \bullet \overline{AC}$. ☐ b. Höhe • Grundlinie. ☐

c. $\overline{AD} \bullet \overline{BC}$. ☐ d. Alle Antworten sind richtig. ☐

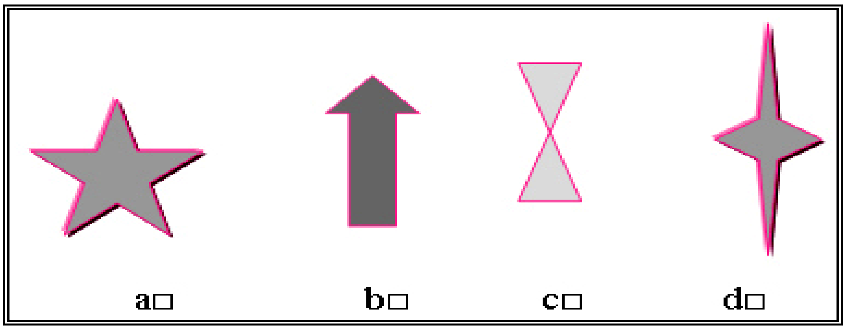
17. Welches Diagramm zeigt die Distanz zwischen zwei Punkten?



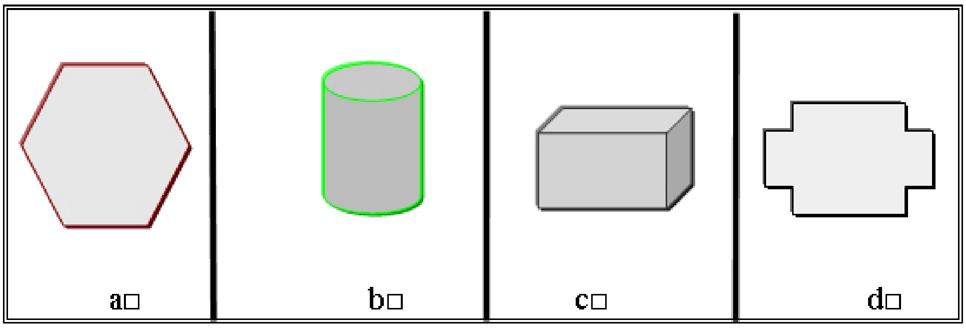
18. Wie heißt die Line zwischen Nordpol und Südpol?
a. Längengrad. ☐ b. Breitengrad. ☐
c. Parallelogramm. ☐ d. Maßstab. ☐

19. Verhältnis des Wasseranteils zur Fläche des Landes der Erde?
a. 2:1. ☐ b. 7:1. ☐
c. 7:3. ☐ d. 3:1. ☐

20. Welches Diagramm zeigt die Himmelsrichtung?



21. Welche geometrische Figur stellt einem Kubus dar?



22. Wie kann der Unterschied zwischen zwei Durchschnittswerten dargestellt werden?
   a. durch die Relation. □   b. durch die Proportionalität. □
   c. durch die Wertigkeit. □   d. durch die Größe. □

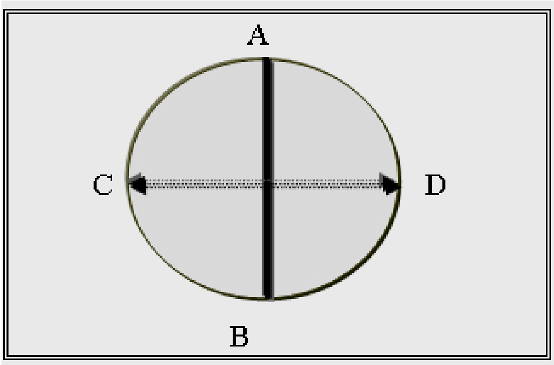
23. Was bedeutet Gleichwertigkeit?
   a. die Identität. □   b. die Proportionalität. □
   c. die Validität. □   d. die Äquivalenz. □

24. Was ist proportional zu den folgenden Zahlen ¾ und 12?
   a. 12. □   b. 15. □
   c. 16. □   d. 18. □

25. Man misst die Temperatur an einer Klimastation am 21. März in fünf aufeinander folgenden Jahren. Was wird sinnvollerweise dargestellt?
   a. der Durchschnittstemperatur. □   b. die Temperatursumme. □
   c. der Temperaturanstieg. □   d. die Proportionen. □

26. Wie groß ist der Durchschnittswert für die folgenden sechs aufeinander folgenden monatlichen Durchschnittstemperaturen, 16°C, 17°C, 18°C, 19°C, 20°C, 25°C.
   a. 19,16°. □   b. 20,15°. □
   c. 16,3°. □   d. 17,8°. □

27. Welche Größe muss man unbedingt zur schnellen Bestimmung der Kreisfläche messen?



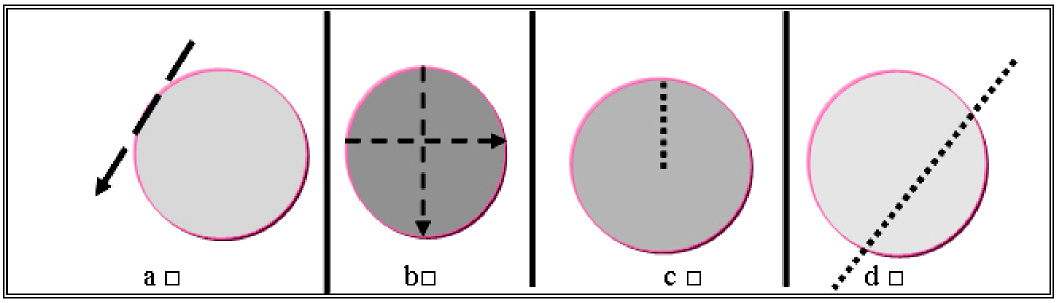
a. $\overline{AB}$. ☐ b. $\overline{AB}$ und $\overline{CD}$. ☐

c. halb $\overline{AB}$. ☐ d. $(\overline{AB})^2$. ☐

28. Die Zeit ist:

a. proportional zur Geschwindigkeit. ☐ b. Distanz/Geschwindigkeit. ☐
c. Distanz • Geschwindigkeit. ☐ d. Geschwindigkeit/Distanz. ☐

29. Welches Diagramm zeigt eine Sekante?



30. Wie groß ist das Volumen der Erde, wenn es $1{,}08 \bullet 10^{21} m^3$ ist?

a. $1{,}08 \bullet 10^8$ km^3. ☐ b. $1{,}08 \bullet 10^{12}$ km^3. ☐
c. $1{,}080 \bullet 10^6$ km^3. ☐ d. $1{,}08 \bullet 10^{15}$ km^3. ☐

31. Wie bestimmt man den Inhalt für eine beliebige Fläche?

a. Vermessung. ☐ b. Distanz. ☐
c. Linie. ☐ d. Triangulation. ☐

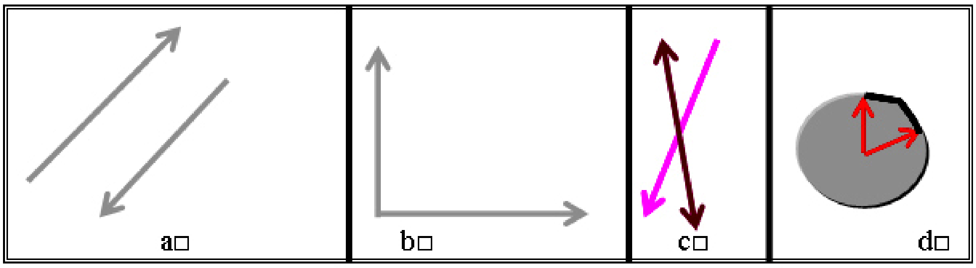
32. Mit welchem Zahlensystem arbeitet der Computer?

a. Binär. ☐ b. Dezimal. ☐
c. Oktal. ☐ d. Hexadezimal. ☐

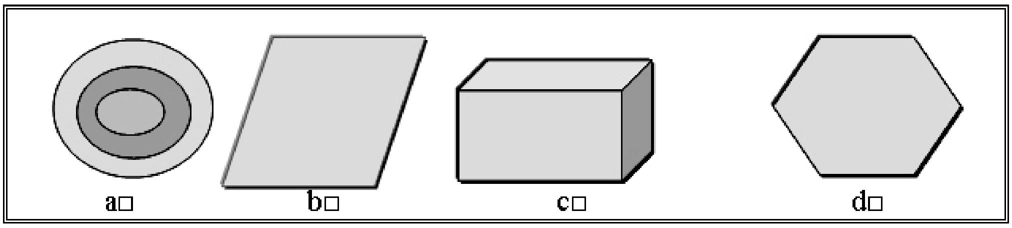
33. Wie kann man die Geschwindigkeit messen?

a. durch Zeit. ☐ b. durch Distanz. ☐
c. durch Zeit und Distanz. ☐ d. durch Durchschnittszeit. ☐

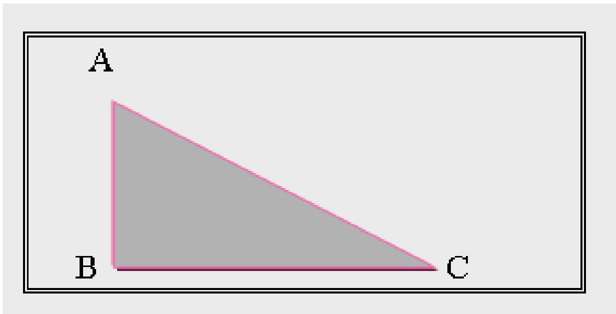
34. Welches Diagramm zeigt zwei linear abhängige Vektoren?



35. Welche Figur kann in einer Karte eine Höhenliniendarstellung sein?



36. Wie bestimmt man die Fläche des Dreiecks?

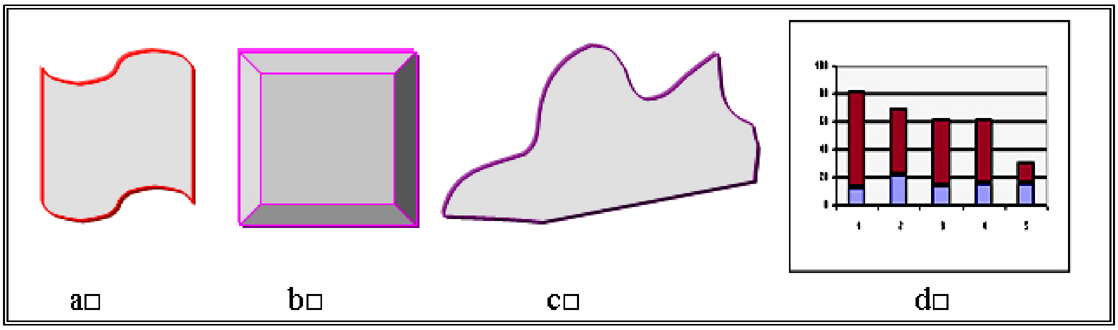


a. ½ • $\overline{BC}$ • BA. □ b. $\overline{AB}$ • $\overline{BC}$ • sin∢CAB. □
c. $\overline{AB}$ • $\overline{BA}$ • cos ∢ BAC. □ d. die Grundlinie • die Höhe. □

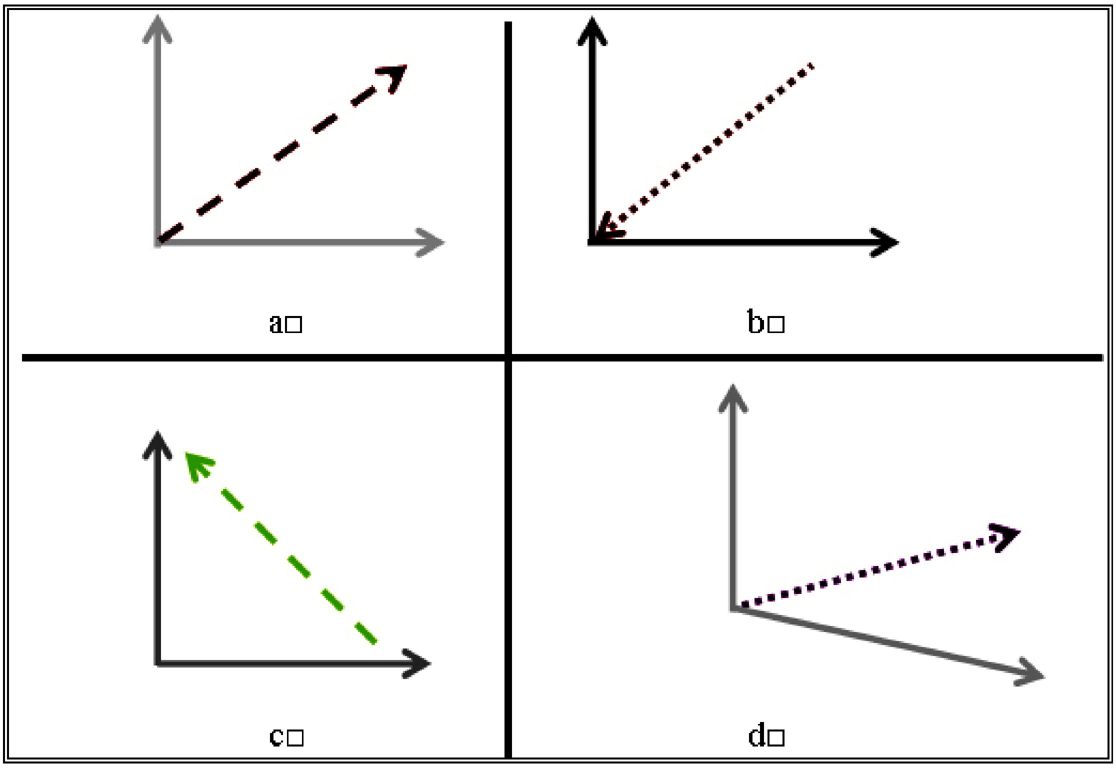
37. Wie heißt die Linie zwischen dem Kreismittelpunkt und jedem Punkt auf diesem Kreis?
a. Der Radius. □ b. Der Längengrad. □
c. Die Sehne. □ d. Die Sekante. □

38. Wie heißt die %-angabe in der Gleichung (3€ = 100€ • 3%)?
a. Prozentwert. □ b. Grundwert. □
c. Prozentsatz. □ d. Häufigkeit. □

39. Welche Graphik zeigt ein statistisches Diagramm?



40. Welche Zeichnung zeigt die Differenz der beiden Vektoren?



Appendix (2)
Achievements Test for Geo-Math Skills

Important Note:
Please read this part before you begin answering the test

Name:.......................................

Term: ...., Diploma.............., LA.................

Date:...

Time duration: 30 minutes

Dear geography students:
This test is for students of geography. The test aims at measuring how far you possess the mathematical skills that are necessary for studying and for mastering geography.

Please consider the following:
- There is only one correct answer for each item.
- Consider the test as a real test that measures how far you possess the following mathematical skills.
- There is no question that has no correct answer.

Please take your time before deciding upon the most appropriate choice

For Example:
In Alexandria, it is exactly 20 o'clock (local time) and in Greenwich it is exactly 18 o'clock (local time). On which degree of longitude is Alexandria?

a. 30° east.	□	b. 35° east.	□
c. 43° east.	□	d. 42° east.	□

(Applicable mark)

And now: Good luck!!

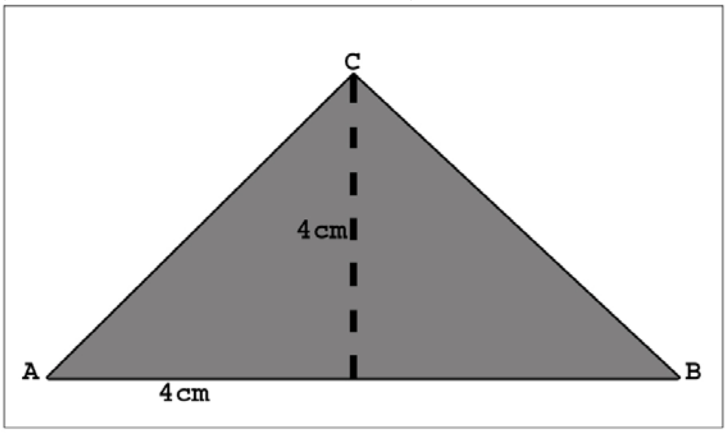
1. The distance between Munich and Frankfurt on the map is 21cm; the scale of the map is 1:1500000. How far is the distance in reality?

a. 330 km.	□	b. 375 km.	□
c. 315 km.	□	d. 350 km.	□

2. The distance between Augsburg and Bremen is approximately 750 km. How far is the distance on a map with a scale of 1:2.000.000?

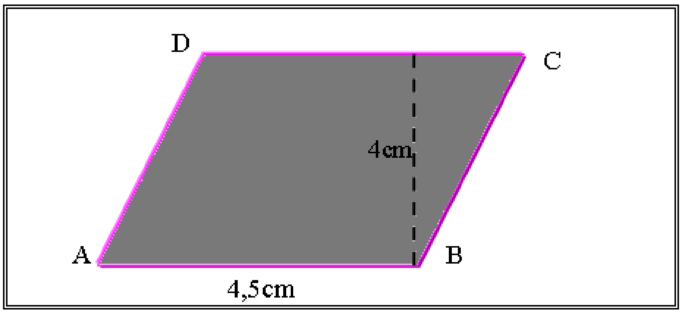
a. 37,5cm.	□	b. 36,5cm.	□
c. 35,6cm.	□	d. 38,2cm.	□

3. The following figure represents a symbol on a map. The scale of the map amounts to 1:200.000. How large is the area surface of the signature, if one transfers it to reality?



a. 22 km^2.	□	b. 32 km^2.	□
c. 12 km^2.	□	d. 10 km^2.	□

4. The following figure shows a symbol of surface on the map, which has an area of 72 km^2 in reality. How large is the scale?



a. 1:2.000.000.	□	b. 1:20.000.	□
c. 1:40.000.	□	d. 1:400.000.	□

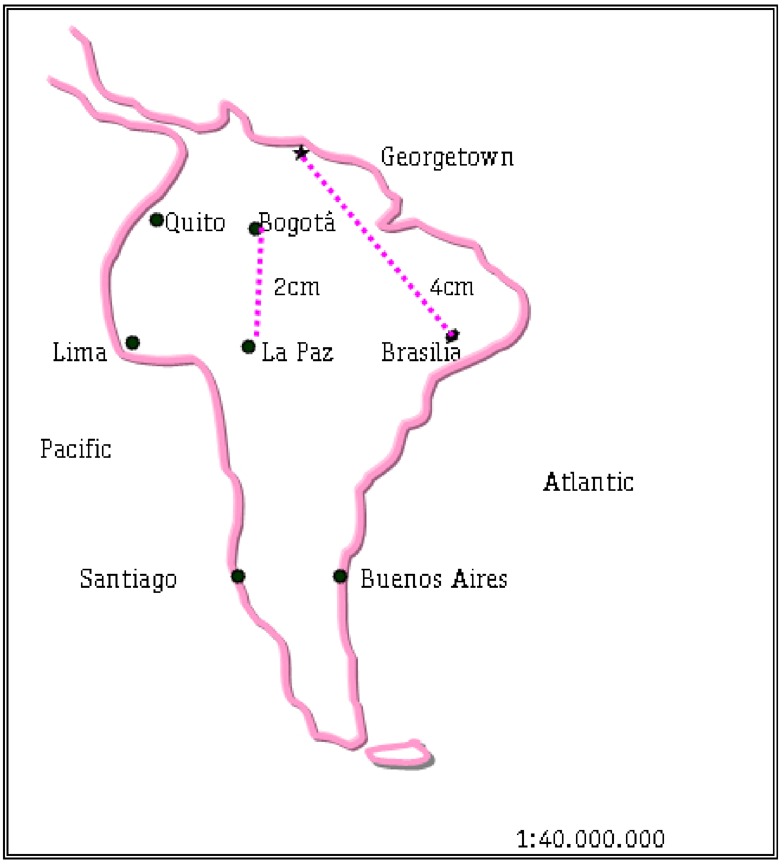
5. How far is the distance between the city of Georgetown and Brasilia on the following map (1)?

a. 1540 km.	□	b. 1600 km.	□
c. 1590 km.	□	d. 1620 km.	□

6. How far is the distance between Bogotá and La Paz in the south on the following map (1)?

a. 740 km.	□	b. 850 km.	□
c. 890 km.	□	d. 800 km.	□

Map (1)



7. We change a map with scale 1:100.000 into a map with scale 1:25.000. How large is the enlargement factor?

a. factor 2.	□	b. factor 3.	□
c. factor 4.	□	d. factor 5.	□

8. We have a map with scale 1:100.000. We reduce the area surface to a quarter. How large is the new scale?

a. 1:200.000.	□	b. 1:300.000.	□
c. 1:400.000.	□	d. 1:100.000.	□

9. It is 12 hours in London (local time) afternoon, and it is 7 hours in Montreal (Canada) (local time) in the morning. On which longitude is Montreal located?

a. ≈ 71° west.	□	b. ≈ 76° west.	□
c. ≈ 60° west.	□	d. ≈ 65° west.	□

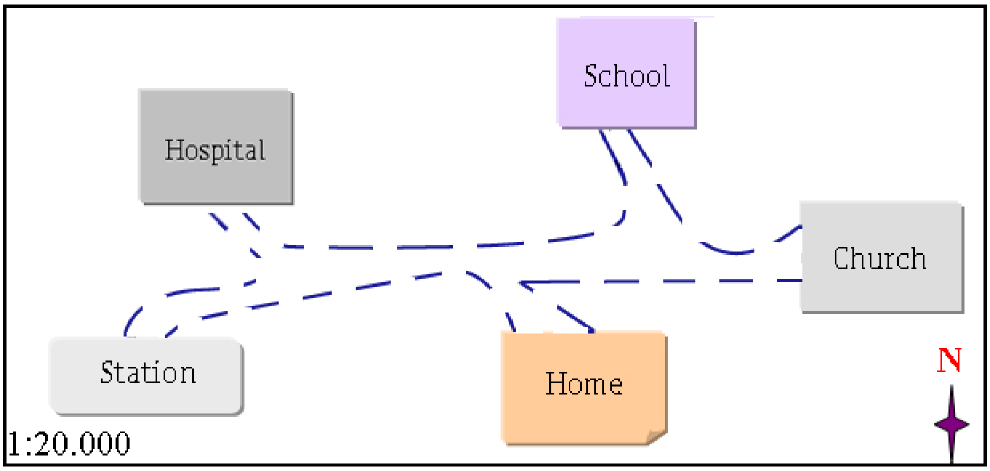
10. The distance between the equator and Khartoum City in Sudan is 1665 km. On which latitude is Khartoum?

a. latitude 15° N.	□	b. latitude 17° N.	□
c. latitude 13° N.	□	d. latitude 16° N.	□

11. If you heard the news in London at 20:00 hours (local time). What is the time in Kuwait (45° E)?

a. 22:00 h (local time).	□	b. 18:00 h (local time).	□
c. 23:00 h (local time).	□	d. 17: 00 h (local time).	□

12. You are at home and driving to the north. Which one of the following buildings will reach first?



a. hospital. ☐ b. school. ☐
c. church. ☐ d. station. ☐

13. The distance between the school and the station is 4,5 cm on map (2). How far is the distance in reality?

a. 600 m. ☐ b. 800 m. ☐
c. 900 m. ☐ d. 200 m. ☐

14. You traveled a certain distance 9,42 km by a car at average speed of 70 km/h. How long it takes the trip?

a. ≈ 8 minutes, 4 seconds. ☐ b. ≈13 minutes, 46 seconds. ☐
c. ≈ 16 minutes, 70 seconds. ☐ d. ≈ 1 hour, 15 seconds. ☐

15. The temperature of a gas is at 20°C with a pressure of 500 (N/m2) and a volume of 100 cm^3. How large is the pressure of the same mass of gas at a volume of 120 cm^3 and the temperature of 60°C, by applying: Pressure • Volume = constant and the volume of the gas expands 1/273 per 1° rise in temperature?

a. (1,2•273)•(500/313). ☐ b. (500:273)•(1,2•313). ☐
c. (500•313)/(1,2•273). ☐ d. (500•273)/(1,2•313). ☐

16. Speed is distance divided by

a. length. ☐ b. mass. ☐
c. time. ☐ d. acceleration. ☐

17. The light needs approximately 7,3 minutes for the distance from the sun to the earth (149 million km). What is the speed of light?

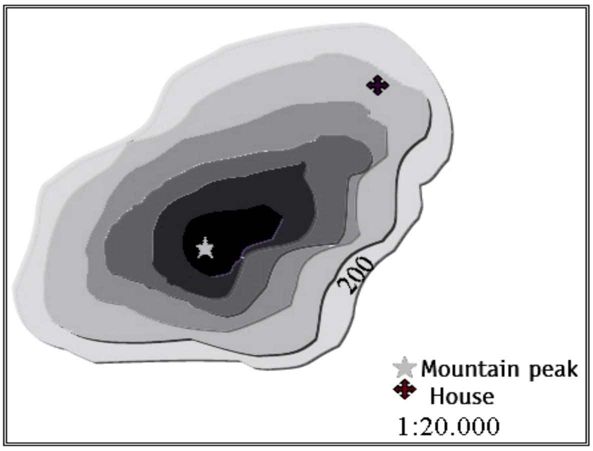
a. 20,41 million km/minute. ☐ b. 19,21 million km/minute. ☐
c. 15,64 million km/minute. ☐ d. 18,404 million km/minute. ☐

18. What is the height of the mountain plateau on the map (3)?

a. 1200 Meter. ☐ b. 800 Meter. ☐
c. 600 Meter. ☐ d. 250 Meter. ☐

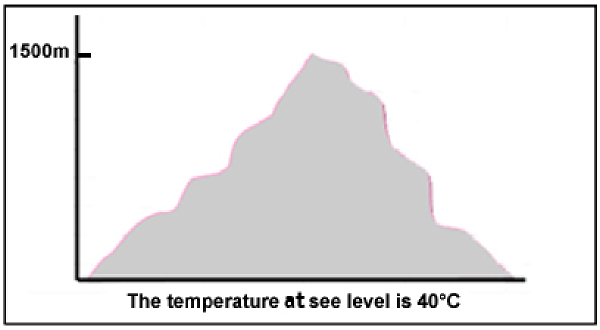
19. How far is the distance between the house and the mountain peak on the map (3) in reality?

Map (3)



a. ≈1060 Meter. ☐ b. ≈800 Meter. ☐
c. ≈700 Meter. ☐ d. ≈1200 Meter. ☐

20. The temperature at sea level is 40°C. What is the temperature on the mountain summit (dry-adiabatic)?



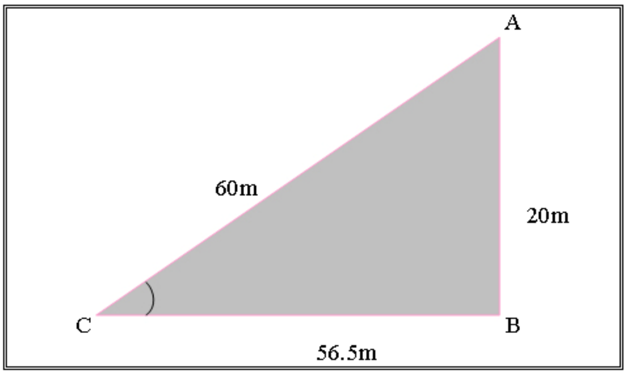
a. 35°C. ☐ b. 25°C. ☐
c. 31°C. ☐ d. 32°C. ☐

21. Al Riyadh in Saudi Arabia is located 47°E. What is the time in Riyadh (local time), if it is 7, 00 h in the morning in London?
a. 9:52 h (local time). ☐ b. 4: 00 h (local time). ☐
c. 17:00 h (local time). ☐ d. 10:08 h (local time). ☐

22. A train needs 3 hours and 30 minutes for the distance from Augsburg to Stuttgart, with an average speed of 65 km/h. How far is Stuttgart from Augsburg?
a. 196 km. ☐ b. 270,4 km. ☐
c. 235,5 km. ☐ d. 227,5 km. ☐

23. How can one distribute percentages on a circle diagram?
a. percent = 1 degree. ☐
b. 100 % = 360°. ☐
c. evenly distributed over the circle. ☐
d. all answers are right. ☐

24. How large is the inclination of the slope [AC] in the following design?



a. 34,4%. □ b. 33,3%. □
c. 33,3%. □ d. 35,4%. □

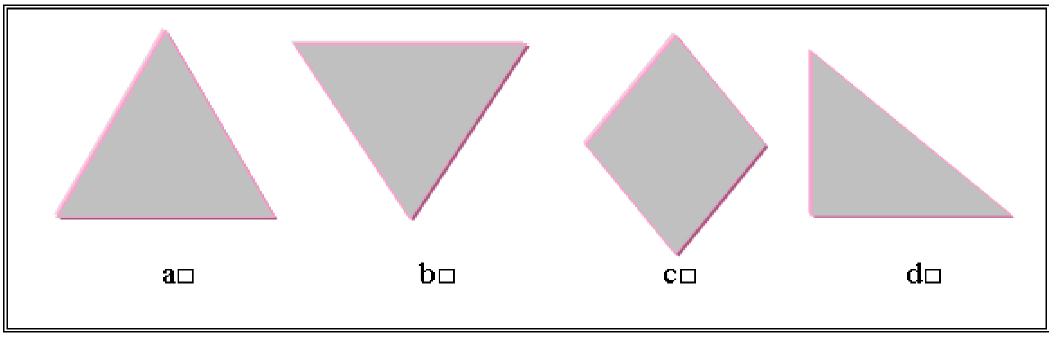
25. What is the scale of a photograph, if the focus of the camera is 150 mm and the airplane flies 3000 m above ground?

a. 1:20.000. □ b. 1:30.000. □
c. 1:40.000. □ d. 1:50.000. □

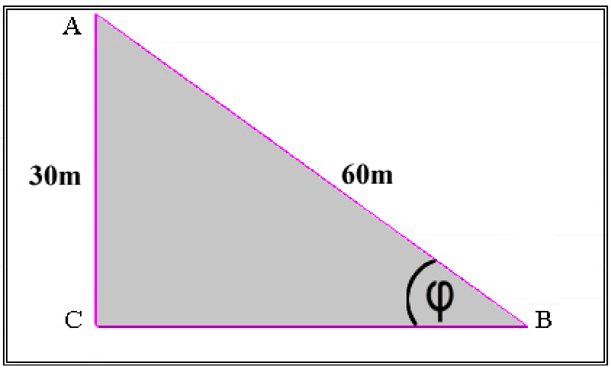
26. What is the height of the airplane, if the scale of the photography is 1:3500 and the focus of the camera is 150 mm?

a. 500 m. □ b. 525 m. □
c. 720 m. □ d. 320 m. □

27. Which geometrical figure is similar to the Matterhorn sketch on the topographic map?

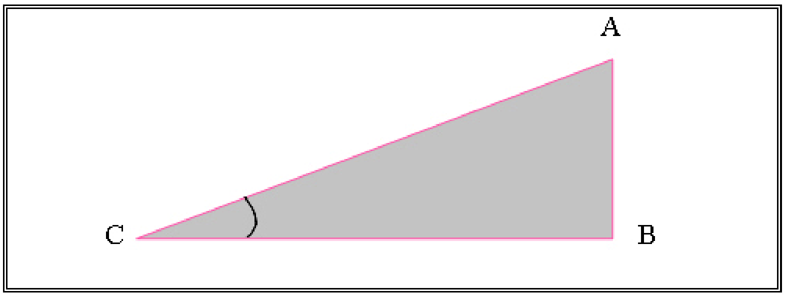


28. How large is the angle of inclination, if $\overline{AB}$=60m and $\overline{AC}$=30m?



a. 40°. □ b. 60°. □
c. 30°. □ d. 45°. □

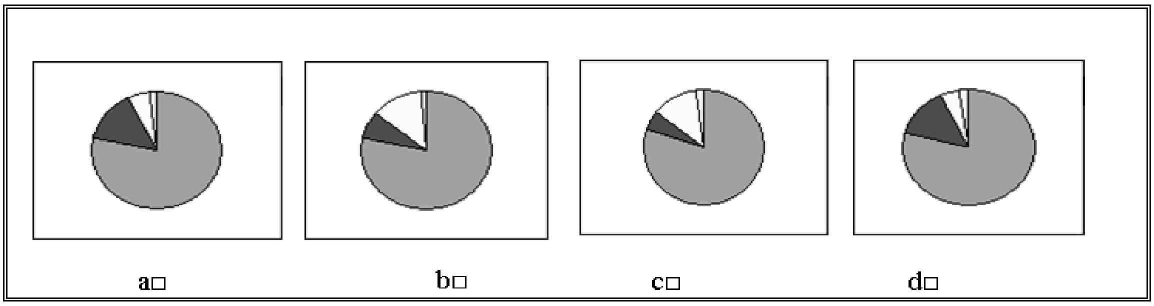
29. The angle ABC is 90°. How large is the inclination angle of the slope [AC], if the inclination is equal to 0,364.



a. 20°. □ b. 3,64°. □
c. 36,4°. □ d. 21°. □

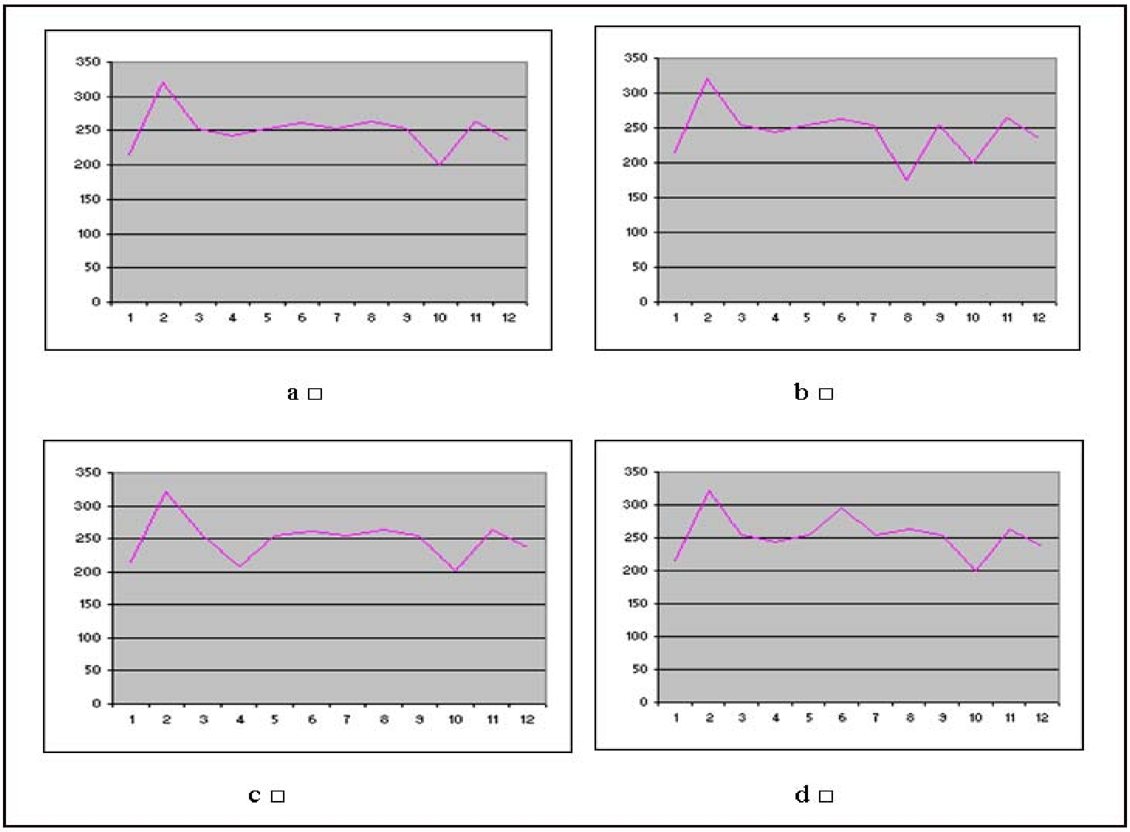
30. Which circle diagram shows the following data?

Product	cotton	fruit	vegetable	Other products
Percent	78.2	14.8	5.6	1.7



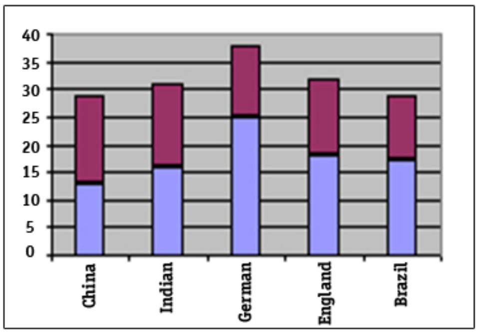
31. These data show the total population of Iraq in the year 1977. Which of the following diagrams shows those data?

Number	The age	Entire population	Number	The age	Entire population
1	10-15	215	7	40-45	254
2	15-20	321	8	45-50	264
3	20-25	254	9	50-55	254
4	25-30	243	10	55-60	201
5	30-35	254	11	60-65	264
6	35-40	262	12	65-70	236

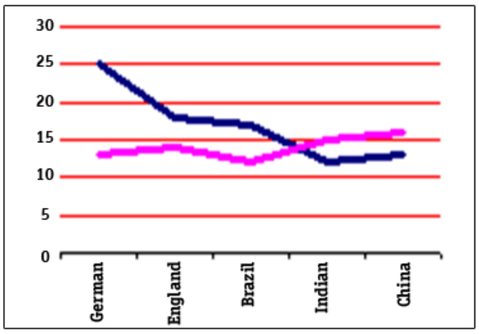


32. Which of the diagrams represent the following table?

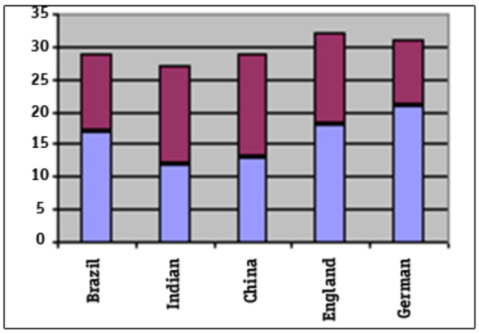
Product	China	Indian	German	England	Brasilia
Cars	13	16	25	18	17
Computer	16	15	13	14	12



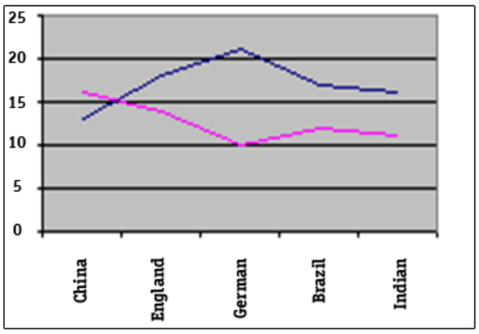
a□



b□



c□



d□

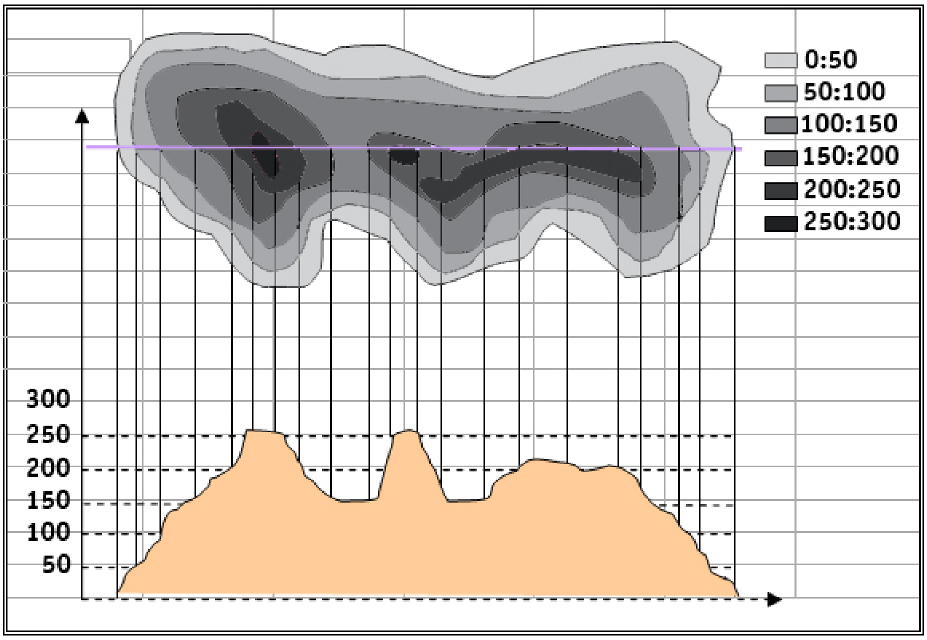
33. What is the height scale of profile in map (4)?

a. ≈ 1:10.000. □ b. ≈ 1:20.000. □
c. ≈ 1:30.000. □ d. ≈ 1:40.000. □

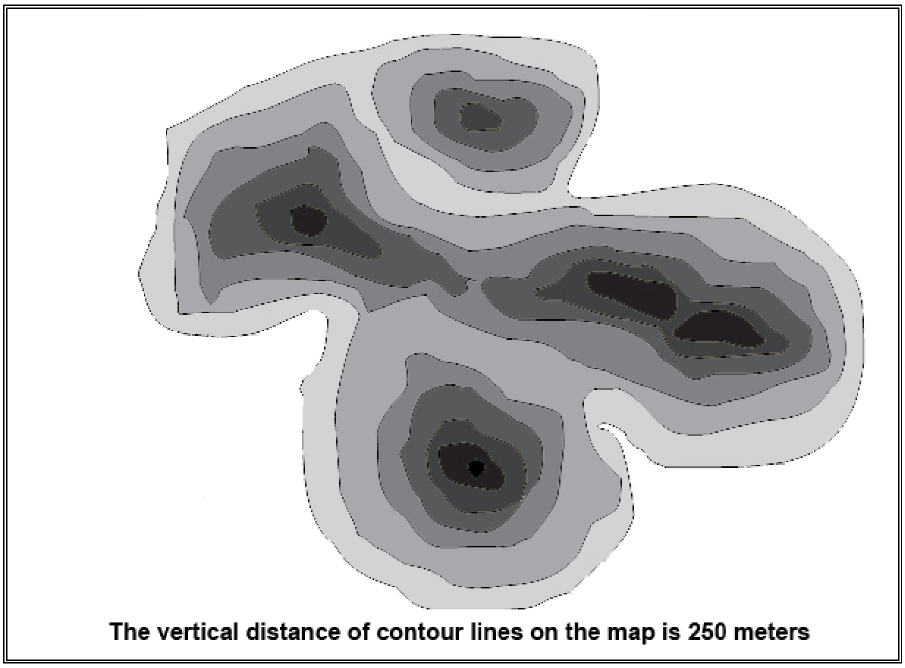
34. What is the maximum height difference in the profile in map (4)?

a. 150 m. □ b. 250 m. □
c. 200 m. □ d. 300 m. □

Map (4)

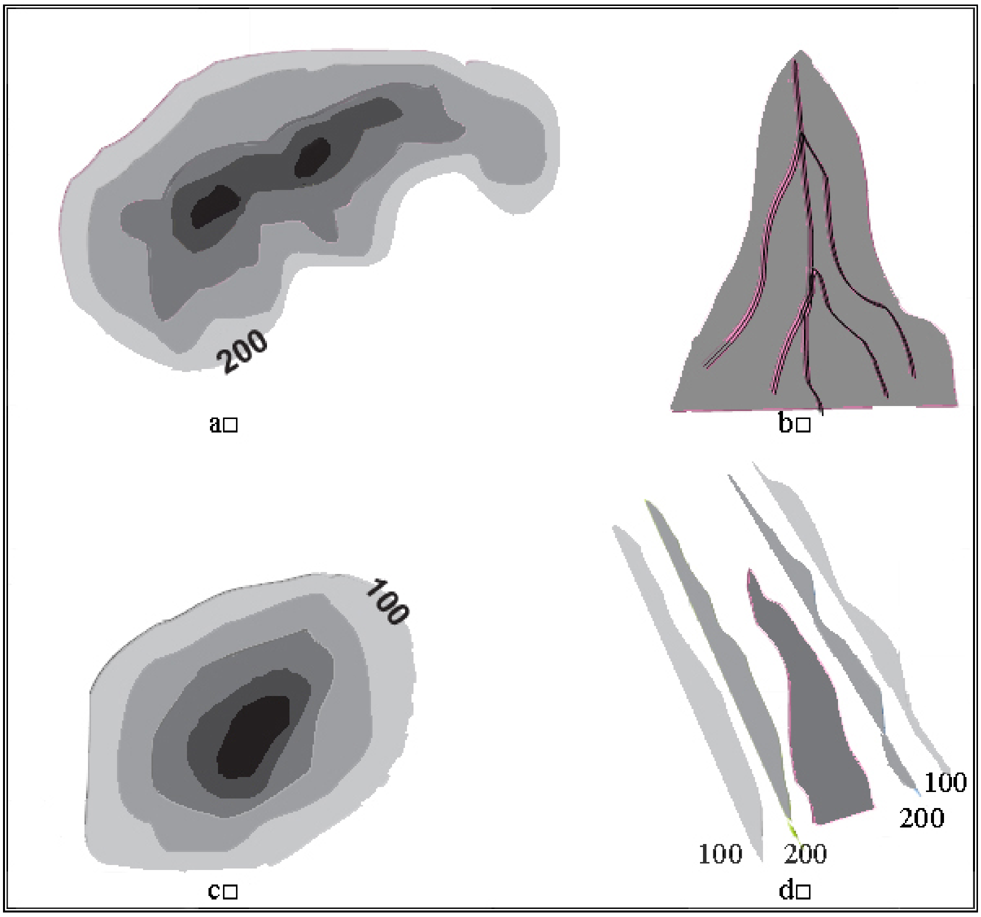


35. Where locate the highest point on the following map?



a. 1500 m. ☐ b. 1750 m. ☐
c. 1200 m. ☐ d. 2000 m. ☐

36. Which representation is conical?



Wichtiger Hinweis:

Bitte lesen Sie diese Seite, bevor Sie mir dem Test beginnen

Name:...................

Datum:...............

Semester............,Diplom........., LA:.........., Fächerverbindung:.........

Testdauer: 30 Minuten

Liebe Studierende des Faches Geographie:

Dieser Test ist für Studenten der Geographie, um ihre mathematischen Grundfertigkeiten zu testen.

Bitte beachten Sie Folgendes:

- Es gibt jeweils eine richtige Antwort pro Aufgabe.
- Die Aufgaben sollen wie in einer echten Prüfungssituation abgelegt werden.

Überlegen Sie sich bitte, bevor sie weiterlesen, für welche Möglichkeiten Sie sich entscheiden.

Beispiel:

In Alexandria ist es genau 20 Uhr (Wahre Ortzeit) und in Greenwich genau 18 Uhr (Wahre Ortzeit). Auf welchem Längengrad liegt Alexandria?

a. 30° östlich.	□	b. 35° östlich.	□
c. 43° östlich.	□	d. 42° östlich.	□

(Zutreffendes ankreuzen)

Und nun: Viel Spaß und Erfolg bei Ihrem Test!

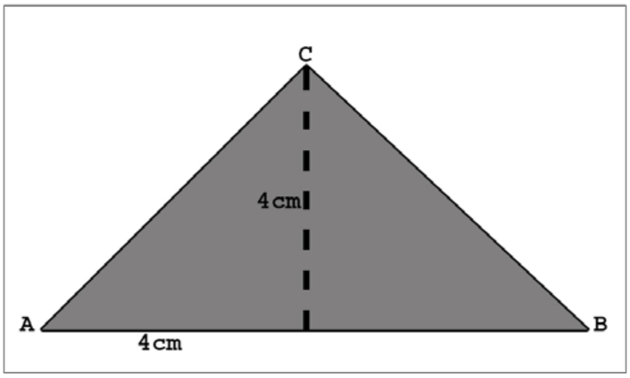
1. Wenn die Distanz zwischen München und Frankfurt in der Karte 21cm beträgt und der Maßstab der Karte 1:1500000 ist, wie groß ist die Distanz in Wirklichkeit?

a. 330 km.	□	b. 375 km.	□
c. 315 km.	□	d. 350 km.	□

2. Die Distanz zwischen Augsburg und Bremen beträgt ca. 750 km. Wie groß ist die Distanz auf einer Karte mit dem Maßstab 1:2.000.000?

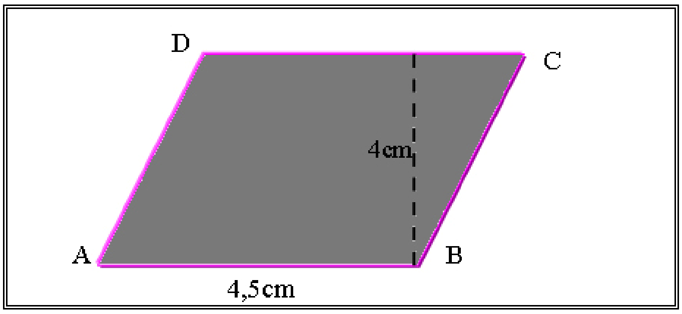
a. 37,5cm.	□	b. 36,5cm.	□
c. 35,6cm.	□	d. 38,2cm.	□

3. Das folgende Symbol stellt eine Signatur auf einer Landkarte dar. Der Maßstab auf der Karte beträgt 1:200.000. Wie groß ist die Fläche der Signatur, wenn man sie in die Wirklichkeit überträgt?



a. 22 km^2.	□	b. 32 km^2.	□
c. 12 km^2.	□	d. 10 km^2.	□

4. Die folgende Karte zeigt eine Fläche, die in der Realität 72 km^2 groß ist. Wie groß ist die der Maßstab?



a. 1:2.000.000.	□	b. 1:20.000.	□
c. 1:40.000.	□	d. 1:400.000.	□

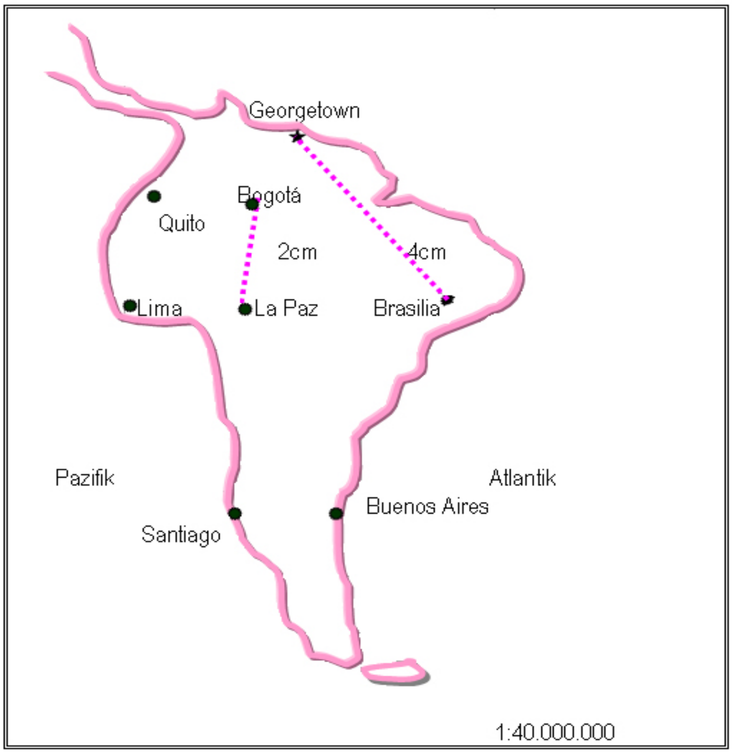
5. Wie groß ist auf der folgenden Karte (1) die Distanz zwischen der Stadt Georgetown und Brasilia?

a. 1540 km.	□	b. 1600 km.	□
c. 1590 km.	□	d. 1620 km.	□

6. Wie groß ist auf der folgenden Karte (1) die Distanz zwischen Bogotá und der südlich gelegenen Stadt LaPaz:

a. 740 km.	□	b. 850 km.	□
c. 890 km.	□	d. 800 km.	□

Karte (1)



7. Sie möchten eine Karte mit dem Maßstab 1:100.000 in eine Karte mit dem Maßstab 1:25.000 umzeichnen. Wie groß ist der Flächenvergrößerungsfaktor?

a. Faktor 2.	☐	b. Faktor 3.	☐
c. Faktor 4.	☐	d. Faktor 5.	☐

8. Ich habe eine Karte mit dem Maßstab 1:100.000 und will die Fläche auf ein Viertel verkleinern. Wie ist der neue Maßstab?

a. 1:200.000.	☐	b. 1:300.000.	☐
c. 1:400.000.	☐	d. 1:100.000.	☐

9. Wenn es in London 12 Uhr (Wahre Ortzeit) Mittag ist, dann ist es in Montreal (Kanada) (Wahre Ortzeit) 7 Uhr morgens. Auf welchem Längengrad liegt Montreal?

a. ≈ 71° westlich.	☐	b. ≈ 76° westlich.	☐
c. ≈ 60° westlich.	☐	d. ≈ 65° westlich.	☐

10. Die Distanz zwischen dem Äquator und der Stadt Khartum (Sudan) beträgt 1665 km. Auf welcher Breite liegt Khartum?

a. 15° n.Br.	☐	b. 17° n.Br.	☐
c. 13° n.Br.	☐	d. 16° n.Br.	☐

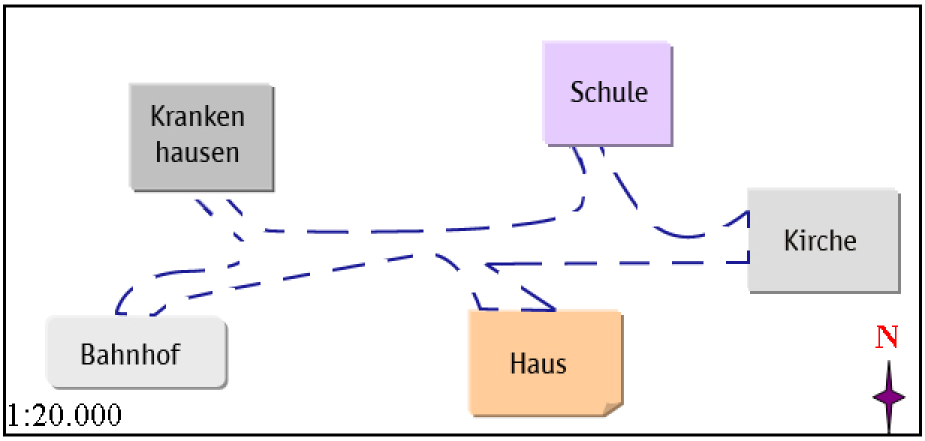
11. Wenn Sie in London um 20:00 Uhr (Wahre Ortszeit) die Nachrichten hören, wie spät ist es dann in Kuwait (45° östl. Länge)?

a. 22:00 Uhr (Wahre Ortszeit).	☐	b.18:00 Uhr (Wahre Ortszeit).	☐
c. 23:00 Uhr (Wahre Ortszeit).	☐	d.17:00 Uhr (Wahre Ortszeit).	☐

12. Sie sind im Haus und möchten nach Norden fahren. Was erreichen sie zuerst?

a. Krankenhaus.	☐	b. Schule.	☐
c. Kirche.	☐	d. Bahnhof.	☐

Karte (2)



13. Die Distanz zwischen der Schule und dem Hauptbahnhof beträgt auf der Karte (2) 4.5 cm. Wie groß ist die Distanz in der Realität?
   a. 600 m. □ b. 800 m. □
   c. 900 m. □ d. 200 m. □

14. Sie legen mit dem Auto eine Strecke von 9,42 km mit einer Durchschnittsgeschwindigkeit von 70 km/h zurück. Wie lange sind Sie unterwegs?
   a. ≈ 8 Minuten, 4 Sekunden. □ b. ≈ 13 Minuten, 46 Sekunden. □
   c. ≈ 16 Minuten, 70 Sekunden. □ d. ≈ 1 Stunde, 15 Sekunden. □

15. Die Temperatur eines Gases beträgt 20°C bei einem Druck von 500 (N / m^2) und einem Volumen von 100 cm^3. Wie groß ist der Druck der gleichen Gasmenge bei einem Volumen von 120 cm^3 und einer Temperatur von 60°C, wenn gilt: Druck • Volumen = konstant und das Gas sich bei 1° Temperaturerhöhung um 1/273 seines Volumens ausdehnt?
   a. (1,2•273)•(500/313). □ b. (500:273)•(1,2•313). □
   c. (500•313)/(1,2•273). □ d. (500•273)/(1,2•313). □

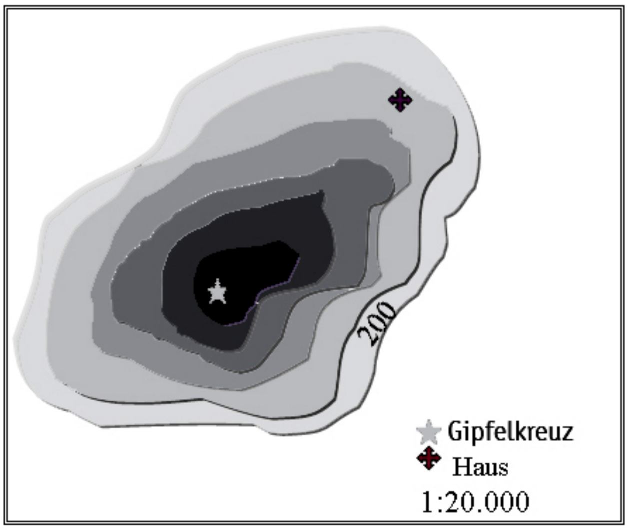
16. Die Geschwindigkeit ist Strecke pro:
   a. Distanz. □ b. Masse. □
   c. Zeit. □ d. Beschleunigung. □

17. Das Licht benötigt für die Strecke von der Sonne zur Erde (149 Millionen km) ungefähr 7, 3 Minuten. Wie groß ist die Lichtgeschwindigkeit?
   a. 20,41 Millionen km/Minute. □ b. 19,21 Millionen km/Minute. □
   c. 15,64 Millionen km/Minute. □ d. 18,404 Millionen km/Minute. □

18. Wie hoch ist das Gipfelplateau des Berges auf der Karte (3)?
   a. 1200 Meter. □ b. 800 Meter. □
   c. 600 Meter. □ d. 250 Meter. □

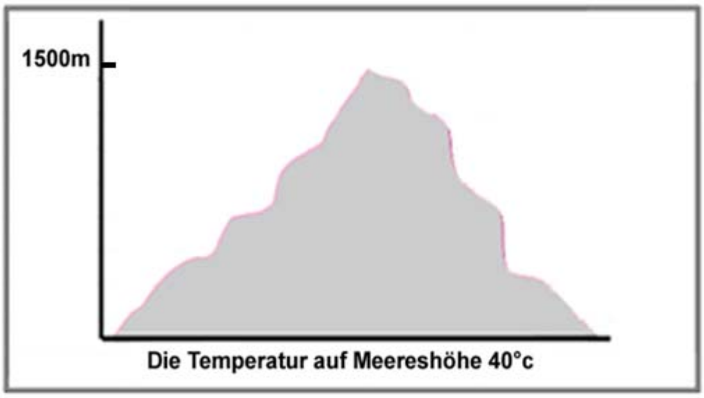
19. Wie groß ist die Distanz auf der Geländeoberfläche vom Haus zum Gipfelkreuz auf der Karte (3)?

Karte (3)



a. ≈1060 Meter.	□	b. ≈800 Meter.	□
c. ≈700 Meter.	□	d. ≈1200 Meter.	□

20. Die Temperatur auf Meereshöhe beträgt 40°C. Welche Temperatur herrscht im Mittel auf dem abgebildeten Berggipfel trockenadiabatisch?



a. 35°C.	□	b. 25°C.	□
c. 31°C.	□	d. 32°C.	□

21. Riad in Saudi Arabien liegt auf 47° östlicher Länge. Wie spät ist es in Riad genau (Wahre Ortszeit), wenn es in London 7.00 Uhr morgens ist?

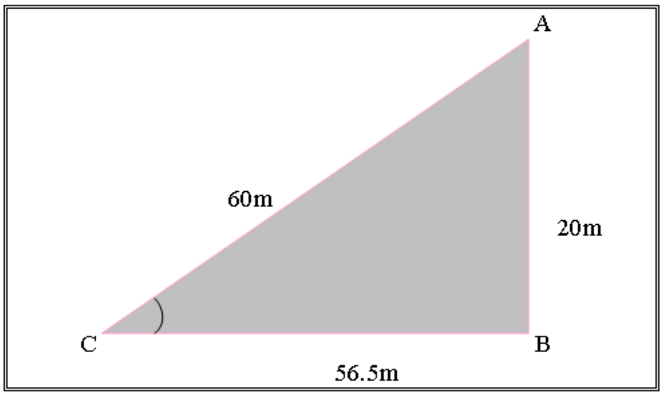
a. 9:52 Uhr (Wahre Ortszeit).	□	b. 4:32 Uhr (Wahre Ortszeit).	□
c. 17:00 Uhr (Wahre Ortszeit).	□	d. 10.08 Uhr (Wahre Ortszeit).	□

22. Ein Zug benötigt für die Strecke von Augsburg nach Stuttgart 3 Stunden und 30 Minuten, wenn er mit einer Durchschnittsgeschwindigkeit von 65 km/h unterwegs ist. Wie viele Bahnkilometer ist Stuttgart von Augsburg entfernt?

a. 196 km.	□	b. 270,4 km.	□
c. 235,5 km.	□	d. 227,5 km.	□

23. Wie stellt man Prozentzahlen in einem Kreisdiagramm dar?
   a. Prozent = 1 Grad. □
   b. 100 % = 360°. □
   c. Gleichmäßige Verteilung über den Kreis. □
   d. Alle Antworten sind richtig. □

24. Wie stark ist das Gefälle der Strecke [AC] in folgender Zeichnung?

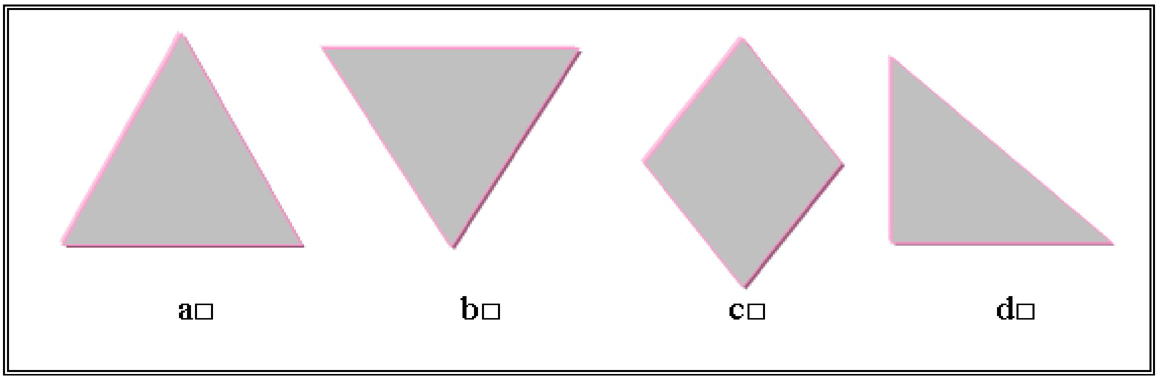


   a. 34,4%. □ b. 33,3%. □
   c. 33,3%. □ d. 35,4%. □

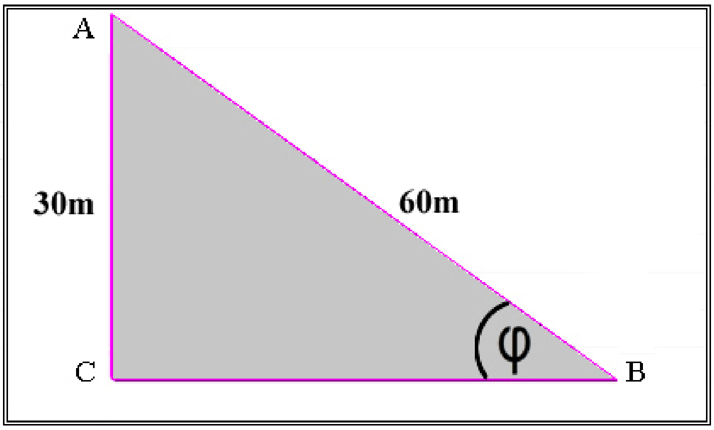
25. Wie groß ist der Maßstab für eine Fotographie, wenn der Fokus für den Fotoapparat 150 Millimeter ist und das Flugzeug 3000m hoch fliegt?
   a. 1:20.000. □ b. 1:30.000. □
   c. 1:40.000. □ d. 1:50.000. □

26. Wie hoch fliegt das Flugzeug, wenn der Maßstab für die Fotographie 1:3500 und der Fokus für den Fotoapparat 150 Millimeter ist?
   a. 500 m. □ b. 525 m. □
   c. 720 m. □ d. 320 m. □

27. Welche Geometrische Figur gleicht dem Grundriss des Matterhorns auf der topographischen Karte?

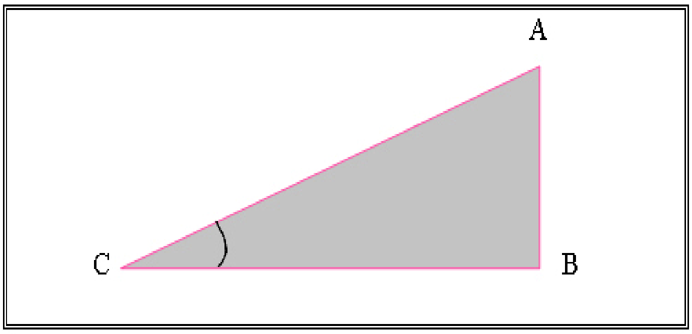


28. Wie groß ist der Neigungswinkel, wenn $\overline{AB}$=60m und $\overline{AC}$=30m?



a. 40°.	□	b. 60°.	□
c. 30°.	□	d. 45°.	□

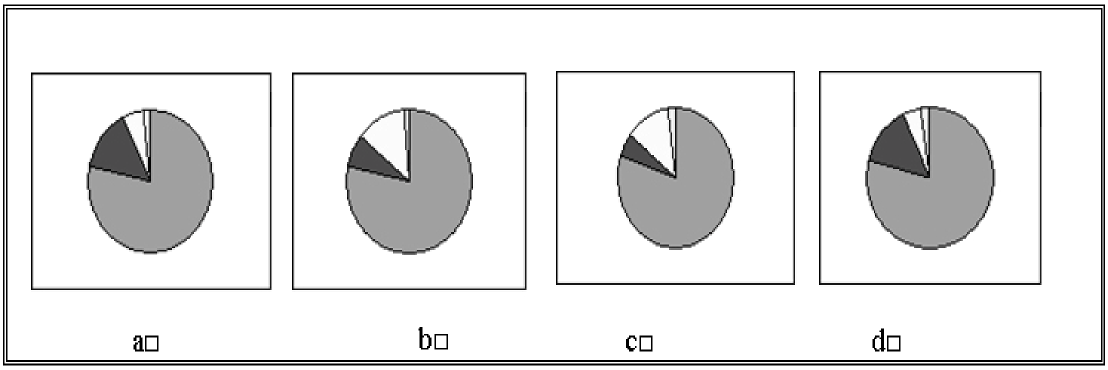
29. Der Winkel ABC ist 90°. Wie groß ist der Neigungswinkel des Hanges [AC], wenn die Neigung gleich 0,364 ist.



a. 20°.	□	b. 3,64°.	□
c. 36,4°.	□	d. 21°.	□

30. Welches Kreisdiagramm zeigt die folgenden Daten?

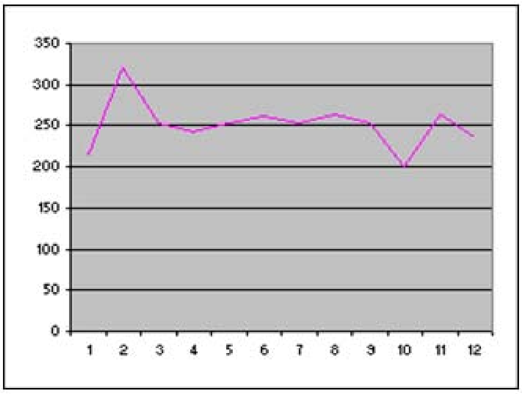
Produkt	Baumwolle	Obst	Gemüse	Andere Produkte
Prozent	78.2	14.8	5.6	1.7



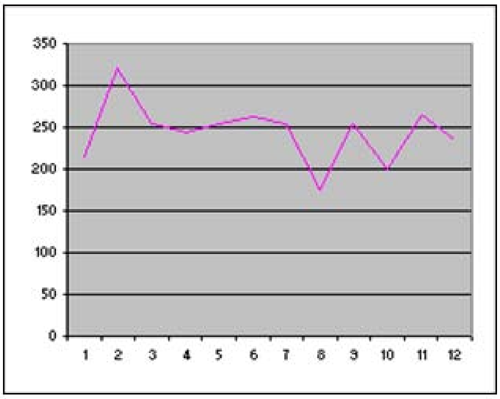
31. Diese Daten zeigen die Gesamtbevölkerung des Irak im Jahr 1977.

Nummer	Alter	Gesamt Bev.	Nummer	Alter	Gesamt Bev.
1	10-15	215	7	40-45	254
2	15-20	321	8	45-50	264
3	20-25	254	9	50-55	254
4	25-30	243	10	55-60	201
5	30-35	254	11	60-65	264
6	35-40	262	12	65-70	236

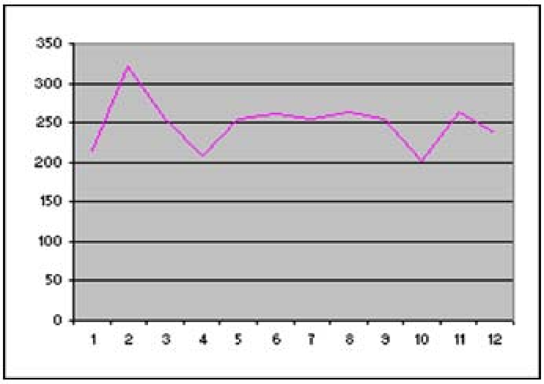
- Welches der folgenden Diagramme zeigt diese Daten?



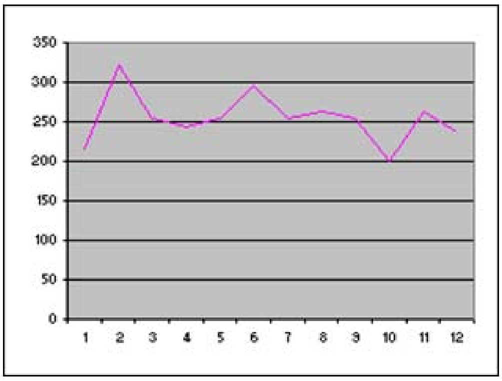
a □



b □



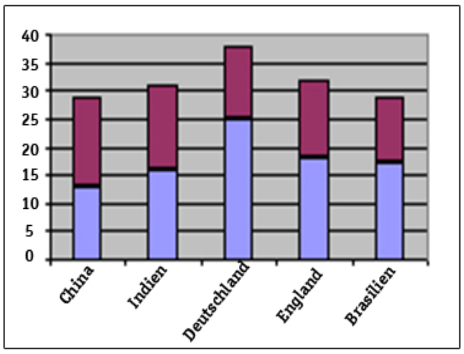
c □



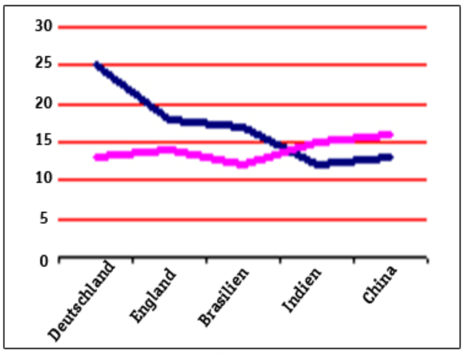
d □

32. Durch welches Diagramm wird folgende Tabelle illustriert?

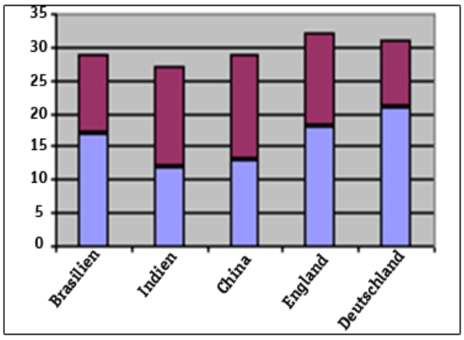
Produkt	China	Indien	Deutschland	England	Brasilien
Autos	13	16	25	18	17
Computer	16	15	13	14	12



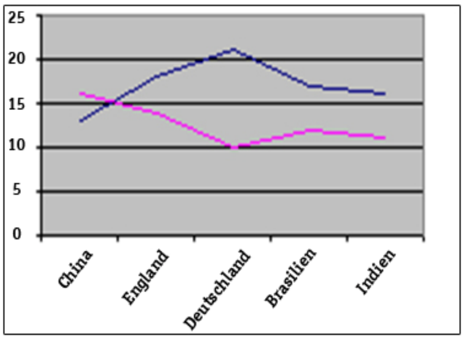
a □



b □



c □



d □

33. Wie groß ist der Höhenmaßstab der Karte (4)?

a. ≈ 1:10.000. □ b. ≈ 1:20.000. □

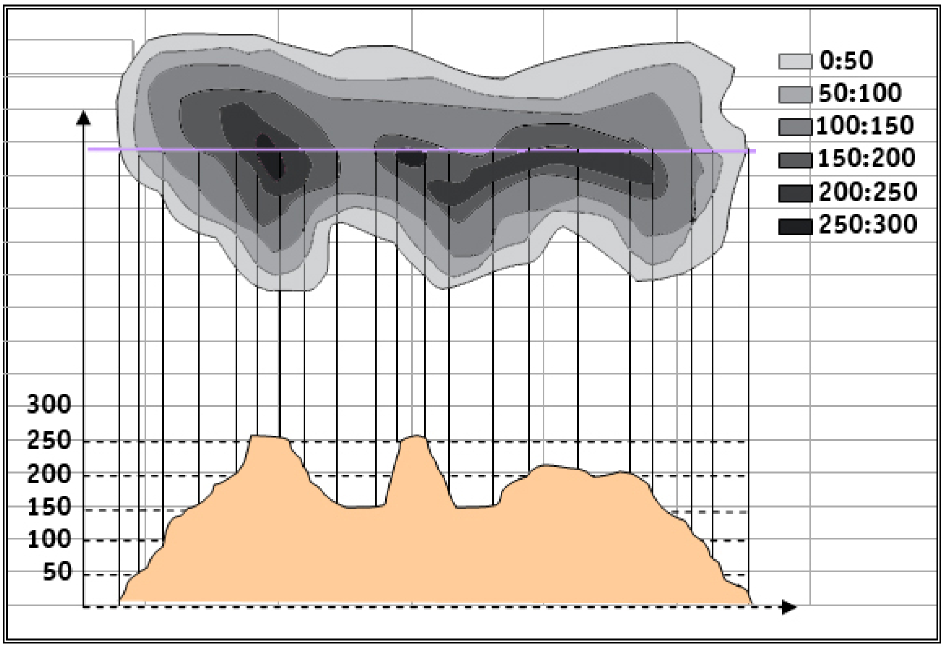
c. ≈ 1:30.000. □ d. ≈ 1:40.000. □

34. Wie groß ist der maximale Höhenunterschied im Profil der Karte (4)?

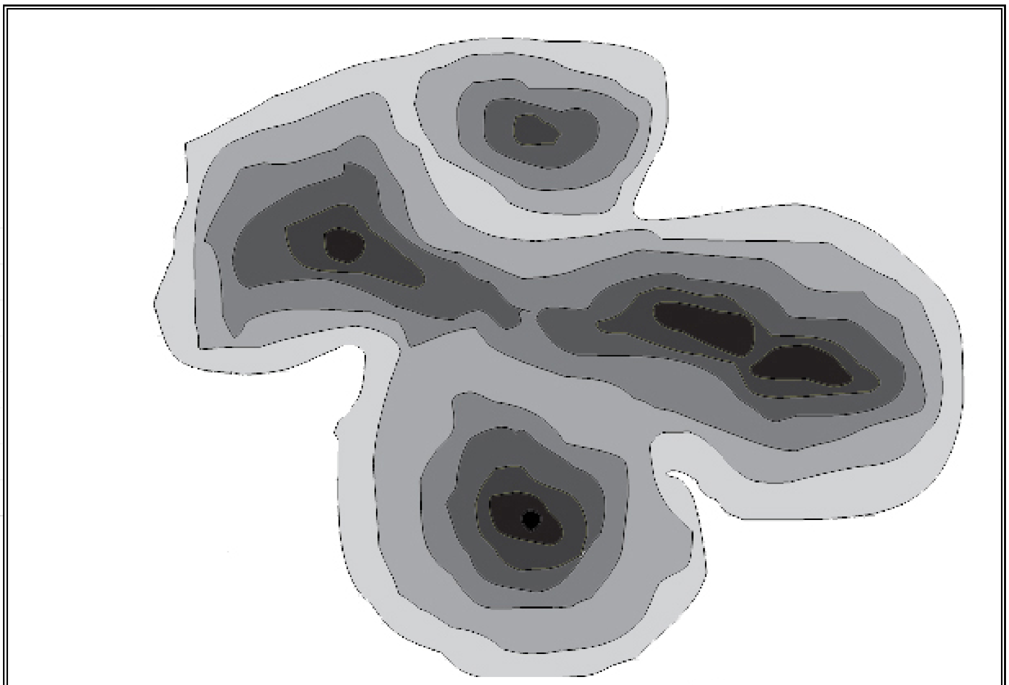
a. 150 m. □ b. 250 m. □

c. 200 m. □ d. 300 m. □

Karte (4)



35. Wo liegt in der folgenden Karte, der höchste Punkt?

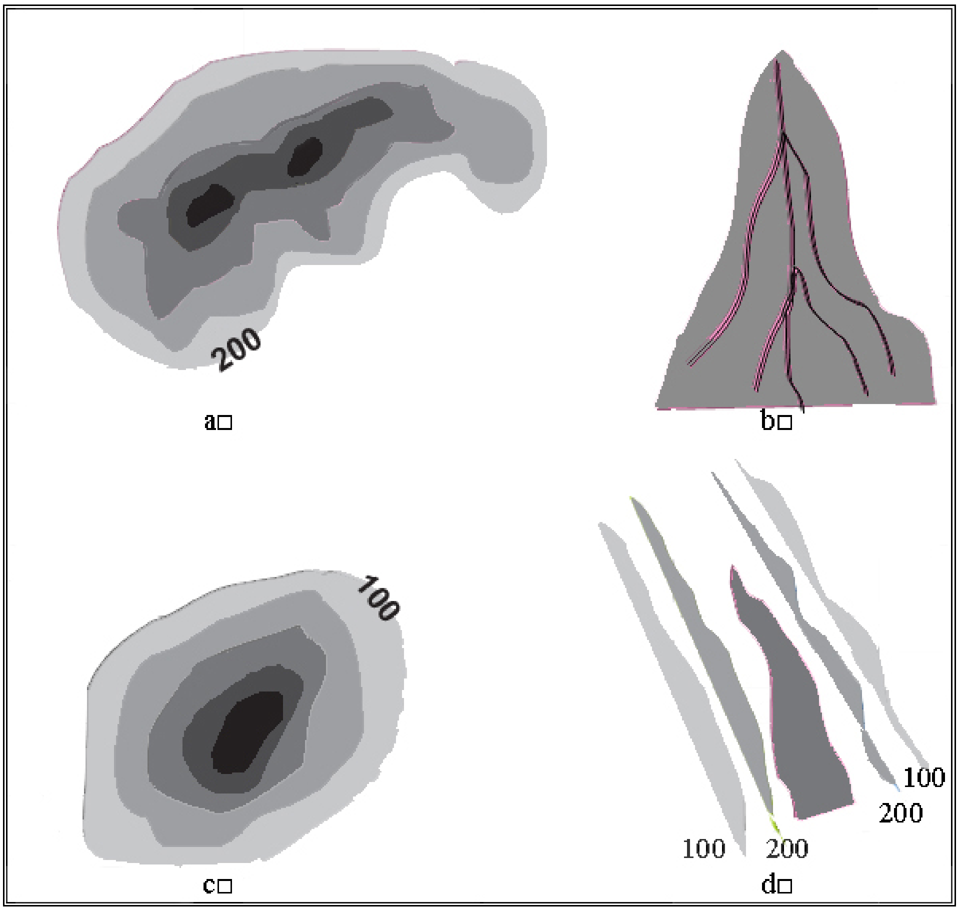


Die Isohypsenabstand ist auf der Karte 250 Meter

a. 1500 m. ☐ b. 1750 m. ☐

c. 1200 m. ☐ d. 2000 m. ☐

36. Welche der folgenden Darstellungen ist konisch?



Appendix (3)
Teacher's Guide of the Proposed Program for Geography Teaching

A Guide of the proposed program for teaching some Mathematical concepts and skills in Geography includes the following.

Introduction

This guide is directed to the teacher in order to guide him/her into the appropriate teaching of the proposed units. It clarifies the following main aspects:

1. The aims, contents, methods, and techniques that can be used throughout the program.
2. Some instructional aids and activities.
3. Some evaluation techniques.
4. The time plan of teaching each unit.
5. The study plan of each topic.
6. A group of references for the teacher.

Aims of the program

This program aims at developing some mathematical concepts and skills that are necessary for studying geography. It helps to overcome some difficulties and obstacles that are faced by certain learners, especially those who do not possess any mathematical tendency or aptitude. Therefore, the program may help the students study geography easily and simply. It can also help to direct and guide the teacher through new methods of teaching concepts and skills in general, and geographical mathematical concepts and skills in particular.

Content of the guide

The guide contains nine instructional units taken from the syllabus of geography. There are geographical topics that are connected to mathematical processes including the concepts and skills that are necessary for studying geography. The researcher introduces each unit, including a set of lessons, which in turn comprise some relevant concepts, whether concrete or abstract, in addition to certain related skills. The concepts that are included in each lesson are taught in previously specified designed methods according to their nature. The study introduces a group of desired objectives, in each lesson of the program, as well as the instructional aids, and the teaching plan. Hence, the teacher teaches each concept or skill in an appropriate way, then provides the activities that should be performed by the students, and finally introduces certain questions for evaluation to ensure the students' realization the concepts and skills that are included in the suggested program.

Methods of teaching

The methods refer to the techniques that the teacher adopts in order to achieve the objectives of different lessons. This program presents several methods for teaching mathematical concepts and skills, whether they are deductive or inductive. Examples of methods include: the conversation and the discussion methods, in addition to lecturing according to the nature of the lesson and the nature of concepts and skills to be taught.

Instructional aids

They are instruments that are used by the teacher to help him in the teaching process, and to achieve the desired objectives. They also contribute to increase the efficiency and effectiveness of the teaching process in the classroom, and to attract the student's attention. Instructional aids contribute to increase tendency toward learning, and to reduce boredom in the learning process.

Examples of the instructional aids used in this program are: different kinds of maps, blackboards, illustrations, models of the globe that help to demonstrate certain geographical concepts, such as latitude and longitude lines, in addition to instructional films, pictures, posters, and guides that help the teacher during the teaching-learning process interpret some geographical facts and clarify many different phenomena.

Evaluation

The evaluation process varied greatly, since it included oral questions, essay questions, and completion questions. In addition, it comprised true or false, matching, and multiple-choice questions.

The Time plan for teaching the units of the program

The lesson	Subjects Name	The time
Lesson One	Drawing scales and their types	45 minutes
Lesson two	Magnifying and minimizing maps	45 minutes
Lesson Three	Specifying the astrological position	45 minutes
Lesson Four	Directions	45 minutes
Lesson Five	Curves	45 minutes
Lesson Six	Geological sectors and relief sectors	45 minutes
Lesson Seven	Climate maps and their explanation	45 minutes
Lesson Eight	Regressions and their measurement	45 minutes
Lesson Nine	Using degrees in graphic designs	45 minutes
Lesson Ten	Air-photographic maps	45 minutes
Lesson Eleven	The contour maps and their types	45 minutes
Lesson Twelve	Similarity between mathematical figures and geographical phenomena	45 minutes
Total		9 hours

Each lesson will be dealt with through the method of combination and integration of knowledge concerning the relevant mathematical concepts and skills

The objectives of the program units

After the students have finished studying the program units, they will be able to:

(1) Recognize the meanings of geographical mathematical concepts that are included in the lessons.
(2) Specify the distinctive characteristics of each geographical mathematical concept.
(3) Classifying examples on each type of concepts that are presented to him.
(4) Deduce a definition in their own style of each geographical mathematical concept.
(5) Recognize the comprehensive skills of each lesson of the program units.
(6) Specify the distinctive characteristics of each geographical mathematical skill.
(7) Recognize the evaluation techniques of the geographical mathematical skills and their relevant concepts.
(8) Recognize the concept and types of drawing scales.
(9) Clarify the concept of drawing scales.
(10) Distinguish among different types of scales and their importance in using maps.
(11) Apply mathematical concepts and skills to new learning situations.
(12) Recognize the different geographical mathematical concepts in the program units.
(13) Draw maps for latitude and longitude lines.
(14) Recognize the meanings of latitude and longitude lines and their importance.

(15) Draw plans in order to specify the shapes of maps and determine regressions and directions.
(16) Distinguish between parallel and perpendicular lines, and their use in geography.
(17) Use arithmetic calculations in drawing climate maps.
(18) Recognize the meaning of each mathematical concept that is used in climate maps such as: means, ratio, and proportion.
(19) Recognize the elements of climate such as wind, pressure, temperature, humidity, and rain.
(20) Apply the mathematical concepts and skills that are related to climate to new life situations.
(21) Recognize regressions, their types, and their degrees.
(22) Use arithmetic degrees in drawing different types of sectors.
(23) Recognize the meaning of regression, sector, integral number, and the like as geographical mathematical concepts.
(24) Explain the similarity between geographical and geometrical figures.
(25) Recognize the figures of a circle, a cube, a cylinder, a triangle, and the like as geometrical figures, in addition to their parallels in geography.
(26) Recognize the graphic designs, their meanings, and their types.
(27) Specify the distinctive characteristics of graphic designs and their meaning.
(28) Draw arithmetic data, tables, and statistics, in the form of graphs, circles, or curves.
(29) Recognize the concepts of time, distance, and speed, and the relationship between them.
(30) Apply the time concepts to measuring distances through different speeds.
(31) Compare the different geographical and mathematical concepts.
(32) Drawing the similar geographical and mathematical figures in natural maps.
(33) Identify the meanings of geographical mathematical concepts and skills.
(34) Recognize the meaning of equal heights lines.
(35) Recognize the geographical figures through the equal proportion lines.
(36) Draw a map of Germany demonstrating the different shapes of relief.
(37) Recognize the meaning of air-photographing maps and their importance, in addition to their usages.
(38) Drawing air-photographing maps.
(39) Recognize the importance of mathematical concepts and skills in the suggested program.
(40) Recognize the techniques of evaluating different concepts and skills.
(41) Realize the importance of studying geographical mathematical concepts and skills.
(42) Apply what is studied through the program units in new life situations.
(43) Cultivate the tendency toward geography and mathematics in the learners' minds.
(44) Feel the importance of achieving integration among different subjects.
(45) Classify geographical mathematical concepts and skills according to the degree of learning them.
(46) Compose an essay about the importance of the mathematical concepts and skills that were studied.
(47) Re-state a composition about geographical mathematical concepts and skills that were studied.
(48) Provide suggestions as solutions for the problems facing learners during the program.
(49) Expressing in their own words style the role that geographical/mathematical concepts play in their daily lives.
(50) Appreciate the importance of studying maps and their relation to other branches of knowledge.

Lesson One: Drawing Scales & Their Types

Lesson one includes measuring distances and areas, specifying geographical position, geographical mathematical concepts: drawing scale, distance, and area. And geographical mathematical skills: specifying distances, areas, and geographical positions.

Objectives of the lesson:

By the end of this lesson, the learner should be able to:

(1) Recognize the concepts of drawing scale, distance, and area.
(2) Specify the distinctive characteristics of each of the concepts of drawing scale, distance, and area.
(3) Use geographical mathematical concepts in specifying distances on maps and their parallels in reality.
(4) Specify areas in reality and their parallels on maps.
(5) Specify geographical positions in different directions (north, south, etc).
(6) Appreciate the importance of using the lesson concepts in daily life.
(7) Specify distances on a blank map between different cities using mathematical instruments.
(8) Determine areas and geographical positions on maps.
(9) Compare geographical positions on maps to their parallels in reality.
(10) Drawing on a blank map some geometrical figures of areas and distances demonstrating some factories or minerals.

Instructional aids:

(a) School textbook.
(b) A group of pictures representing certain geometrical figures.
(c) A natural map of the world.
(d) Some pamphlets in the school library such as principles of natural geography and principles of mathematics.

Activities:

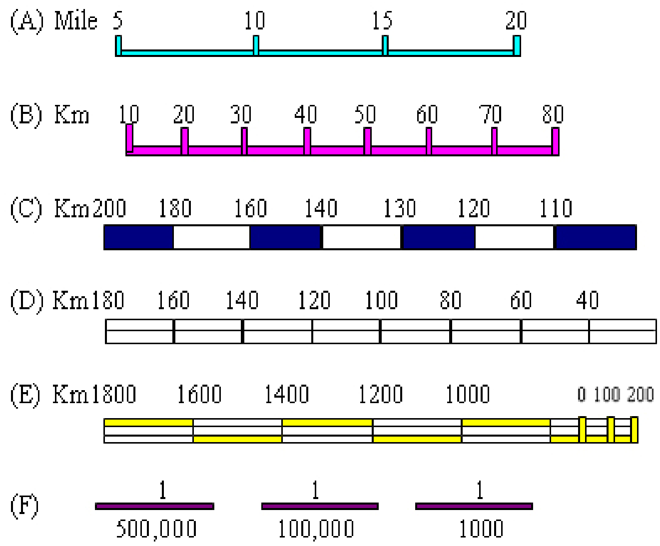
(a) Planning and performing a mini-play dealing with the concepts of drawing scales, distances, and areas, where a group of the students represent each of these concepts.
(b) Preparing a photo-album including projects about scales and their types.
(c) Writing reports about the importance of drawing scales in specifying geographic position, distances, and areas on maps.

The lesson plan:

Preliminary representation: In such a representation, the teacher introduces a general idea about the lesson including the mathematical concepts and skills to be studied. The lesson concentrates on some geographical/ mathematical concepts, such as drawing scales, distances, and areas. Then, the teacher asks students about these concepts. The lesson also concentrates on some geographical mathematical skills, such as locating distances and natural areas or vice versa, in addition to the ability of the students to perform them before explaining the lesson.

Instructional activity: The teacher announces the label of the geographical mathematical concept such as “drawing scale”, which means the ratio between two dimensions, the first of which is on the map, whereas the other is in reality. Then, he writes a definition of the term on the blackboard, and illustrates the different types of drawing scales as follows:

Figure (6)



The teacher identifies the different types of drawing scales in the following forms on the map from the previous figures:

(a) A fraction such as 1:10000 or in which the unit of measurement may be the meter, inch, foot, centimeter, and the like.
(b) It is written directly on the map in the same way we write that each centimeter on the map is equal to 3.2 kilometers in reality or each inch is equal to 6 kilometers in reality and so many other examples that show the written drawing scale in a map.
(c) Linear scale in the form of a line divided equally.
(d) A time form in which the distance and time are illustrated to indicate differences in time.
(e) A web scale to measure decimal fractions or percentages for inches or centimeters.

Exercise:

The teacher asks the students to recognize the correct example compared to the false one without informing them of the reason, such as the following two figures, of which are them represents a drawing scale on the map.

The teacher asks students to specify the distinctive characteristics of these concepts and record them according to the students' opinions. The teacher asks each student to state the concept of drawing scale in his own style and practice some exercises dealing with the concept of drawing scale.

Example:

If the distance between two points on the map is 3.5 cm, and the drawing scale is 1:400000, what will be the distance between these points in reality?

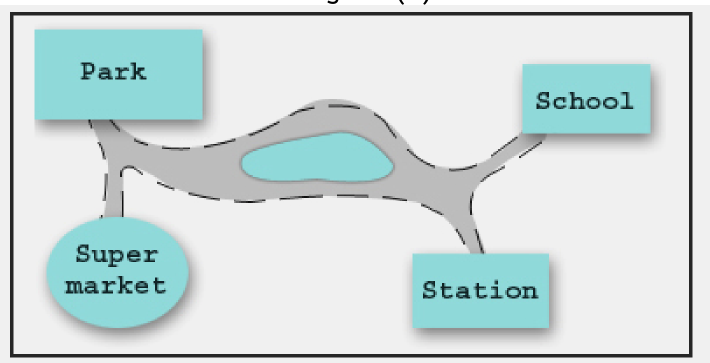
The answer:

400,000 • 3.5cm = 1,400,000cm = 14 km.

An instructional activity dealing with the concept of “distance” is introduced as follows:
Introductory definition: The teacher introduces the label of the geographical mathematical concept “distance”, then he clarifies the distinctive features of the concept “distance”. After that, the teacher writes a definition of the concept on the blackboard as follows:

"Distance" is one of the analytical geometrical concepts, which refer to the line drawn between two points (e.g. A and B). It is known in mathematics as the distance function. Demonstrating examples: In the figure below, locate two points using a ruler, thread, or compass. The unit of measurement in reality is the meter, mile, inch. For example, the teacher demonstrates the different forms of distance from the garden to the station in the figure below:

Figure (7)



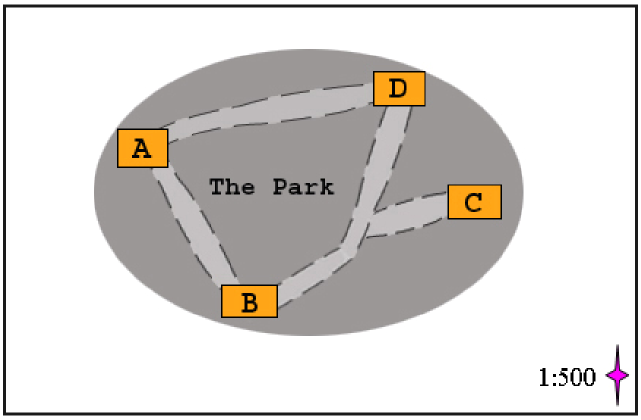
Exercise:

The teacher asks the students to draw a blank map, and specify two points on it. These points are measured using some mathematical instrument. Then, he asks the students to show the distinctive features of this concept.

The teacher asks the students to write a definition of "distance" in their own style and record these definitions on the blackboard and ask each student to identify them on a sheet of paper with some examples.

Example:

How can we measure this distance from park A to park C on the following figure?



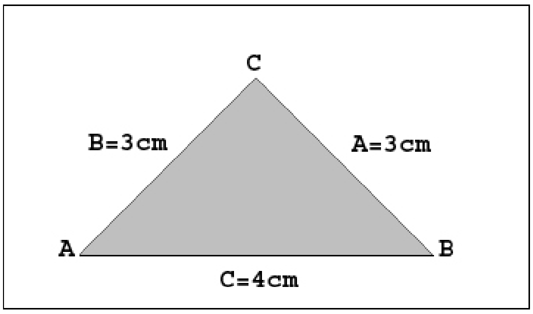
In the above figure, the distance between the two points, A and C, can be measured by using a thread. Because the line linking the two points together is not straightforward, we can put the thread on the beginning of point 'a' and extend it till it reaches point 'b'. After that, this part can be put on a ruler just to identify the length of it in centimeters and to know how long this distance is in reality. The actual distance in reality can be easily obtained by multiplying the distance measured in the above figure by the drawing scale on it.

An instructional activity that deals with the concept of "area" that can be performed is introduced as follows:

Introducing the definition: The label of the concept is introduced (the area), and the main features are clarified. Then, a definition of "area" is determined and written on the blackboard. The "area" is one of the mathematical concepts that are used in space geometry. It is a part the dimensions of which are specified and points are determined. Through its length and width, we can calculate its area, such as in a triangle. We can calculate the following triangle area by this formula [JAMES, 1999, p 2]:

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

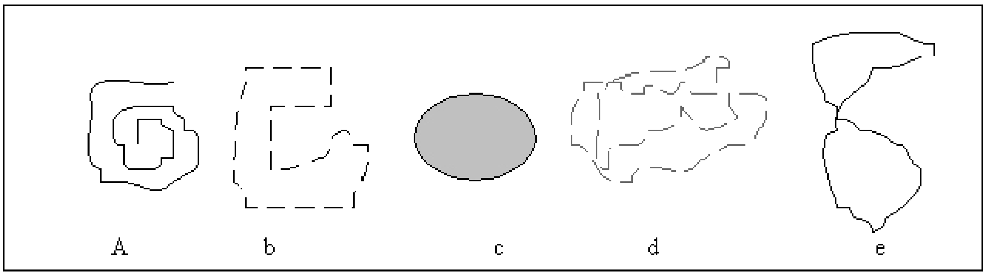
$$s = \frac{a+b+c}{2}$$



Through this formula, we can calculate the area depending on realizing the length of its straight lines. The teacher provides the relevant examples in addition to some incorrect examples to make the students differentiate between the concepts of area, size, etc…

Exercise:

The teacher asks the students to recognize the correct and incorrect examples without revealing the reason. Then, he demonstrates the most important relevant and irrelevant examples, such as the following figures:



The teacher collects the students' answers, records them on the blackboard, then he asks each student to write a definition of "area" in his own style and provide new examples of area on a sheet of paper.

The teacher illustrates how to measure different areas, whether these areas were in the form of a rectangular, a triangle, or any other geometric shape commonly found when measuring such areas.

An instructional activity dealing with the concept of "geographic position" can be performed as follows:

Introducing the definition: The teacher reveals to students the label of "geographical position", then he specifies the essential and secondary features of the concept. After that, the teacher identifies the "geographical position", and writes the definition on the blackboard. "Geographical position" is the place of any territory in relation to its neighbors. Through the previous concepts: "drawing scale, distance, and area", the geographical position can be determined accurately. The teacher demonstrates a group of examples of the concept, such as the natural map of the world on which he specifies the tropical territories and the like.

The teacher can teach these concepts using the following steps:

(1) *Location*: where a place is on earth can be described in absolute or relative terms

(1.a) Absolute location: the exact position on earth in which a place can be found. It is usually found by using imaginary lines that mark positions on the surface of the earth.

(a.1) Equator: circles the globe halfway between the North and South Poles

(a.2) Divides the world into two hemispheres a half of the earth,

(1.b) Creates the Northern Hemisphere (between the Equator and the North Pole) and the Southern Hemisphere (between the Equator and the South Pole) The North Pole is at 90°N and the South Pole is at 90°S. These poles are located at the end of the earth's axis, an imaginary line extending through the center of a sphere.

(2) *Lines of latitude* (parallels): they are imaginary lines that run parallel to the Equator

(2.a) Measure latitude: the distance a place is north or south of the Equator; measured in degrees from 0° to 90° north and from 0° to 90° south.

(3.b) Two special latitude lines mark the boundaries of the earth that receive the most direct sunlight and the greatest heat energy from the sun during the year.

(3.c) Measure longitude: The distance a place is east or west of the Prime Meridian; measured in degrees from 0° to 180° east, and 0° to 180 west.

(3.d) Prime Meridian: an imaginary line that runs through Greenwich, England at 0° longitude. It divides the earth into two hemispheres: the Eastern Hemisphere and the Western Hemisphere.

(3.e) Distance between meridians is greater at the Equator and decreases toward the poles. The global grid formed by lines of latitude and longitude crossing each other can be used to name the precise or absolute location of any place on earth. Every place has only one absolute location that never changes. To identify absolute location, list the latitude coordinates first, followed by the longitude coordinates: e.g. 40°N, 70°W. Each degree can be broken into minutes ('), and each minute can be broken into seconds ("): e.g. 40°41'22" N, 70°40'24" W.

(3.f) Relative location: the position of a place in relation to another place; every place has many relative locations, which can change over time.

Exercise:

The teacher encourages his students to perform a positive practicing process in the following way: He asks students to recognize the location of Egypt throughout a map of the Arab World and its neighboring countries, and then measure the distance between Egypt and Saudi Arabia and its equivalence in reality. He asks them to specify the concept accurately, and then collects their answers to record them. After that he asks each of them to do the task of determining the concept precisely in his own style. At the end of the lesson, the teacher reinforces the concepts and their skillful applications with the students using the worksheets administered to them with the lesson.

The teacher also explains the benefit of using drawing scales in specifying positions, and determining distances and areas on the map and what parallel to them in reality.

Lesson Two: Magnifying and Minimizing maps

Through the present lesson, the following concepts will be studied: scale, magnifying and minimizing, and locations. Through this lesson, we will also study how to magnifying; minimizing the maps and determine the different scales from magnifying and minimizing.

Objectives of the lesson:

By the end of the lesson, the students will be able to:

(1) Mention what is meant by magnifying and minimizing maps.
(2) Mention in their own style what is meant by the previously mentioned concepts.
(3) Specify the distinctive positive or negative example of each concept.
(4) Mention selected causes for the positive examples and the negative definition.
(5) Deduce mention for scale, magnifying, minimizing locations.
(6) Specify the scale for the maps after magnifying or minimizing.
(7) Design different magnifying and minimizing maps.
(8) Mention a definition in their own style for the concepts included in the lesson.
(9) Appreciate the importance of studying maps and its relation to other branches of knowledge.
(10) Develop the accuracy and speed of performance for the previous skills.

Instructional aids:

(a) Different physical maps of the world.
(b) Some guiding books and geographic encyclopedia.
(c) Graphic illustrations for demonstrating and applying concepts and skills.

Lesson activities:

(1) Establishing teamwork of the students to draw different maps and specify their drawing scales after magnifying and minimizing.
(2) Assigning some students to write a report about their ideas on plans and their types.
(3) Discussing the students' ideas of plans and their types.

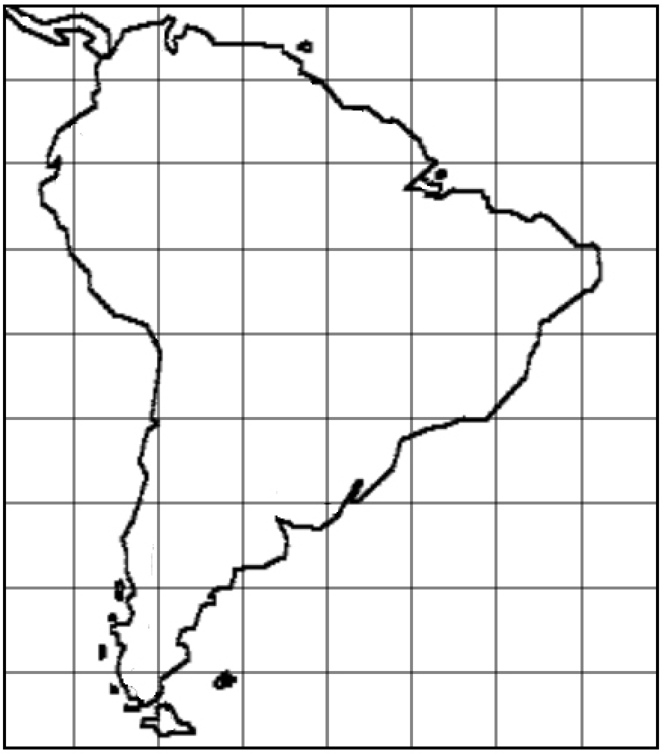
The lesson plan:

Preliminary representation: The teacher introduces a general idea about the lesson. He also reveals the mathematical concepts that will be taught and write their labels on the blackboard. For instance, this lesson concentrates on the concepts of scale, magnifying, minimizing, and locations.

An instructional activity: The teacher presents the label of “minimizing” as a mathematical concept that is used in order to show that magnifying is a change of the extreme frame and specifying information on the map from a state to another connecting it with the scale and comparing it with reality. He specifies the basic characteristics of the concept as well as the secondary ones, and then writes a report on the blackboard.

A demonstrative example: Reaching accurate results out of the map depends on the students’ abilities and their training on drawing maps and comparing them with reality. This technique includes two methods:

(1) *Squares method:* We can design a new map with minimizing by factor 4 like the following map:



Contemplating the above example, we can observe that when magnifying a map, the drawing scale will consequently change by the magnifying ratio used. This is apparent when we double-magnify a map whose drawing scale is 1:10000. In this case, the drawing scale of the new map will be 1:5000. This means that the drawing scale will be smaller before magnifying. The opposite occurs when we minify a map; the drawing scale will be greater before minifying.

(2) *Triangle method:* Apply the same methods previously methods used in the minimizing methods.

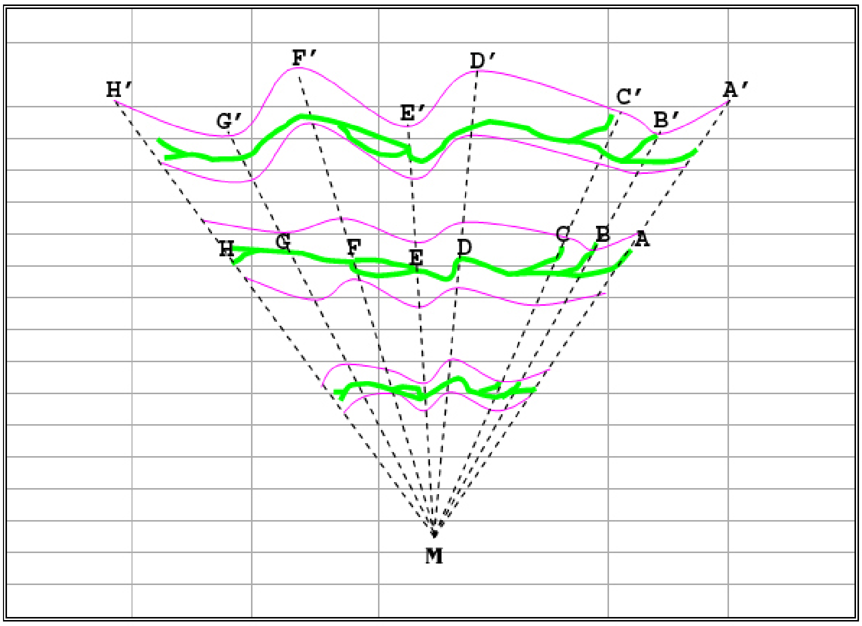
An instructional activity: The teacher reveals the label of the mathematical concept of "magnifying" which is refers to changing size and scale map from one figure to another without being limited to the figure which needs minimizing or magnifying. The teacher determines the basic characteristics of the concept as well as the secondary ones.

An applied example: In order to reach accurate results out of the map, this depends on the students' ability and training on drawing maps and comparing them to reality. This includes the following steps:

(1) *Square method:* For example magnifying the Australian map by factor 4 as in the following map:

1:88 million

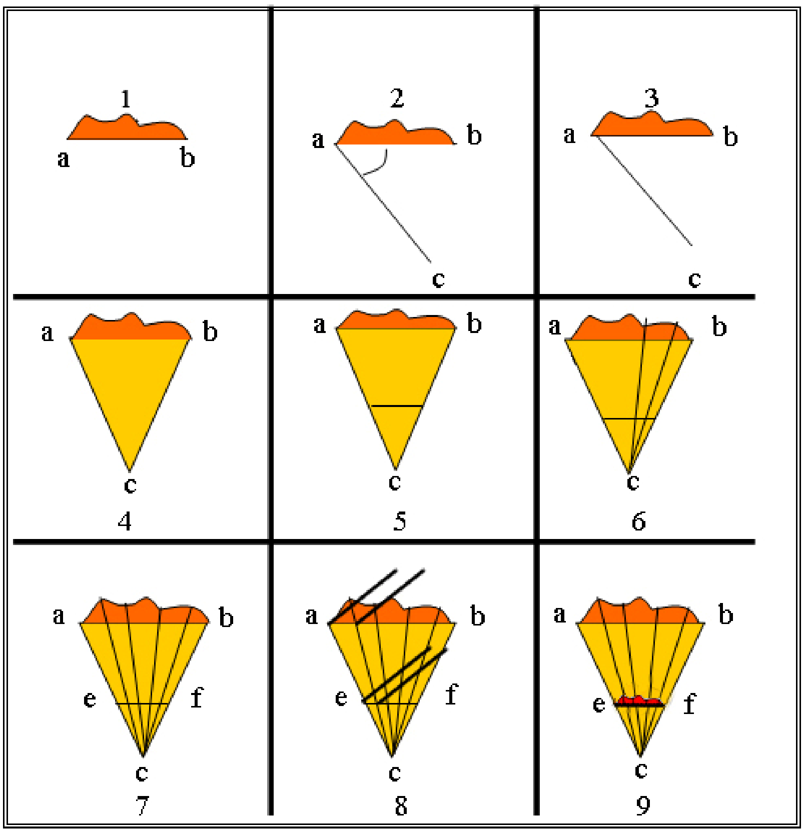
(2) *Triangles method:* According to the following example shown in the following figure:



- Determine the points A´, B´, C´,...etc, by given magnifying quotes or given minimizing quotes from $\overline{MA}$, $\overline{MB}$,......etc.
- Connect between the new points.
- Measure the distance between M and other points like in the previous figure. MA=10units. MB=9,1units. MC=9,6units. MD=8,5units. ME=9,4units. MF=9,1units. MG=9,1units. MH=9,8units.
- The equation: can obtain the magnification from the following [DAVID, 2005, p 3]:
- Calculate quote $= \dfrac{\overline{MA'}}{\overline{MA}}$
- Magnifying quote for area $= \left(\dfrac{\overline{MA'}}{\overline{MA}}\right)^2$

- When enlarging the area of a map by factor 3, the result becomes: MA′=17,3cm. MB′=15,7units. MC′=16,6units. MD′=16,9units. ME′=14,7units. MF′=16,2units. MG′=16,2units. MH′=15,7units.

Throughout the previous example and the figure below, scores obtained during maximizing or minimizing the figure can be clarified as in the figure below.



According to the previous examples, the teacher can mention similar examples of the other magnifying and minimizing maps; he also clarifies their effects on variance in addition to explaining the reasons behind this variance. Thus, the teacher can train the students at maps of the region in which they live.

Lesson Three: Specifying the astrological position

The concepts which are studied in this lesson include: the latitude and magnitude lines, direction, distance, time, parallel, and vertical. The skills implied in these concepts include applying the previously learned concepts in new educational situations, for example specifying directions and determine the latitude and scales on the maps.

Objectives of the lesson:

By the end of this lesson, it is expected that the students will be able to:

(1) Mention an accurate definition of the concept of latitude, scale, direction, distance, time, parallel, and vertical.
(2) Distinguish the different types of longitude and magnitude.
(3) Specify how the main directions can be determined.
(4) Draw latitude and magnitude on maps.
(5) Specify the time separating between longitude and magnitude.
(6) In his own style, a student is supposed to mention a definition of the concepts included in the lesson.
(7) Appreciate the importance of concepts and skills in studying geography and mathematics.
(8) Write a brief report about these concepts.
(9) Realize the value and importance of concepts and skills in contemporary daily life.

Instructional aids:

(1) Different physical maps of the world.
(2) Graphic illustrations for demonstrating and applying concepts and skills.
(3) Some guiding books and geographic encyclopedia.
(4) The school textbook.

Instructional activities:

(a) Drawing models for the earth from environment tools.
(b) Writing a mathematical geographical essay on the importance of specifying previous concepts and skills.
(c) Dividing students into groups to draw different concepts and skills.

Instructional methods: The teacher begins with students by questions method and teacher's methods.

Lesson plan: The teacher begins with a preliminary question reviewing the concepts of the previous lesson, and provides the appropriate reinforcement for good performance.

Preliminary introduction: In this introduction, the teacher discloses the main concepts in the lesson, writes their labels on the blackboard, and reads what has been mentioned (e.g. latitude or longitude) to stimulate the students' attention to the concepts of the lesson. Then, he receives students' answers to identify their background in this area and see their comments on them.

Definitions: The teacher provides a definition for each concept included I the lesson showing its implications and applications in the following way:

(1) Longitudinal lines: They are imaginary lines drawn on the map meeting in the North Pole and South Pole like a half circle intersecting with magnitude lines. There are 360

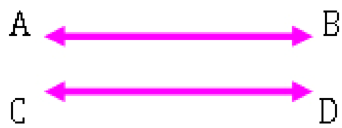
intervals of 1°. Their importance lies in identifying the time and the geographical locations.

(2) Latitudinal lines: They are imaginary lines drawn on the map matched to equator line (90°S to 90°N). There are 180 intervals of 1°. Their importance lies in identifying the geographical locations and lands climate.

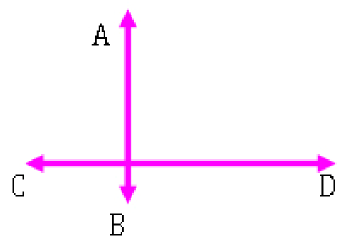
(3) Direction: It refers to determining locations or places from other places and determining the north geographical direction and the main directions which are north, south, west, and east.

(4) Time: The concept of "time" refers the time taken in performing or doing something or the time taken between two points or places.

(5) Parallel: Refers to the two lines that never meet together, like to this figure.

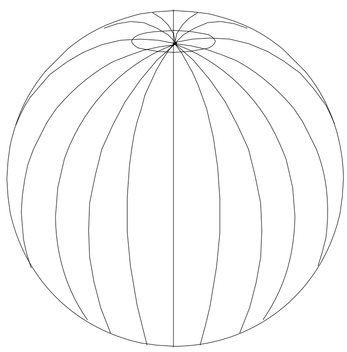


(6) Vertical: It refers to perpendicular level on the horizontal level; the result is a right or vertical angle, like in this figure



We can say that AB is parallel to CD in the first figure, but in the second figure AB is vertical to CD. The teacher presents a group of examples for the concepts and asks the students to mention their characteristics and meanings in the activity notebooks.

The skills implications of the lesson in how to draw the previously learned concepts: *First: the longitude:* There are many mathematical methods to draw longitude like in the following figure:



The longitude numbers are 360° and the measurements units are 1/360° each degree is divided into 60 minutes, and each minute is divided into 60° seconds; the distance between the lines at the equator is standard and the following table shows the longitude lines by kilometers or miles.

The degree	Miles	Kilometers
0	69,172	111,322
5	68,911	110,902
10	68,129	109,643
15	66,830	107,553
20	65,026	104,650
25	62,729	100,953
30	59,956	96,490
35	56,725	91,290
40	53,063	85,397
45	48,995	78,850
50	44,552	71,700
55	39,766	63,997
60	34,674	55,803
65	29,315	47,178
70	23,729	38,188
75	17,960	28,904
80	12,051	19,394
85	5,049	9,735
90		

We can say the following *example*? The location line for Al Madena Al Monawara in Saudi Arabia is 45°, what is the time in Al Madena Al Monawara in Saudi Arabia when the time in London is 7 h a.m.?

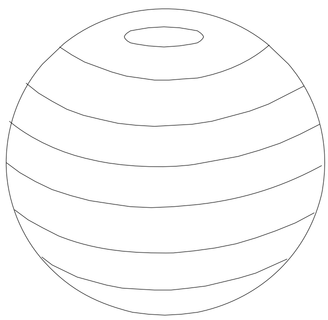
Answer: the difference between London and Al Madena Al Monawara in Saudi Arabia

= 45°· 4min/°=180 minutes

4 minutes means the time between two longitudes lines; So 180/60= 3hours.

So, the time in Al Madena Al Monawara in Saudi Arabia = 4 h a.m.

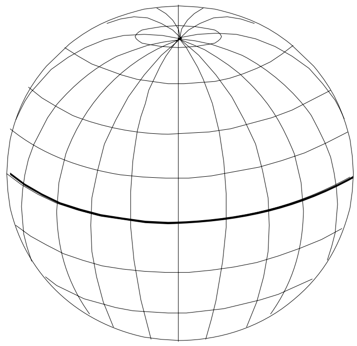
Second: the latitudes: The teacher presents definitions like the previously mentioned examples of the concepts, and then asks students what the meaning of latitude is, like in the following figure:



The distance between the Equator and the other latitude circles in the north or in the south of the Equator is 111 km (69 miles). The latitude lines are important to determine geographical locations and the distance between the Equator and another line, For example, the distance between Alexandria City and the equator line is 3885 km, what is the latitude degree?

Answer: the distance between the two latitudes degree is 111 km.

Thus we have 3885/111=35°



Three directions: time, parallel and vertical:

The teacher presents a group of examples for the concepts and asks the students to mention their characteristics and meanings in the activity notebooks. When applying these concepts to skills like directions, we can note this on the different maps, also we can note the time or parallel and vertical on the map from the sun rays in summer or winter, and the sun rays changing the vertical and the parallel of the equator and this will lead to a change in season.

Lesson Four: The Directions

The concepts studied in this lesson include: directions, the magnetic north, mathematical north, and geographical north. The skill implications of these concepts imply applying the previously learned concepts to new educational situations, such as specifying directions.

Objectives of the lesson:

At the end of this lesson, it is expected that the student will be able to:

(1) Mention an accurate definition of the concept of directions, the magnetic north, mathematical north, and the geographical north.
(2) Mention the characteristics of each concept included in this lesson.
(3) Determine the main directions.
(4) Draw a map and determine the main directions.
(5) Mention an accurate definition of the mathematical north concept.
(6) In his won style, students are supposed to mention a definition of the concepts included in the lesson.
(7) Appreciate the importance of concepts and skills studied in geography and mathematics.
(8) Write a brief report about these concepts.
(9) Determine the difference between the magnetic north and geographical north.
(10) Realize the value and importance of concepts and skills in contemporary daily life.

Instructional aids:

(a) Different natural maps of the world.
(b) Graphic illustrations for demonstrating and applying concepts and skills.
(c) Some guiding books and geographical encyclopedia.
(d) The school textbook.

Instructional activities:

(1) Drawing models for the earth using environmental tools and determining the direction on the earth.
(2) Writing a mathematical geographical essay about the importance of specifying the previous concepts and skills.
(3) Dividing students into groups, each one draws different concepts and skills.

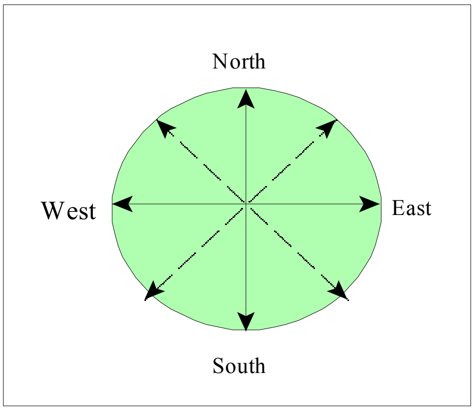
Lesson plan:

The teacher begins the lesson with a preliminary question, reviews the activity of the previous lesson, and provides the appropriate reinforcement of the good activity.

Preliminary introduction: In which the teacher reveals the main concepts in the lesson, writes their labels on the blackboard, and reads what was mentioned such as longitude or latitude to stimulate the students' attention to the concepts of the lesson.

Definitions: Throughout these definitions, the teacher provides a definition for each concept and its implications.

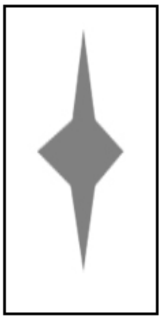
- *Direction:* Determining locations or places from other places through determining the north geographical direction, the main directions north, south, west, and east, or the sub-directions.



Kinds of directions:

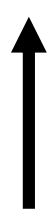
(1) The geographical north:

It is the north that is indicated by the North Pole and longitudes, and it is immovable because the two poles, the north and the south, are stable on the earth, and in the following figure:



(2) The magnetic north:

It is the north that is indicated by the free magnetic needle pointy toward the magnetic pole positioned in south of the island of "Somerset", and east of the island of "Prince of Wales", of the Arctic islands in the north of Canada on a longitude line 100 west. A line referring to direction like an arrow determines this position.



(3) Mathematical north:

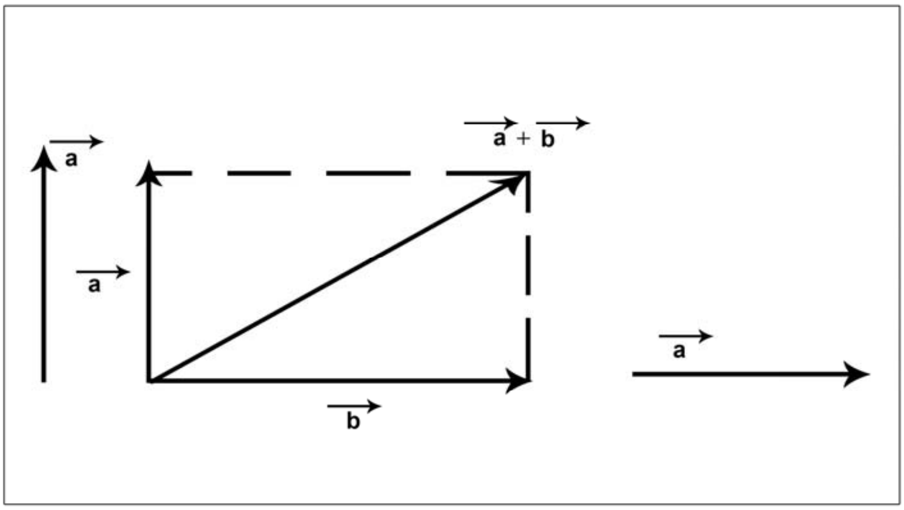
It is the north that parallels the middle longitude line of a certain system of maps e.g. Mercator. A straight line only symbolizes it. The degree of magnetic deviation varies from place to place on earth, and from time to time according to the position of the place in relation to the North Pole on one hand, and the magnetic Pole of the north on the other.

How can we use the latitudinal and longitudinal lines in order to specify directions?

This can be performed in cases where there are no arrows referring to the north on the map. Longitudinal lines are used to specify directions between the north and the south on the maps. The latitudinal lines are used to specify the directions between the east and the west on the maps.

What is the mathematical direction?

- Mathematical Vector is defined as a stable distance in a stable direction. It takes the symbol $\longrightarrow$ and takes the following mathematical forms:



-The mathematic directions have the same directions.

-We can gather two directions from the parallelogram periphery and we can use this to measure the area and geographical locations.

-The teacher presents a group of examples on the concepts and asks the students to mention their characteristics and meanings in the activity notebook.

Lesson Five: The Projections

Throughout the present lesson, the following concepts will be studied: plan, slope, project and direction. Through this lesson, we will also study how to make plans and how to use mathematical data in making a plan.

Objectives of the lesson:

By the end of the lesson, the student will be able to:

(1) Mention what is meant by a map plan, projection, curve, and slope.
(2) Mention in his own style what is meant by the previously mentioned concepts.
(3) Specify different curves and slopes on the map using equal proportion lines.
(4) Determine the direction of the map.
(5) Deduce the importance of using mathematical data and information from recognizing plans and their types.
(6) Appreciate the importance of studying mathematics with all its different sciences.
(7) Draw a map easily on a paper.
(8) Appreciate the importance of studying geography and its relation to other branches of knowledge.
(9) Write a report about the concepts of the lesson and their applicability in actual life.

Instructional aids:

(a) A group of different maps.
(b) The school atlas.
(c) Some books from the school library.
(d) Graphic illustrations for demonstrating and applying concepts and skills.

Lesson activities:

Establishing team works of the students to draw different maps and specify their drawing scales and assigning some students to write a report about their ideas on plans their types.

The lesson plan:

Preliminary representation: The teacher introduces a general idea about the lesson. He also reveals the mathematical concepts that will be taught, and write their labels on the blackboard. This lesson concentrates on the concepts of plan, slope, curve, and direction, parallel, perpendicular.

Instructional activity: The teacher reveals the label of the mathematical concept: “a plan” which is one of the mathematical concepts that are used in order to find the slope or tendency, or any dimension by the use of another. It is used in geography to recognize deviations and slopes of places and directions. The teacher specifies the essential characteristics and the secondary ones of the concept. Then, the teacher writes a report on the blackboard.

Essential Question: Why are all mapping projections distorted?

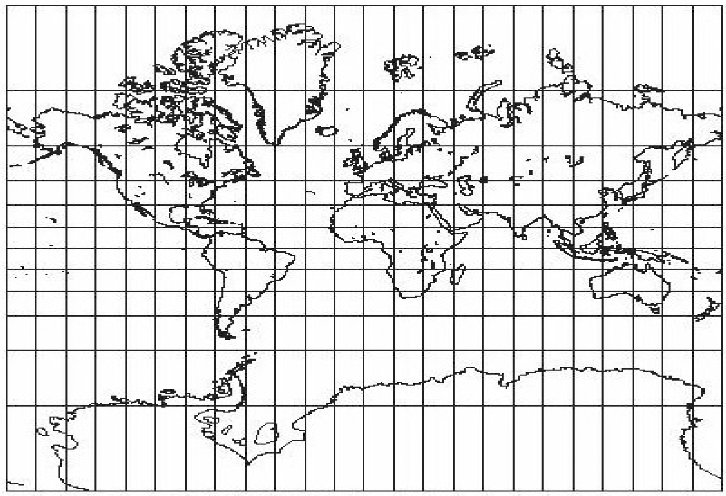
All maps distort the earth’s representation. They do not exactly show areas of the world. This occurs because of the difficulty of showing the earth's spherical (curved) surface on a flat map. Cartographers can take the information from a globe and flatten the surface of the earth. They use different map projections (ways of showing the round earth on a flat surface). However, size shape, and distance are distorted when curves become straight lines.

Essential Question: What are the ways in which specific projections are used to represent data?

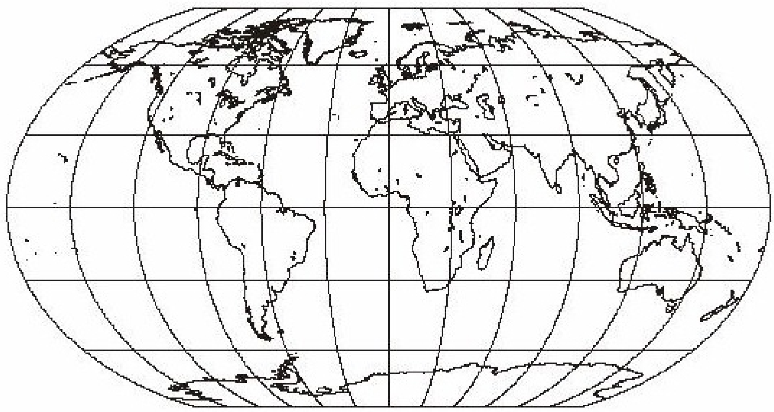
There are four basic aspects of the earth that can be distorted on maps. Mapmakers choose a projection to use depending on which of these map properties is the most important to the area being shown. No world map can have all those properties undistorted. Most maps show one of the properties accurately, but distort the others. In any map, distortion is generally less toward the centre of the map and greater at its edges. Different map projections are developed for different purposes.

1. Aspect of the earth which can be distorted:

1. Correct shape: Maps that do not distort shape are called conformal maps-shapes of land area conform to, or look like, the shapes on a globe.

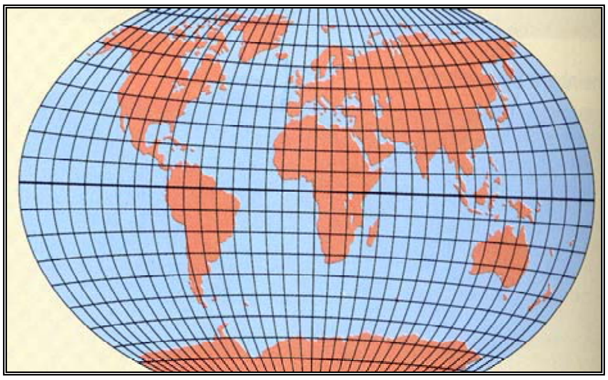


2. Correct size: Maps that not distort size as are called equal-area maps-show relative size correctly.



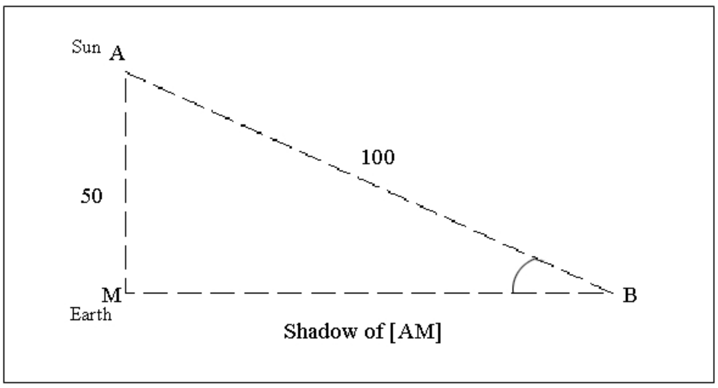
3. Correct distance: Maps that show correct distance are called equidistant maps.
4. Correct direction: Maps that show true compass direction area zimuthal maps-show the earth centered in such a way that a straight line from the center to any other point represents shortest distance.

2. Compromised projections have none of these properties and, therefore distort all of these aspects of the earth.



An applied example: In order to get accurate results out of the map, the map should be drawn on a plan for equal areas. This emphasizes the importance of plans in measuring areas of different figures like a triangle or rectangle according to the rules of area based on the drawing plan.

Example: Suppose that sunrays are 100 meters far from the point AB, and that the altitude of the sun from point 'm' represented in the earth is 50 meters far. Then, how can we measure the angle of sloping as illustrated in the figure below.



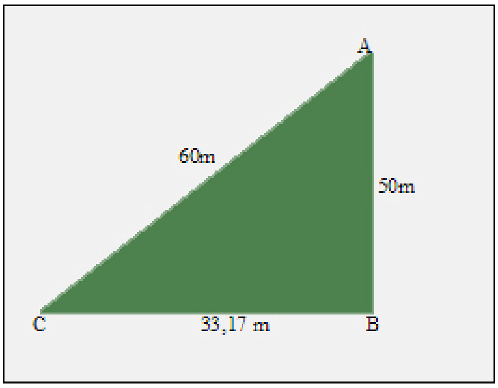
In order to calculate this, we hypothesize that the distance between A and B is 100 m. And the distance between A and the perpendicular center is 50 m; we can calculate the curve angle as follows:

$$(AB)^2 = (AM)^2 + (BM)^2$$
$$(100)^2 = (50)^2 + (BM)^2$$
$$BM^2 = \sqrt{(100)^2 - (50)^2}$$
$$\sqrt{10000 - 2500} = \sqrt{7500} = 86{,}6$$

-Through this, we find that the curve angle = arc tan $\frac{AM}{MB}$ = arc tan 0, 57

Thus, it is applicable to all other mathematical examples that are similar to slopes or curves in using plans. Among the types of plans or curves, then the teacher assigns each student to state a definition of the concept "plan" in his own style on a sheet of paper. He finishes the activity with assigning three of the students alternatively to introduce a new essay of the concept "plan" and provides reinforcement that is appropriate to the correct answer. An instructional activity deals with the concept of "slope" which is the degree of variance between the proportion points in the lines between the horizontal distance and the vertical separation line. Slopes have different types that will be dealt with in a separate lesson. The teacher deals with these four types in this lesson through classifying them. They can be measured as follows:

Example: In triangle ABC are AB = 50m, AC = 60 m, BC = 33.17m. When we need to calculate the inclination of a slope, we can do this throughout the following answer:



The inclination of slope $= \frac{AB}{BC}$

$= \frac{50}{33.17} = 1.51$. This means 1.51m/1m=151%

Concerning the concept of slope, the teacher provides a definition of it. Before he presents the definition, he gathers information from students about the concept of slope. It is a statistical form that demonstrates the relationship between quantities without being restricted to position. It indicates the variant geographical figures on the map through proportion lines like heights or through statistical tables which demonstrate the representation of different phenomena on maps like crops, and rain in a certain country. Then, the teacher asks the students about the concept and the congruent examples and the different ones. After that, each student is assigned to state a definition for the concept of slope. The teacher then reinforces the correct answers.

Concerning the concept of direction, parallel, and perpendicular, the teacher can ask the students about the meaning of these concepts in the previous lessons, and their applicability in the present lesson, in order to achieve cognitive communication among different concepts and their application in new instructional situations. Thus, the teacher can train the students to use numbers and mathematical data in making different kinds of a plan.

Lesson Six: Climate Maps

The concept of climate, weather, climatic territory, wind, rain, means, ratio, proportion, size, and mathematical processes are studied in this lesson. Concerning the applications, we have: the skill, the ability to calculate the means of temperature, or the means of pressure in certain places, in addition to the speed of wind or the rain scale.

Objectives of the lesson:

By the end of this lesson, it is expected that the students will be able to:

(1) Mention the definitions of the previously mentioned concepts.
(2) Specify the distinctive features of each concept.
(3) Clarify through drawing the climate territories on the world map and the types of wind.
(4) Justify in their own style a comparison between weather and climate.
(5) Recognize the way of calculating the means of pressure or temperature.
(6) Deduce the effect of relief phenomena on the climatic aspects.
(7) Realize the importance of the zone layer and the disadvantages that result from damaging it.
(8) Compare the different climatic phenomena according to climate components.
(9) Use the mathematical processes in distinguishing the means of temperature among different places.
(10) Write a report in their own style about climate and the importance of studying it.

Instructional aids:

(a) The atlas.
(b) Illustrations and mathematical graphs of climate forms.

The lesson plan: The teacher begins the lesson with a review of the activity performed in the previous period, and a representation of appropriate reinforcement for good activity.

Preliminary introduction: The teacher reveals the main concepts of the lesson, writes them on the blackboard, and read, the daily newspaper weather bulletin as a stimulus to direct the students' attention to the concept "climate". Then, he asks the students about the definition of each concept in order to recognize the scope of their information.

The teacher provides a definition for each of the following concepts:

- *Climate:* This means the atmosphere conditions, in a period of time such as a month, season, year, or years, concerning temperature, pressure, wind, rain, and humidity.
- *Climate region:* This is a region that is characterized by similar climate conditions.
- *Wind:* Is a movement of air that comes from places of high pressure to lower ones.
- *Barometric pressure:* Is a power of body movement on an area in which it moves. It is affected by temperature and speed. Wind is the movement of air blocks that is caused by temperature and the moving of pressure from higher-pressure regions into lower ones.
- *Percentage:* Is one of the mathematical concepts that is represented in the total scores multiplied in percent or the frequency of wind, pressure, temperature in relation to the total components.
- *Means:* They are among the arithmetic processes that are used in calculating the means of temperature. They are usually measured through the total scores divided by the frequency of these scores.

- *Proportion:* Is equality between two or more ratios such as the ratio between the earth and the sea.
- *Size:* Is part of a space occupied by a solid material whose form is not changing compared to liquids, for example.

The teacher presents a group of examples for the concepts and asks the students to mention their characteristics and meanings in the activity notebooks.

A positive activity of the learners:
The teacher mentions the gas covers or the layers of atmosphere which are:
(1) Troposphere.
(2) Stratosphere.
(3) Ionosphere.
The teacher mentions the elements of climate, which are:
- Temperature.
- Pressure.
- Wind.
- Rain.
- Humidity.

- Applicable examples can be provided in order to measure temperature in °C in a certain place: if the temperatures in Cairo during five successive days are 20, 22, 23, 26, 30°C, the means of temperature will be = $\frac{20+22+23+26+30}{5} = \frac{111}{5}$ = 22, 2.
- In ordinary conditions, the pressure is 1013 HPa. That equals a mercury column height is 76 cm. On a square cm, a person will find the mercury height equals 120 cm. if he enters a room for measuring pressure. On a square cm, the barometric pressure in this room will be $\frac{120}{76}$ · 1013 HPa = 1600 HPa [THE FREE ENCYCLOPAEDIA, 2003, Pp 1-3].

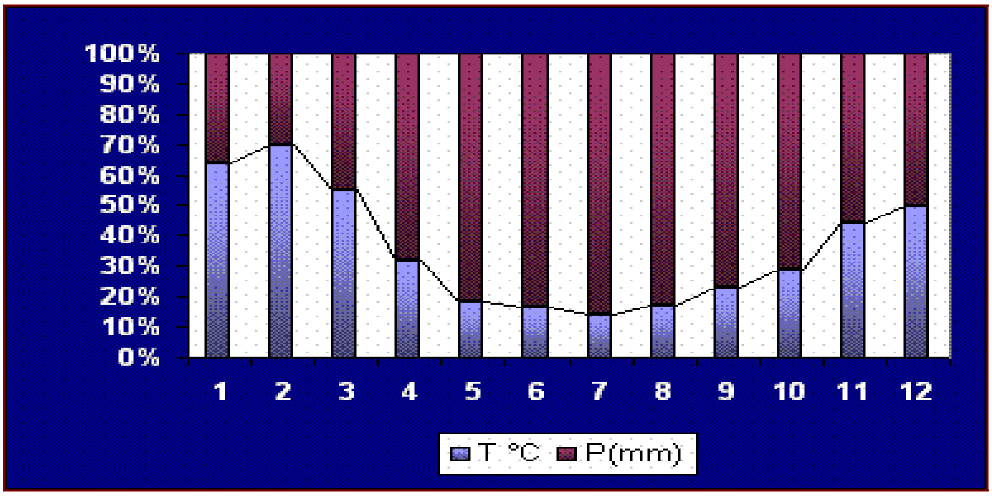
- According to the previous examples, the teacher mentions similar examples of the other climate components, he also clarifies for the students their effects on the variation of regions and climatic territories as it appears on map number, in addition to explaining the reasons behind this variance. Thus, the teacher can train the students on making climatic maps of the region in which they live.

The lesson activities:
- The students listen to a tape recorder of the daily weather bulletin.
- One of the students reads the weather forecast from the daily newspaper.
- Using the different maps of the world in the Atlas, the teacher and his students identify the different kinds of climatic cantons and the climatic differences between them, especially the climatic cantons in which the students live.

The teacher prepares a field trip to the nearest weather station in order to enable students to understand how to record and predict the wind and temperature.

Exercise: Using the following table and map that display the mean temperature and raining for a certain city throughout the months of the year, calculate the following:

	J	F	M	A	M	J	J	A	S	O	N	D
T °C	23	23	21	18	14	13	11	12	14	17	19	21
P(mm)	13	10	17	38	62	66	65	59	46	42	24	21
Location	Adelaide 35 °S											



(1) Total annual precipitation (add up all monthly figures).
(2) Mean monthly precipitation (total divided by 12 months).
(3) Maximum (heights) monthly temperature.
(4) Minimum (lowest) monthly temperature.
(5) Annual temperature range (max-min. temperature).
(6) Rainfall seasonality (summer max. =>60% of rainfall during the warmest 6 months; winter max, =>60% of rainfall during the coolest 6 months).

Lesson Seven: Regressions and Their Measurement

The concepts that are studied in this lesson include: the concept of slope, types of slope (concave, regular, moderate, severe, slight, convex), and measurement of slope. The skill implications on the previous concepts comprise the ability to calculate the degree of slope, distinguish its types, and draw slopes of different kinds of relief.

Objectives of the lesson:

By the end of this lesson, it is expected that students will be able to:

(1) Mention a definition of slope and its types.
(2) Specify the distinctive characteristics of each concept.
(3) Compare the different types of concepts.
(4) Use mathematical data to calculate the ratio of slope for different forms of relief, and its degree.
(5) Draw different forms of relief using the differences in slope degrees.
(6) Differentiate between the concave slope and the convex slope as mathematical forms.
(7) Find out the level of curve for these slopes.
(8) Draw concave and convex forms of relief by the use of mathematical instruments.
(9) On a map, draw figures to indicate the rate of slope of a certain hill, or mountain, and the like.

Instructional aids:

(a) Graphs and illustrations.
(b) Natural maps of the world.

Activity:

(1) The teacher divides the student group into team works in order to design some forms of relief.
(2) School atlas.
(3) Holding a workshop and dividing students into groups to draw different steepness shapes

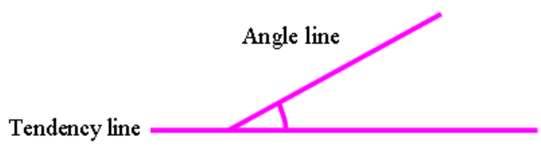
The lesson plan:

The teacher begins by reviewing the activity of the previous period and provides the appropriate reinforcement for good performance.

Preliminary introduction: The teacher reveals the main concepts of the lesson, writes their labels on the blackboard, and reads what was mentioned about the lesson, like commentaries or geographical phenomena in order to stimulate the students' attention towards the concepts included in the lesson. The teacher also receives the students' answers in order to recognize their information and comment on them.

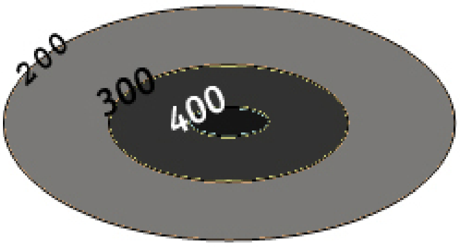
Definitions: The teacher defines each concept of the following:

- *Slope:* This is the angle that lies between tendency line and the angle line.

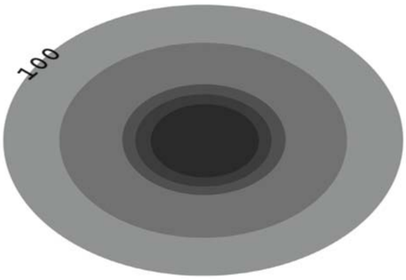


A slope is measured on a map according to the degree of closeness of contour lines.
There are many types of slope such as:

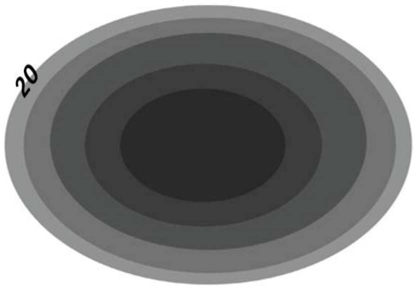
- *Gentle slope:* Where the contour lines are removed far from each other. In other words, the horizontal distances among contour lines are great compared to the vertical separator



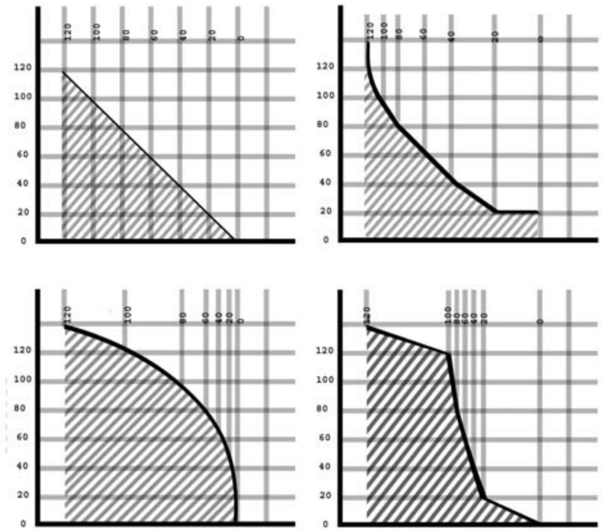
- *Severe slope:* Where the contour lines are very close to each other. In other words, the horizontal distances among contour lines are narrow compared to the vertical separator.
- *Moderate slope:* Which is a medium stage between the two previous kinds, where the relationship between the horizontal distance and the vertical separator is moderate.
- *Regular slope:* This is gentle or severe, in a regular tendency.
- *Concave slope:* That begins with a very severe slope at the top, then it comes smoother toward the base. This can be discovered through observing the closeness of contour lines at the top, in contrast to their position at the base.



- *Convex slope:* That begins with a slight slope at the top, then it becomes severe at the base, as it can be observed through contour lines.



A slope may combine more than one of the previous types in a single phenomenon, as in the following figure:



Measuring slope [David, 2005, Pp 1-5]*:*

Rate of slope = arc tan $\left(\dfrac{\text{Vertical separator}}{\text{Horizontal distance}}\right)$

The unit of measurement: It should be combined in each of the horizontal distance and the vertical separator.

- Degree of slope = arc tan $\left(\dfrac{\text{Vertical separator}}{\text{Horizontal distance}}\right)$

- The horizontal distance = arc tan $\left(\dfrac{\text{Vertical separator}}{\text{Degree of slope}}\right)$

- Vertical separator = Horizontal distance · tan (degree of slope)

Through measurement, we can calculate the rates of slope in mathematical figures according to what was previously mentioned.

Lesson Eight: Geological Sectors and Relief Sectors

This lesson is concerned with specifying the shape of relief and calculating the different degrees of regression among places. The concepts that are studied in this lesson include: the sector and its types (serial, sectional, inter-valleys, longitudinal, interrelated, panoramic, and moving). The skill implications of these concepts comprise the ability to use mathematical data and numbers to draw a relief sector, and distinguish types of sectors.

Objectives of the lesson:

By the end of this lesson, it is expected that the student will be able to:

(1) Mention an accurate definition of the concept of sector.
(2) Distinguish the different types of sectors (longitudinal and cross-sectional).
(3) Define the serial and interrelated types of sectors.
(4) Draw a relief sector.
(5) Distinguish panoramic and compound sectors.
(6) Write a brief report about these sectors.
(7) Appreciate the importance of relief sectors in studying geography and mathematics.
(8) Draw a relief sector using mathematical instruments.
(9) Specify the vertical and horizontal separators in drawing sectors.

Instructional aids:

1. Different natural maps of the world.
2. Graphs and illustrations.
3. Some guiding books and geographic encyclopedia.

Instructional activities:

1. Drawing maps representing the forms of different relief sectors.
2. Writing a mathematical geographical essay about the importance of specifying sectors.
3. Collecting some pictures of different regions to demonstrate the forms of sectors.
4. Dividing groups of students to draw different relief sectors.

Lesson plan:

The teacher begins with a preliminary question, reviews the activity of the previous period, and provides the appropriate reinforcement of the good performance.

Preliminary introduction: The teacher shows the main concepts in the lesson, writes their labels on the blackboard, and reads what has been mentioned, such as commentaries and geographical phenomena, to stimulate the students' attention towards the concepts included in the lesson. The teacher receives the students' answers to recognize information and comment on them.

The teacher provides a definition for each concept and their implications.

- *Sector:* One of the mathematical concepts that are used in geography since it is part of a phenomenon representing distinctive relief features like valleys, and heights. Sectors have many kinds such as:
- *Sequential sectors:* Drawing a group of ordinary sectors to indicate the main changes in a region distinguished by a valley; for example, series of sectors are established and if they are drawn from the beginning to the end, the first figure appears, and the bottom of the valley changes to affect appearance due to environmental factors combining them in a single graph.

- *Cross-sectional sectors of river valleys:* Where the sectors are drawn perpendicular to these valleys. Thus, we can draw a cross-sectional sector of the upper river valley, a second sector of the middle valley, and a third sector of the lower valley. Then, these three sectors help us study the environmental factors affecting the river, and recognize the stages distinguishing the river life.
- *Sectors representing intra-valleys lands:* They are relief sectors of dividing water drawn above each other or demonstrating each sector according to its position on the map. Thus, the sectors are arranged like a valley or a natural region. They are plain, slope, or successively renewed.
- *Interrelated sectors:* In which cross-sectional and longitudinal sections are drawn together according to their position on the map. They provide a depiction of the relationship between the earth and the base levels. They can be explained correctly if they are combined with geological formations.
- *Panoramic sectors:* Refers to drawing a group of sectors in different angles. The sector varies according to the angle of vision.
- *Compound sectors:* They are sectors that demonstrate the surface of earth as if man watches it from a very distant point.

The skill Implications of the lesson in how to draw a relief sector:

There are many mathematical methods to draw sectors that vary according to the kinds of sectors. Throughout the following example which shows in drawing how to draw a sector of a geographical phenomenon following these steps:

(1) Determining the part for which we want to draw a sector it by drawing a straightforward line linking between all the parts of the portion we want to draw. This is evident in figure (1).

(2) Determining the drawing scale of the portion we want to draw as well as the vertical and horizontal splitters.

(3) Draw a horizontal line that is parallel to the sector line as a base of the desired sector.

(4) Draw columns on the sector base from the points where the line AB intersects with contour lines. Then, we write the value of the contour line under each column.

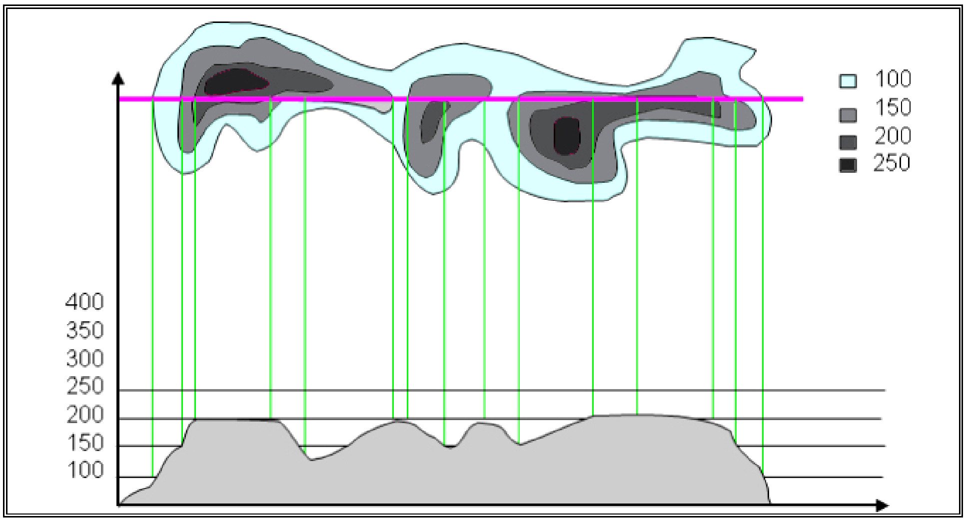
(5) Draw a vertical axis on the base of the sector, on which we specify the height of the sector segments. Thus, we have two axes, a horizontal axis, which is the sector line, and a vertical one on which heights are specified.

(6) Select the appropriate drawing scale for the heights.

(7) Relate the points that were specified on the length of columns with a curve.

(8) Delete the columns made from the contour map to get the maximum form of the sector.

Figure (1)



Throughout the previous steps and figure, sectors of different kinds can be drawn and their drawing scales can be obtained through the vertical interlude. Also, through this, differences between heights that the sector includes throughout its contour lines can be determined easily and smoothly.

Lesson Nine: Using Degrees in Graphic Designs

The concepts that will be studied in this lesson include the graphic line, graphic columns, graphic circles, graphic pyramid, graphic rectangles, graphic triangle, mathematical axes, and divided circles. The skill implications include the way of designing the previous concepts in the form of graphs, statistical tables, and diverting quantitative numbers into graphs on the map.

Objectives of the lesson:

By the end of the lesson, it is expected that the students will be able to:

(1) Recognize what is meant by statistical figures and graphic lines.
(2) Recognize the relationship between quantitative numbers and their representation on graphic maps.
(3) Distinguish graphic as a pyramid and a graphic triangle.
(4) Draw the different graphic forms using statistical data and tables.
(5) Mention a definition in their own style of the concepts included in the lesson.
(6) Design different statistical maps.
(7) Realize the importance of statistical figures in recording different phenomena.
(8) Distribute phenomena in the form of divided circles, and graphic triangles.
(9) Draw mathematical axes easily and accurately.
(10) Write a brief report about graphs and statistical figures.

Instructional aids:

(a) Different graphs.
(b) Economic maps and population maps.
(c) The school textbook.
(d) Reports about some population phenomena in graphic forms.

Instructional activities:

(1) The teacher divides the students into small working teams in order to draw the different forms of graphs.
(2) He writes a report about statistical tables and their importance in graphs.
(3) He conducts a trip to economical institutions and recognizes the rates of their development through numbers and data.

The lesson plan: The teacher begins by asking the students a preliminary question to get an idea about their background information and to attract their attention.

Preliminary introduction: In this introduction the teacher reveals the main concepts of the lesson, writes their labels on the blackboard, and reads what is written in the newspapers about topics related to graphs.

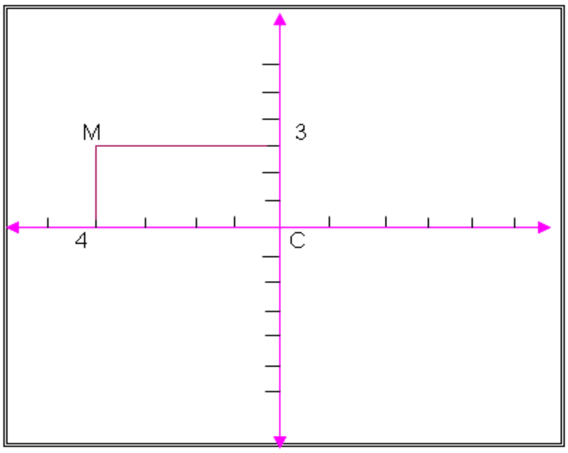
The teacher provides a definition for each concept and its skill implication as follows:

(1) Statistical figures: They refer to diverting quantitative numbers about a certain phenomenon into a graph that varies in design according to whether it is a column or a curve, and so on.

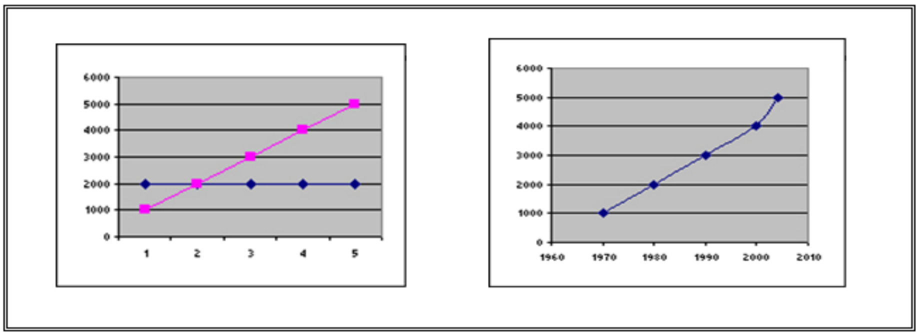
(2) Mathematical axes: They are two straight orthogonal lines; one of them is horizontal while the other is vertical intersecting orthogonally with the horizontal coordinate. Then we determine the measurement units by a compass or in centimeters on each coordinate dividing it into equal parts. Coordinates can be classified into either

positive or negative the purpose of which is to show the numeric value of the variable within a certain period of time. These values can be either proportional or absolute.

How to specify a certain point on these axes? We have to know the point distance from the origin point and its direction.



(3) Graphic lines and curves: They are statistical forms indicating the relationship between quantities regardless of their position. They are represented in points connected through straight lines. The resulting figure is called a frequency diagram or a frequency curve. This is useful in comparing different phenomena of many types as represented by the following figures:



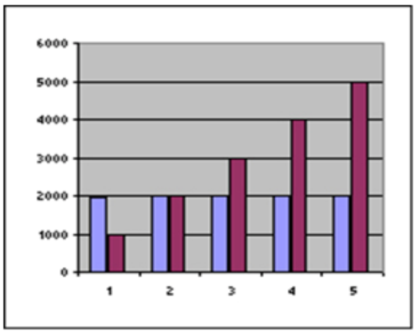
(4) Graphic circles: They are used to represent the division of the total circle angles (360˚) in proportion to the quantities of data. They are calculated as follows:

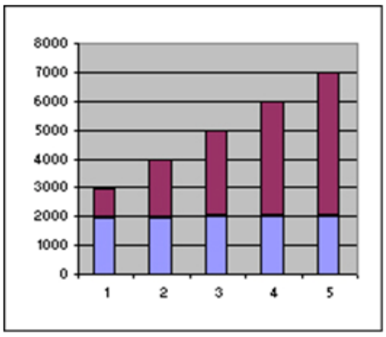
$$\text{Central angle} \bullet \frac{\text{One of the values}}{\text{Total values}} = \text{sector angle}$$

Represented by this value, the central angle equals (180˚) when it represents a semicircle, whereas it equals (90˚) when it represents a quarter of a circle. We have the divided circles in which it is necessary to find the percentage of each phenomenon and multiply the ratio in (3.6) in order to find the central angle.

(5) Graphic columns: They are geometrical figures whose lengths are used to represent statistical data, and these lengths are proportioned to the quantity represented. The thickness of these columns is usually equal and the main purpose of them is to indicate the numerical values of a certain variable during a certain period of time.

These values may be absolute or relative, represented in the form of individual graphic columns, or dual ones, and in addition to the divided and segmented types as the following figures indicate:



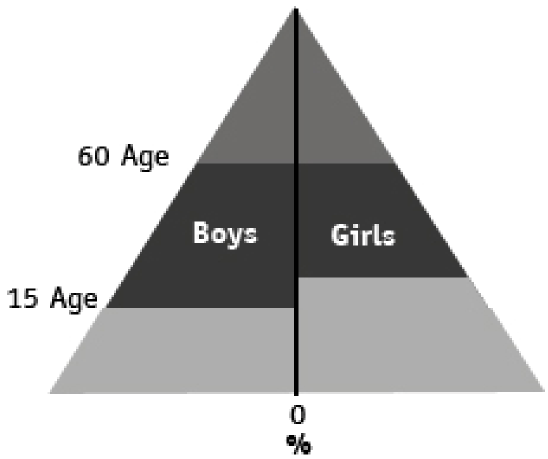


Raw scores or different data can be indicated on data columns through displaying data or scores on these columns in such a way that shows each value independently or a set of values within a column. This was evident in the above figure in which values were displayed, either by comparing between each of the values, or by displaying two phenomena together within the same column.

(6) The demographic pyramid: It demonstrates features of a certain population composed of males and females and specifies its productive categories that shoulder the responsibility of earning the living for the other. It is a product of the factors that influence population growth such as birth and death cases and immigration. Its main types are as follows:

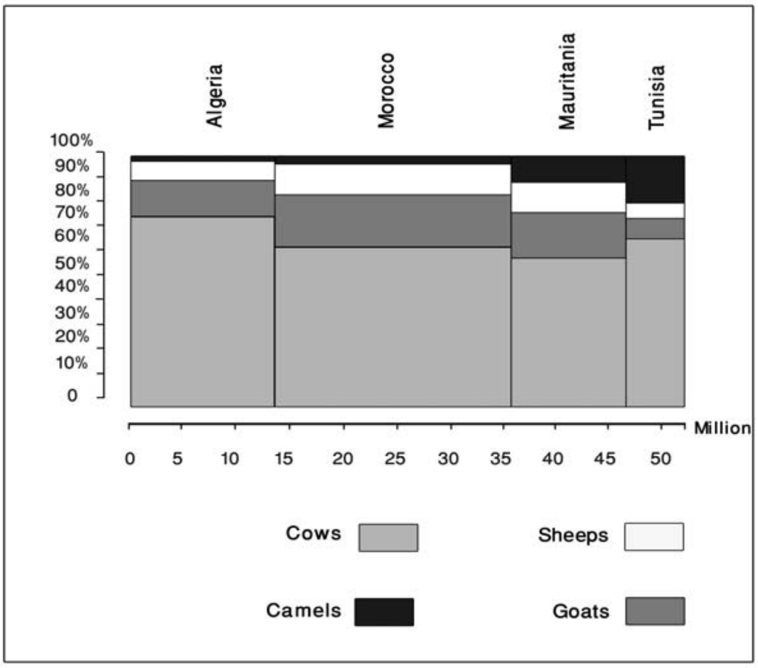
The wide-base pyramid having slightly sloping sides toward the top
The narrow-base pyramid with convex top
The medium-base pyramid

(7) The graphic triangle: Its three sides can be used to indicate age categories: the young people, middle-aged and the old people respectively.



The above figure displayed a population pyramid for one of the countries on a data triangle that shows comparison between the different age categories. There are many examples and data triangles figures through which different types of

(8) *The divided rectangles:* They are used to represent the components of a single phenomenon or several phenomena in a comparison. This is done through drawing them inside the rectangle where each part of the phenomenon is represented by part of the rectangle according to its proportion in relation to the total parts, as appears in the following figure:



(9) *Frequency statistical graphic figures:* They represent phenomena in frequency distribution tables through frequency quadrangle, gradient, or curve.

The teacher presents some positive and negative to demonstrate the difference between the types to reach the evaluation stage.

Lesson Ten: Air-photography Maps

The geographical mathematical concepts include: air-photography, perpendicular, tendency, focal distance, and height. The geographical mathematical skills include: specifying the drawing scale of air-photography map, calculating the height ratio of air-photography, designing air-photography maps.

Objectives of the lesson:

By the end of this lesson, the students will be able to:

(1) Recognize the concepts of air-photography, perpendicular air-photography, tendency, height, and focal distance.
(2) Specify the distinctive features of each of the previous concepts.
(3) Apply the geographical mathematical concepts of specifying the drawing scale of air-photography map.
(4) Draw scale of air-photographs, and calculate the ratio of height of photography through the drawing scale and the focal distance.
(5) Make maps for different project sites like dams through air-photography.
(6) Realize the value and importance of air-photography to contemporary daily life.
(7) Design maps accurately and precisely through specifying the main dimensions by using air-photography.
(8) Recognize the way of performing air-photography.
(9) Distinguish between the perpendicular, tendencies, high tendency air-photography, position air-photographs through the relevant equipments.
(10) Write a brief report about air-photography and its importance.

Instructional aids:

(1) Telescopes designed for air-photography.
(2) Pictures and pamphlets about air-photography.
(3) Science laboratories and educational films about air-photography.
(4) The world map.

Instructional activities:

(1) A visit to one of the museums or centres specialized in air-photography.
(2) Dividing students into working teams for specifying and designing air-photography maps.
(3) Writing reports about the importance of air-photography to contemporary life.

Lesson plan:

Preliminary introduction: The teacher provides a general idea about the lesson through which he reveals to the students the mathematical concepts and skills to be taught and writes the label of each concept on the blackboard. The teacher concentrates on mathematical concepts such as perpendicular air-photography, height, and focal distance. Then, he asks the students about previous information, moving to skill and performance application.

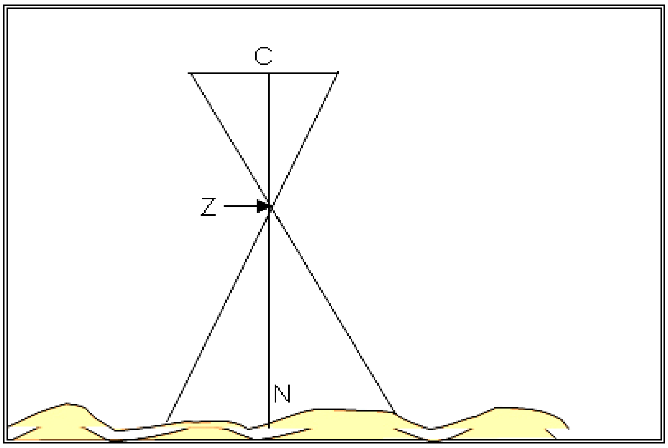
Instructional activity: In which the teacher reveals the concept air-photography, which is a science dealing with interpretation of phenomena, and designing different types of maps leading to speed in achievement, in addition to overcoming bad natural conditions, such as different climate factors and geographic relief.

Categories of air-photography:

- *Perpendicular air-photograph:* That is taken when the axis of the camera is perpendicular or near perpendicular. It is rare to have a completely perpendicular photograph due to several factors. The tendency angle in such photographs should not exceed (+ 3). They are exploited in survey works.

- *Leaning air-photograph:* That is taken when the camera axis is leaning compared to the perpendicular position. The air-photographs are considered central plans, whereas maps are represented in perpendicular plans. The drawing scale of the air-photograph varies according to the degree of tendency or leaning.

- *Focal distance:* The distance between the focusing centre and picture surface. It is useful in determining the drawing scale of a picture, and in the process of internal direction, since the drawing scale of an air-photograph is the ratio between the focal distance and the air height. The following figure indicates the plane height (Z), the main distance (C), and the scale (S).



So, the scale = $\frac{\overline{CZ}}{\overline{ZN}}$

The scale of the air-photograph can also be found without resorting to the plane height and the main distance if we manage to measure the distance between two known points on both the picture and earth. The result of dividing the distance on the air-photograph between these two points on the distance between them on earth will give the desired scale.

Example: If the distance on the air-photograph is 4 cm. and the distance between the same two points in reality is 400 meters, the scale of air- photograph will be:

$$\frac{\text{The distance on the photograph}}{\text{The distance on earth}} = \frac{4\text{cm}}{100.400\text{cm}} = \frac{1}{1000}$$

Example:

Find the drawing scale of the air-photograph, if the focal distance of the photography lens was 150 mm, and the plane height was 5000 meters above sea level, and the mean of earth surface level (relief is plain) ≈ 500 meters.

The scale of the air-photograph = $\frac{1500\text{cm}}{5000\text{m} - 500\text{m}} = \frac{15\text{cm}}{4500\text{m}} = \frac{1}{300}$

However, photography is performed merely by the eyes, and this is varied due to the difference between the vision of the right and the left eye by the eye nerves that move the pictures to the brain that makes the two visions a single embodied picture. There are also several sophisticated equipments that are used in making air-photographs.

The steps of conducting on air-survey: This is done through designing an air-map which is plane with a height and its precautions, in addition to the periods of photography. At the end of the lesson, the teacher reinforces the concepts and their skilful applications with students through the final evaluation of the lesson.

According to what was previously mentioned, the teacher explains how to take air-photographs, then he collects the answers from the students and writes them on the blackboard.

Lesson Eleven: The Contour Maps and Their Types

The geographical mathematical concepts that are included in this lesson: contour line, contour separator, height, proportion, and reduction. The geographical mathematical skills are designing contour maps and specifying geographical figures through contour lines.

Objectives of the lesson:

By the end of this lesson, the students are expected to be able to:

(1) Recognize the concepts: contour line, contour separator, slopes, and heights.
(2) Specify the distinctive features of each of the previous concepts.
(3) Apply the concepts that are included in the lesson to designing contour maps.
(4) Use geometrical instruments in drawing contour sectors for geographical figures.
(5) Design geographical figures through the counter lines.
(6) Appreciate the importance of recognizing the height lines through studying them to clarify geographical figures.
(7) Draw contour lines in a way that indicates different geographical figures.
(8) Write a definition in their own style for the types of concepts and skills that are included in the lesson.
(9) Compare the different geographical positions on the map through the equal height lines.
(10) Write a report in their own style about the contour lines.

Instructional aids:

(a) Drawings and illustrations.
(b) A group of pictures for some geographical phenomena.
(c) Natural world maps.
(d) The school textbook.
(e) Some geographical books from the school library.

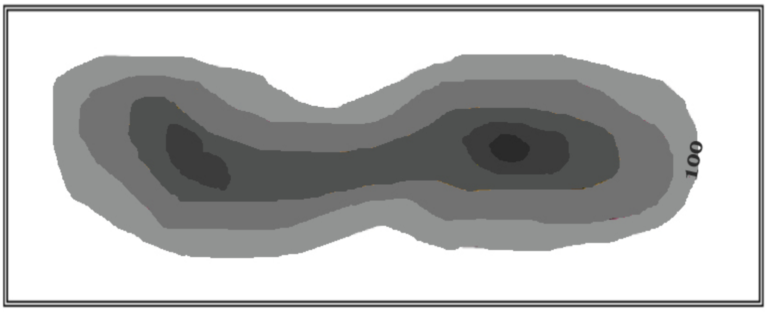
Lesson activities:

(1) The teacher assigns the design of some geographical figures to students through the contour maps.
(2) The teacher assigns students to make contour maps.

The lesson plan:

Preliminary introduction: The teacher provides a general idea about the lesson, and reveals to the learners the geographical mathematical concepts and skills that will be taught. Then, he writes the label of each skill and concept on the blackboard. The lesson concentrates on these concepts and the teacher asks the students about their previous information about these concepts.

An instructional activity: The teacher defines the concept “contour line” indicating that it means the equal height lines which are drawn on the map, but have no real existences. They are determined by horizontal surfaces which have equal spaces between each others. Each intersection between the flat surface and the elevated or high surface represents the determined heights in the horizontal surface. When the external borders of a figure are drawn within each intersection between the horizontal surface, we obtain the contour map as follows:



- *Proportion points:* They are the first stage of drawing contour lines after specifying heights and points of proportion. We examine them to recognize the highest and the lowest lines in order to associate the number of contour lines and the relief scope that they represent on the map. The proportion is usually positive. Thus, the contour lines number should not increase without a similar increase in the density of proportion points on the map.

- *Contour separator:* It is the second vertical distance between contour lines since the lines provide a correct idea about the nature of the earth. However, they do not provide information about the nature of composition of the earth surface. It is specified according to the nature of the earth and the drawing scale.

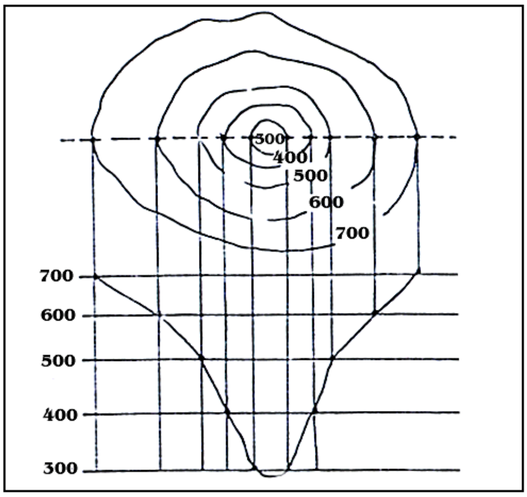
The features of contour lines that make a contour map:
A training activity:

(1) The contour lines are drawn towards the wellsprings of rivers in the region. In this way, the contour map can be drawn precisely including wellsprings.
(2) The high or low points on the contour line compared to the points positioned on the neighboring contour lines refer to the second vertical distance. The shorter the distance, the higher the tendency will be and vice versa. The direction of this tendency at any point is located in a perpendicular way on the contour line.
(3) The closeness of contour lines indicates the severe slope and vice versa. The form of contour lines helps to specify the types of slopes on the earth surface through studying the relationship between the vertical separator and the horizontal distance.
(4) All contour lines are endless closed lines.
(5) Contour lines do not intersect except in the case of having a slope whose angle is more than a degree with a shape that resembles a cave

Question: what are the types of contour lines?

The contour lines are divided into distinctive contour lines that are drawn in a single thickness with a single vertical separator, chief contour lines, moderate and simplified ones, etc.

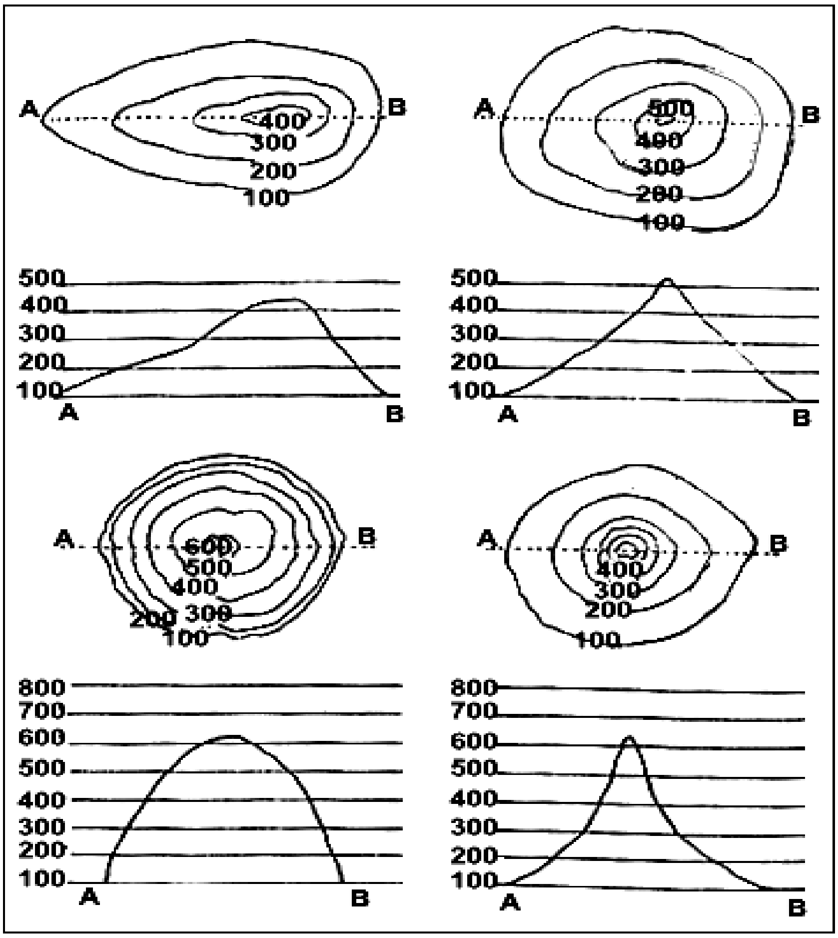
A training activity: Through the following figure, students become able to draw or recognize the figure on the page and the way to demonstrate the relief figure



Analysis of the figure shows a hill whose sides are in the form of a concave slope that begins slightly at the base, and then increases in height points till the hill ends with a severe slope on the top. This can be realized through the map depending on the closeness of contour lines.

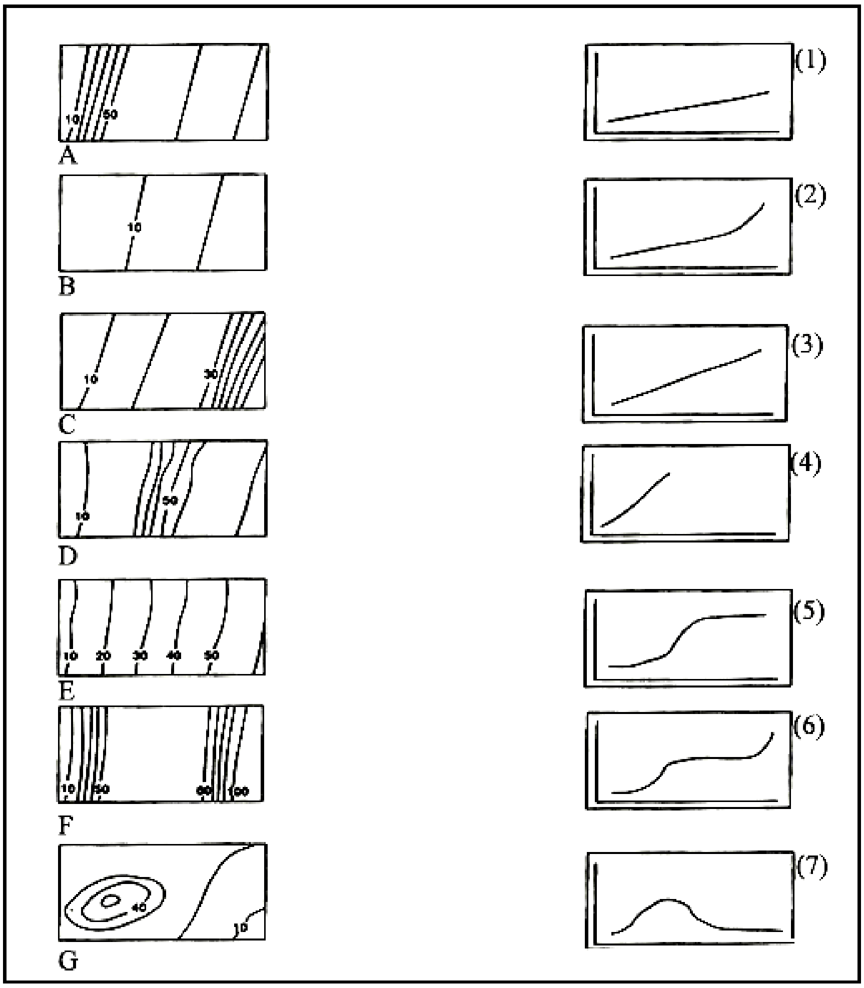
Question: What are the geographical figures that are demonstrated by contour lines?

The teacher provides a group of examples through drawing such as a cone hill, a mountain, and other figures.



Exercise:

Match the contour patterns (A-G) with the land surface shapes (1-7). Write the numbers next to the letter.



Lesson Twelve: Similarity between Mathematical figures and Geographical phenomena

The concepts that are included in this lesson are the mountain the knoll, the hill, the valley, the plain, the prominence, a circle, a triangle, a rectangle, a cube, a parallelogram, a cone, and other geometrical figures. The geographical mathematical skills include the method of explaining similarity and analogy between geographical and mathematical concepts, and the method of calculating the area of each of the previously mentioned concepts.

Objectives of the lesson:

By the end of this lesson, students are expected to be able to:

(1) Mention a precise definition of each of the previous concepts.
(2) Specify the descriptions and distinctive features of each of the previous concepts.
(3) Apply these concepts to new life situations.
(4) Calculate the area of the previous concepts and specify them precisely.
(5) Draw the figures of triangle, circles, rectangles, and other mathematical figures.
(6) Compare the shapes of mountains, triangles, and the like.
(7) Connect the concepts and skills that are included in this lesson to those in the previous lessons.
(8) Mention an example in their own style dealing with the importance of these concepts and skills.
(9) Appreciate the importance of recognizing figures and illustrations in demonstrating different phenomena.

Instructional aids:

(a) Using geometrical mathematical instruments.
(b) Natural maps of the world.
(c) Graphs, pictures, and guiding books.
(d) The school textbook.

Instructional activities:

(1) The teacher divides the study group into team work in order to design geometrical figures and their geographic counterparts.
(2) Conducting a mini- plan in which each student mentions the name of one of the lesson concepts, specifying its geometrical significance and the way of designing it.

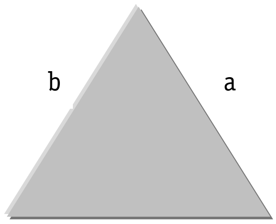
The lesson plan:

Preliminary introduction: In this introduction, the teacher poses review questions related to the previous lesson relating the previous topics to the coming ones. The teacher concentrates on the concepts and skills that are included in the lesson. He provides a definition to each concept and skill. Then, he writes them on the blackboard, asking students about what goes on in their minds concerning these definitions and concepts.

An instructional activity: The teacher introduces the following definitions of some geographical figures:

- *A Mountain:* Is a high region with long and severe slop that connect high peaks with deep valleys.

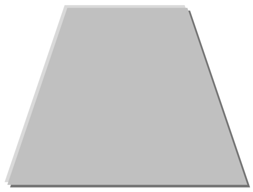
Question: What is the geometrical figure that resembles a mountain?
The answer: The Mountain is similar to a triangle. The area of a triangle can be calculated according to its type as follows:



The triangle: Its area $= \frac{1}{2} \cdot$ (the base · the height). The area of the triangle whose three lines a, b, c are known [JAMES, 1999, p 2]: $\sqrt{s(s-a)(s-b)(s-c)}$

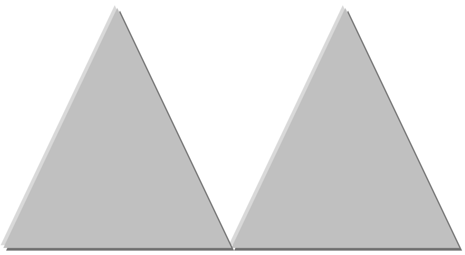
Where S $= \dfrac{a+b+c}{2}$

- *The knoll:* It refers to an elevated high region (but not as high as a mountain) with a flat equable peak. Using contour lines, it can be drawn as lines close in the edge with no complication in the peak. It sometimes takes the following shape:



- *The hill:* It takes many forms like a dome or cone, etc.

- *The valley:* It is a low piece of land that goes in a certain direction according to the river path. Thus, the lines are represented in the form of regressive curves into the river origins. It may be positioned between two mountains, like two triangles.



- *Prominence:* It is the prominent part in the side of a hill or mountain that appears on the map in the frame of a high land part that is similar to a triangle, a hexagon, or a pentagon.
- *Island:* It is one of the geographical phenomena that resemble a rectangle or irregular geometrical figure, like a hexagon, or pentagon and the like.

The teacher asks his students the following question:

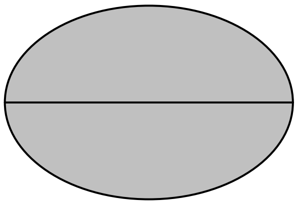
(1) If the length of the circumference of the earth pole is 24950 miles, how can you estimate this in kilometers? (The teacher tries to know the correct answer from the students before he shows it to them).

Note: This is an example of the approximation concept, the distance between the centre of the circle and any point on its circumference is:

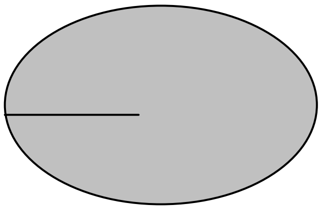
a. the diameter.
b. the circumference.
c. half the circumference.
d. half the diameter).

The answer is half the diameter.

(2) Through your knowledge of the earth dimensions such as, the equator, a diameter is: "The straight line connecting any two points on the circle circumference passing in the centre".



(3) The straight line coming from the centre of the circle into any point on it is called "half diameter".



(4) You know that the cone whose base is a circle and sides are sloping is part of a volcano. One of the following figures represents a volcano.

An example of analogy:

Thus, the teacher can mention many other mathematical examples and their counterparts in geography. Then, he can write an instructional summary about what goes on in the period.

Exercise (1)

Map Scale

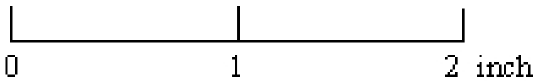
1)

Look at the example in figure (1) to identify the scale number of the map scale.

2)

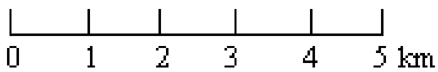
The English mile is represented on the maps scale by the kilometer, as illustrated in example (1).
Determine the relationship between the English mile and the kilometer:

3)



Maps drawn in English frequently use 1 inch for 1 mile. Determine the scale number!

4)



Determine the scale of figure (4).

How many kilometers is one inch?

Exercise (2)

Scale representation

1.1)

0 1 2 Kilometers

Advantages of representation 1.1

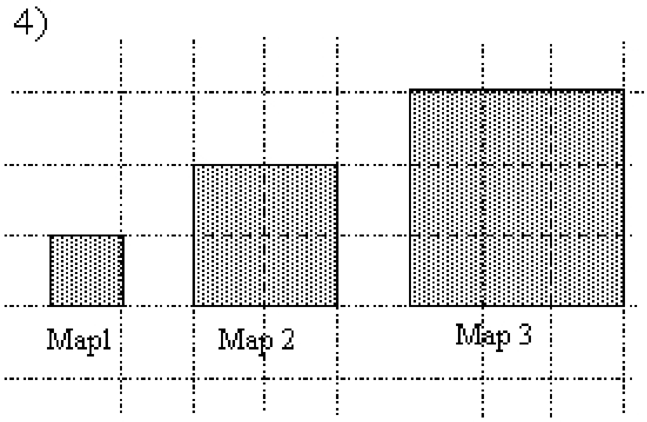
Disadvantages of representation 1.1

1.2) Mapscale 1:50 000

Advantages of representation 1.2

Disadvantages of representation 1.2

Exercise (3)



A square is represented in maps of different linear scales, what is the relation between the scales?

From map 2/ to map 1________

From map 3 / to map 1_______

From map 3 / to map 2_______

5) By which factor is the area increased in 4)?

From map 2 / to map 1 ____________________

From map 3 / to map 1____________________

From map 3 / to map 2____________________

6) The mathematical connection between F and M is obtained through the following equation:

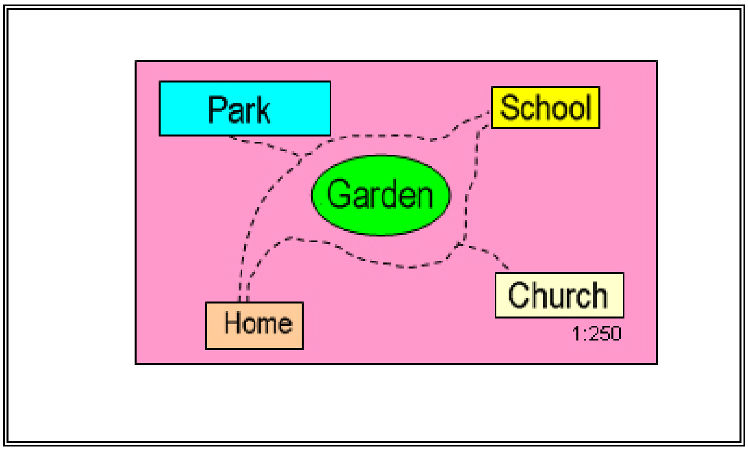
____

____

Exercise (4) Distance

1) Get the distance in the map as exactly as possible and determine the distance in reality!
(Measurement always to entrance, and/or entry)

Figure (1)

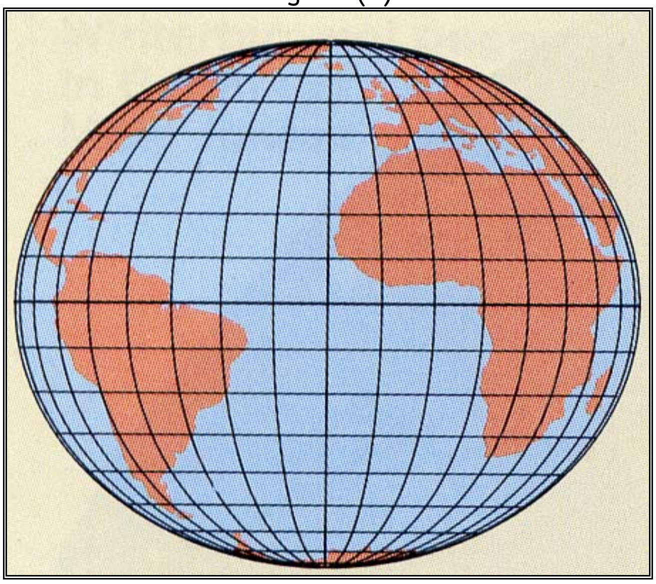


Home - School without the Church:
- Map: ______________Reality: ____________

Park - Church:
- Map: _____________ Reality: ____________

2) Determine the distance between 30°N und 45°N!

Figure (2)



2.1) in kilometres ____

2.2) in English miles ____

Exercise (5)

1) The shortest distance between two points on the globe is located on ………………………..

---

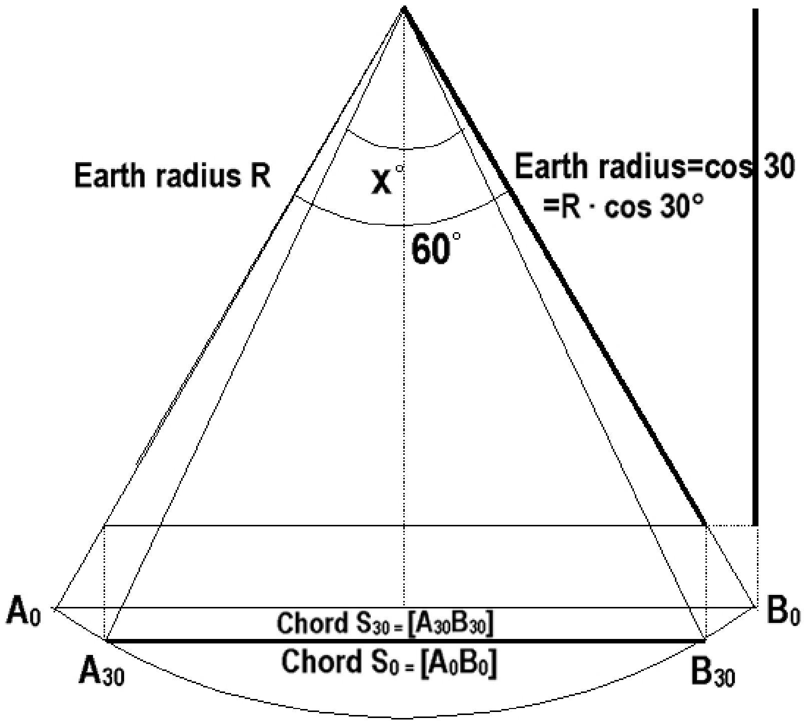
2) Determine the distance for those two points: A_0 and B_0, which are located on the equator on 16° W and 44° E!

---

3) Determine the distance separating between those two points: A_0 and B_0, which are located on the circle 30° between 16° W and 44° E!

Procedure of point

Part 1: Determine the Chord between A_{30} und B_{30}. In the following drawing!



Chord C_0 = ____________________ Similar representation C_{30} =

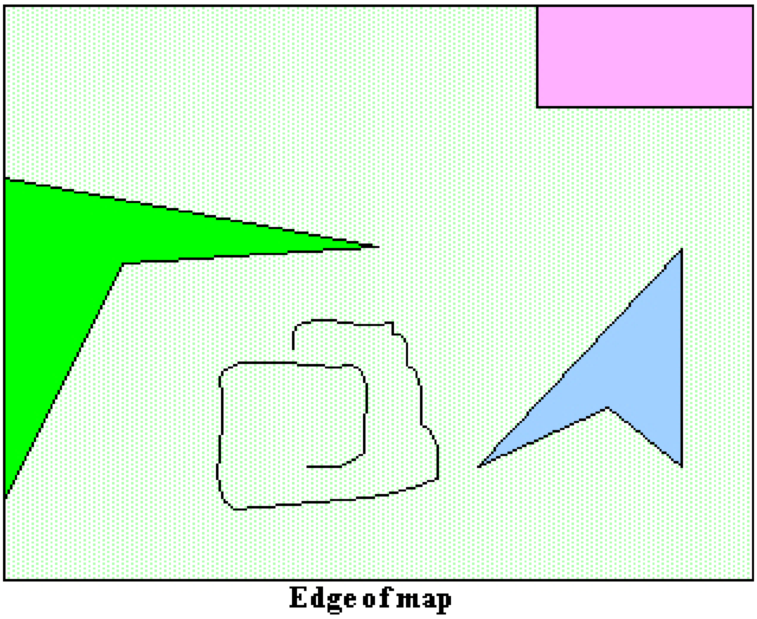
Part 2: Determine the angle of x°:

Part 3: Determine the arc length $A_{30}B_{30}$:

Exercise (6) Surfaces signatures and area

1) Color the areas in the below figure using different colors, and then, identify the shape that represents an area!

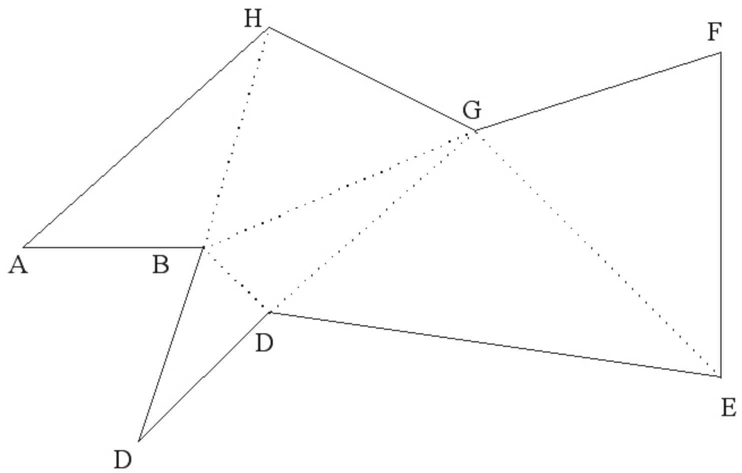
Figure (3)



2) Calculate the area surface in the following area with the help of Heron's formula [JAMES, 1999, p 2]!

$$A_{\Delta} = \sqrt{s(s-a)(s-b)(s-c)}$$

$$S = \frac{a+b+c}{2}$$



Exercise (7) Geographical direction in degrees

Figure (4)

1. Which geographical direction you have to take if you are heading from Lauenburg to Luebeck (in degrees)?

....

....

....

2. The distance between Talkau city and Lauenburg city in reality is...............................

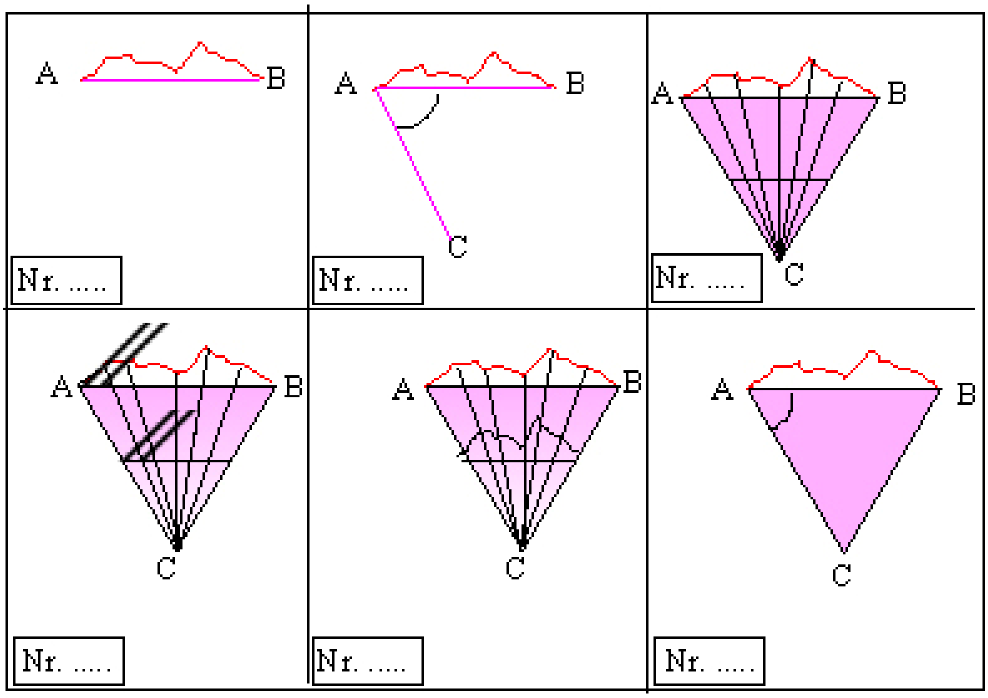
....

....

Exercise (8) Enlargement and Reduction

1. Sort the following construction phases!

Figure (5)



2. Enlarge the following figure by factor 1.5!

Exercise (9)

3. Suppose that we want to transfer a map with the scale of 1:150.000 into a map with the scale 1:25.000, how then can you determine the enlargement factor of the area!

4. Suppose that we want to transfer a map with a scale of 1:150.000 into a map with the scale of 1:100.000, how then can you determine the enlargement factor!

5. If we have a map with the scale 1:100.000 the area surface should be lessened to a quarter. How large is the new scale!

6. We have a map with a scale 1:100.000 and want to increase the area surface by factor 3. How large is the new scale!

Exercise (10) Degree of longitude, degree of latitude, time, parallel, speed and vertical

1. Compute the distance between the equator and the degree of latitude 15°! (In km).

____

____

2. If we only know the degrees of longitude for the comparison between two locations on the map or in reality, what can we compare?
   a. the distance. □
   b. convergence of meridians. □
   c. the time. □
   d. the situation. □

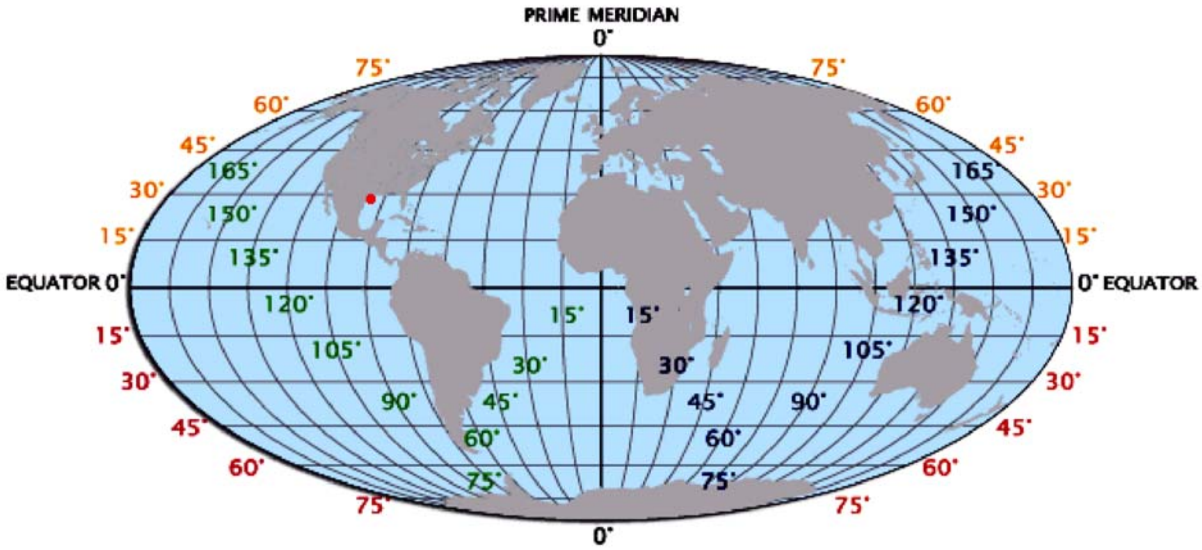
3. If it is 9 hours in London (local time) morning, and it is 12 hours in Al Riad (Saudi Arabia) (local time) in the afternoon, on which degree of longitude is Al Riad.

____

____

4. Any degree of longitude intersects uprightly with the Equator in the figure below:

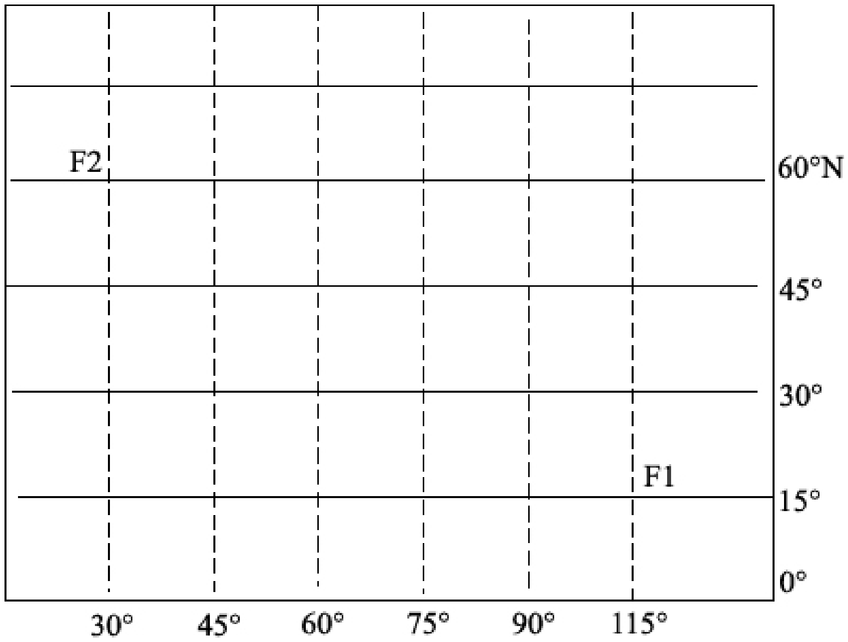
Figure (7)



Exercise (11)

5. The places F1 and F2 are given in the map (Mercator-projection).

Figure (8)



Determine:

a) The time difference.

b) The difference of the sun height at 12 hours (local time).

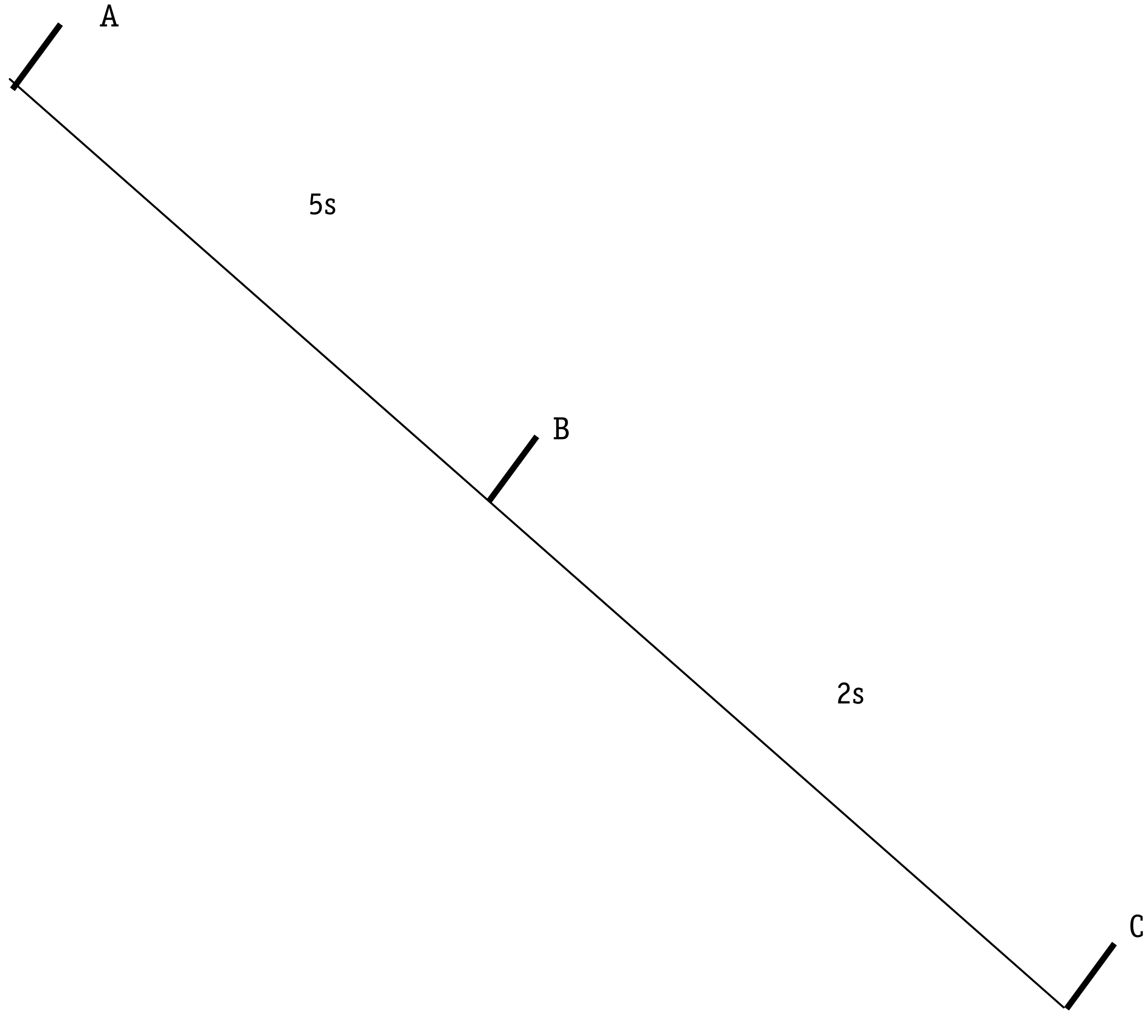
c) The direction, which one must take of F1, in order to come to F2.

Question: Which one of the tasks can be solved accurately?

Exercise (12)

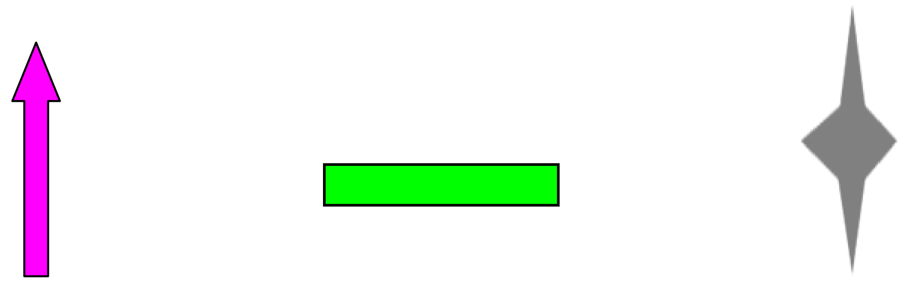
6. You need 8 hours and 30 minutes to go from Berlin to Munich. If you have an average speed of 70 km/h, how far is Berlin from Munich?

7. Determine the average of the speed!



Exercise (13) Geographical position, distance and parallelism

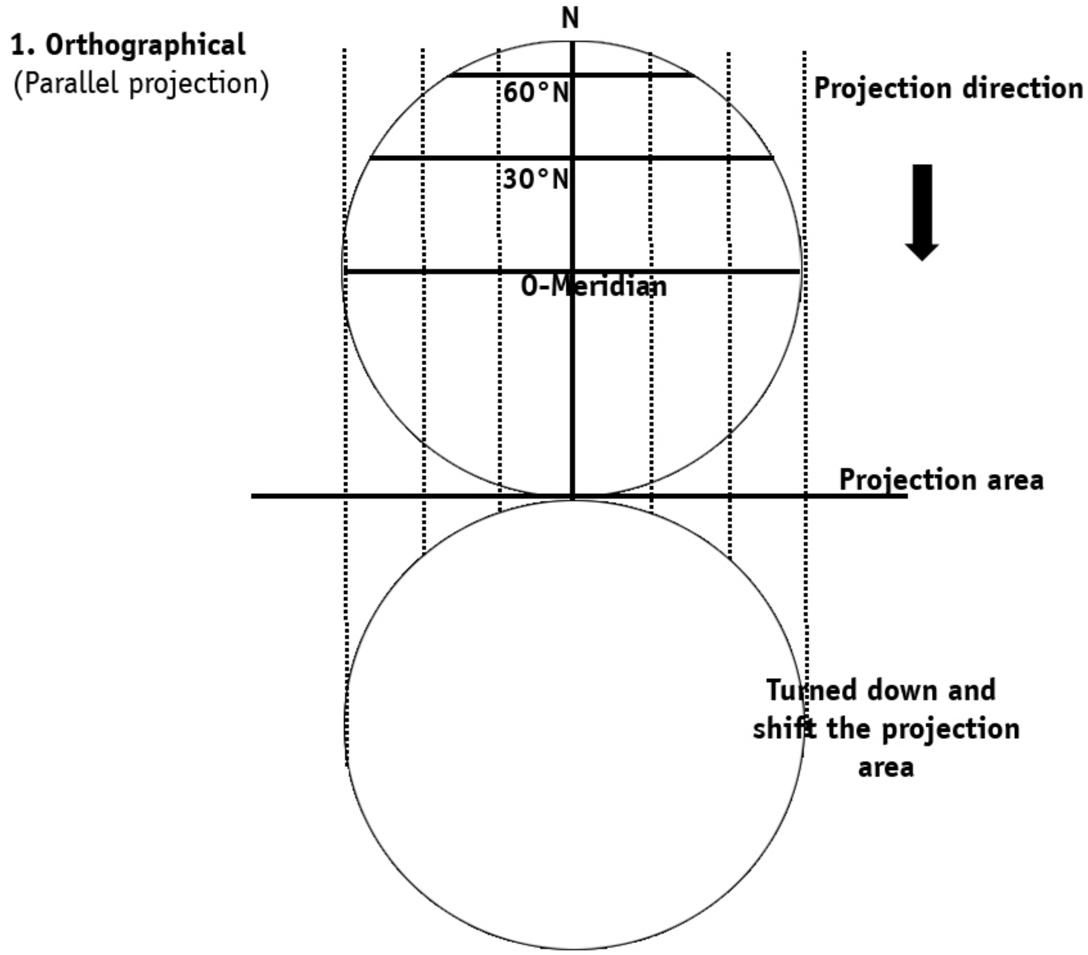
1. What do we call the following shapes that one can see on a map?



A ……………………………. B. ……………………… C. …………………………

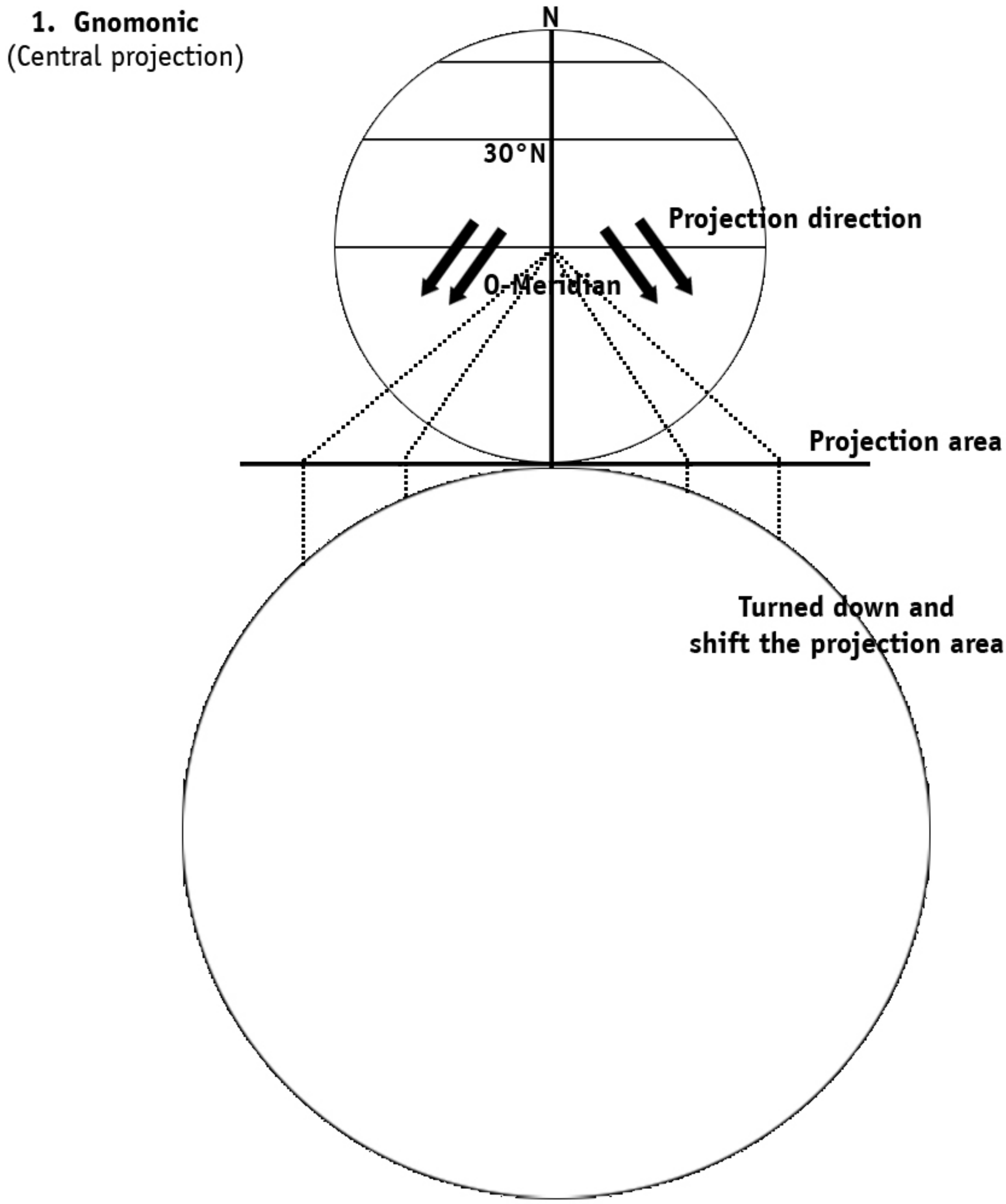
2. Draw a straight line [F D] into North direction!

Exercise (14) Map projection - Azimuthal or planar projections



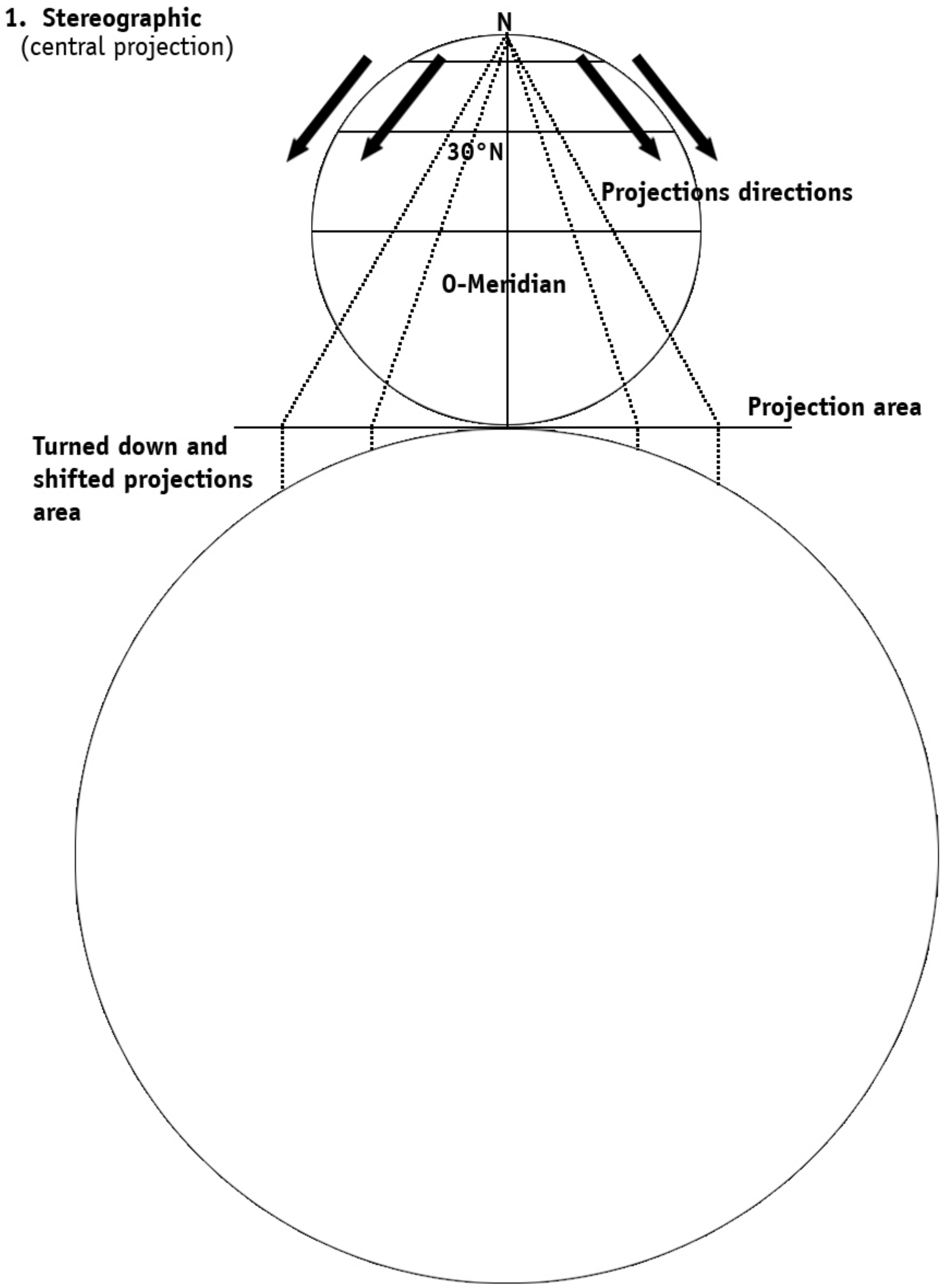
Task: Construct on the turn down the projection area for the following :
- The equator. The 30°N. and 60°N. The north pole.
- The meridian 0°, 30°0, 60°0°, 90°0, 30°W, 60°W, 90°W°.

Exercise (15) Map projection - Azimuthal or planar projection



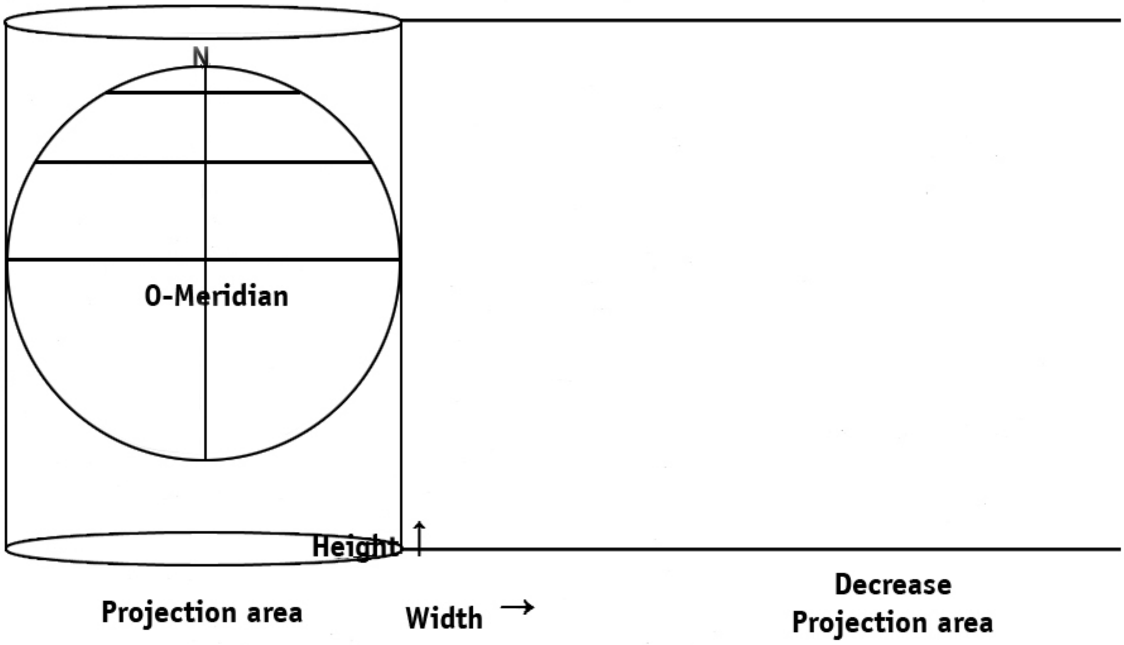
Task: Construct into the projection area which is turned down:
- The equator. The 30°N. and 60°N. The north pole.
- The meridian 0°, 30°O, 60°O°, 90°O, 30°W, 60°W, 90°W°.
- Try to construct the equator on the turned down projection area.

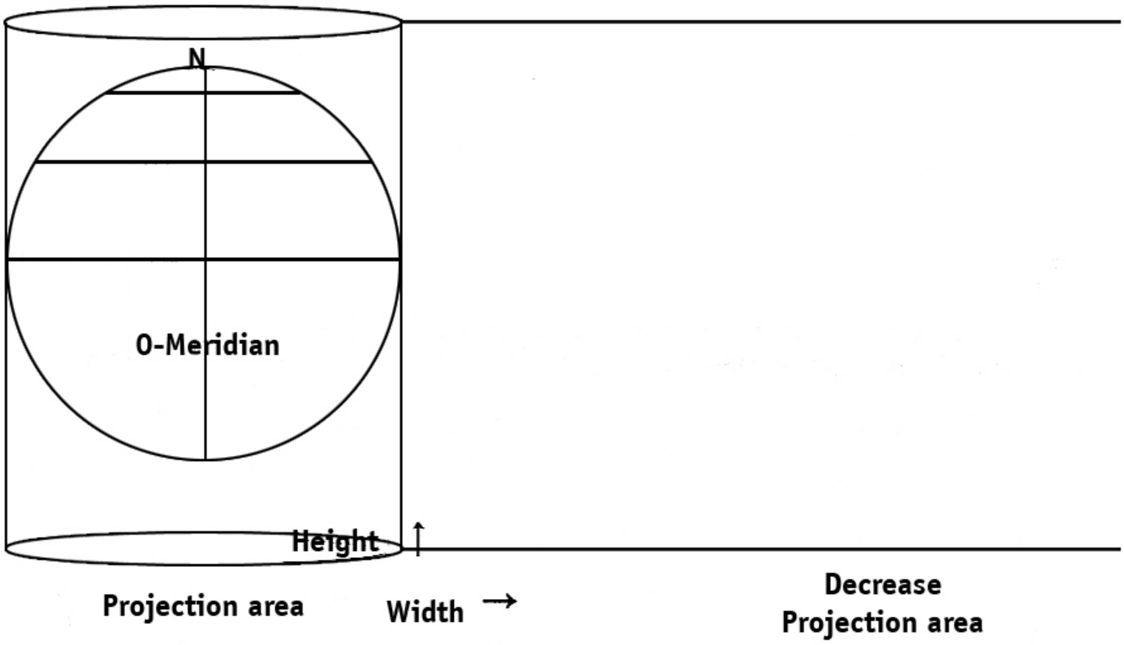
Exercise (16) Map projection - azimuthal or planar projection



Task: Construct into the projection area which turned down:
- The equator. The 30°N. and 60°N. The north pole.
- The meridian 0°, 30°O, 60°O°, 90°O, 30°W, 60°W°,90°W°.

Exercise (17) Map projection - Cylinder projection



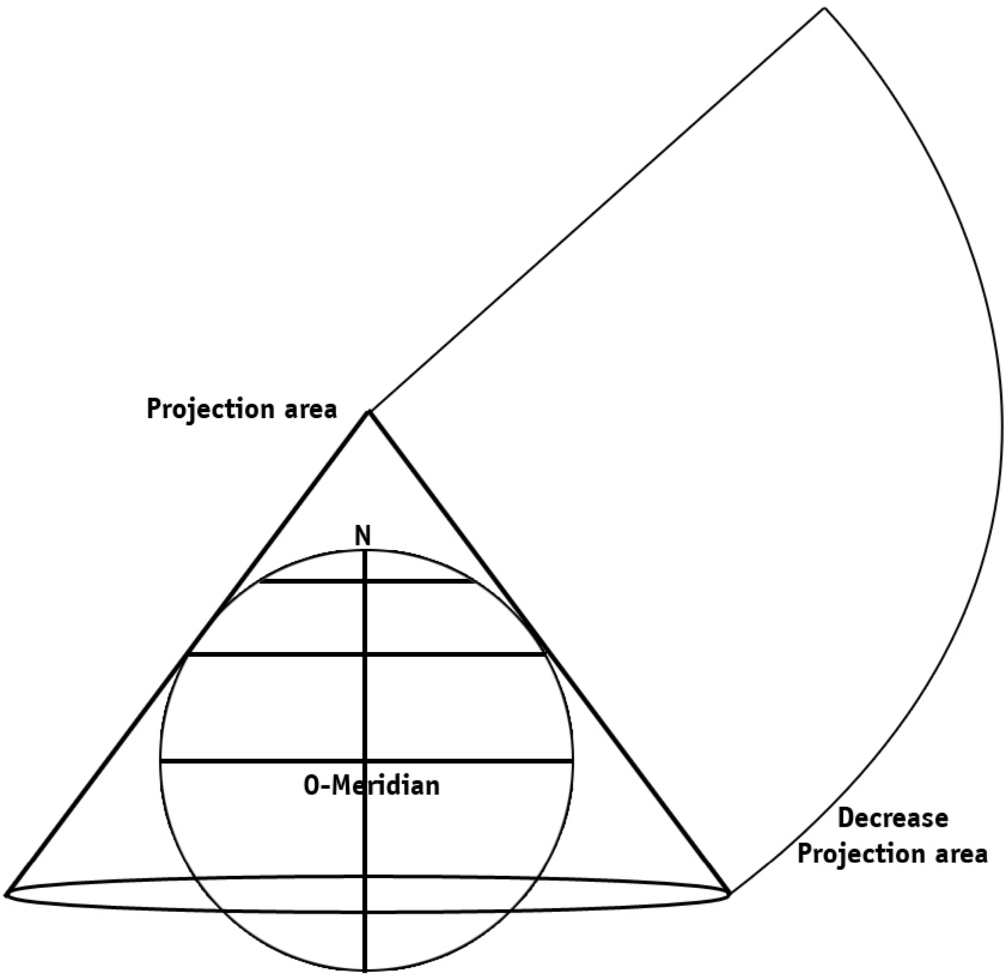


Out line the most important two basic forms of cylinder projection for the both above sketch.

What is the width of the decreased area of the cylinder?

____

Exercise (18) Map projection - Cone projection



How are meridians and latitude circles presented with the centre and the parallel projection?

	Meridians	Latitude circles
Parallel	---------------------------------	-------------------------------------
Centre	---------------------------------	-------------------------------------

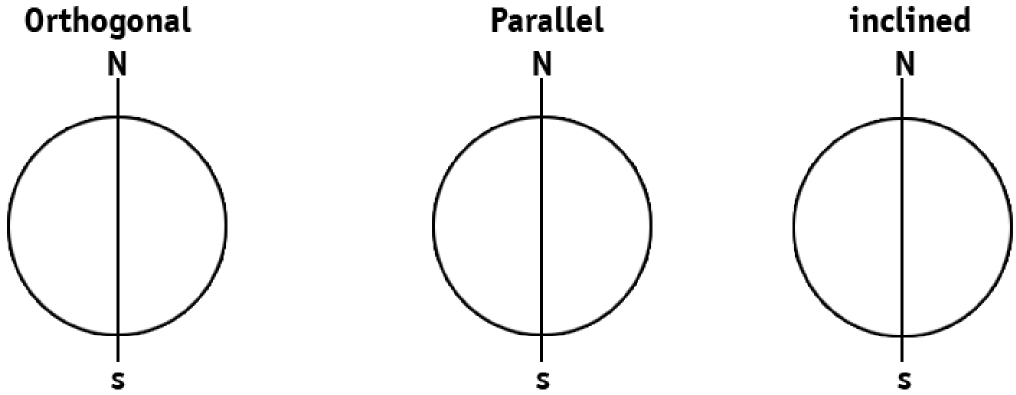
Which of the projections center is not useful?

Exercise (19) Map projection

1. Possible positions of the earth's axis to the plane projection surface (azimuthal projection):

Orthogonal, parallel, inclined

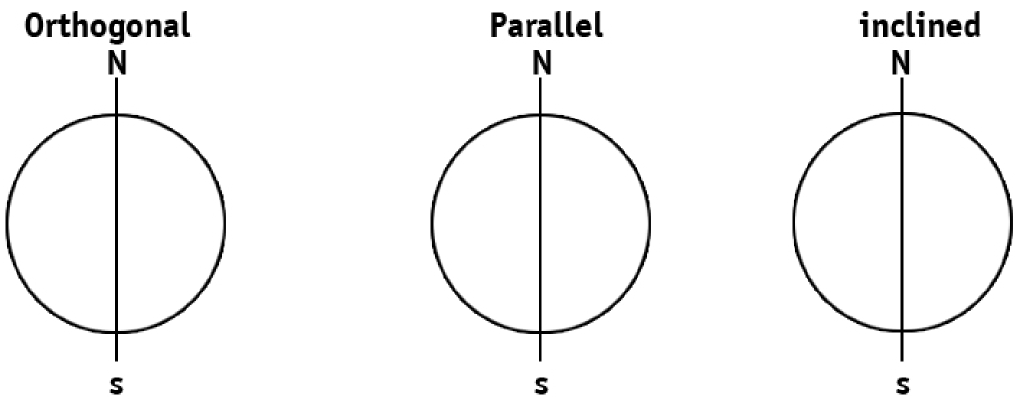
Draw the projection surface



2. Possible positions of the earth to the cylindrical and to the conic projection surface:

Orthogonal, parallel, inclined

Draw the projection surface



Exercise (20) Map projection

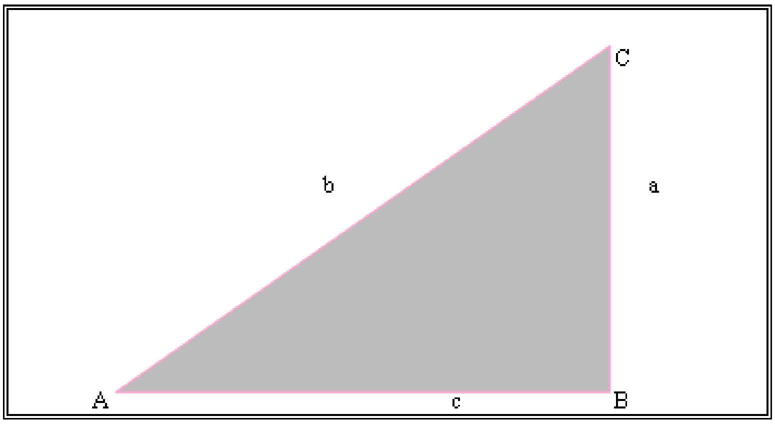
Determine suitability of the following projections:

	Suitable for	Unsuitable for
Azimuthal projection	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Cylindric projection	__________ __________ __________ __________	__________ __________ __________ __________
Conic projection	__________ __________ __________ __________	__________ __________ __________ __________

Exercise (21)

4. Determine the slope of line b in %:

Figure (9)



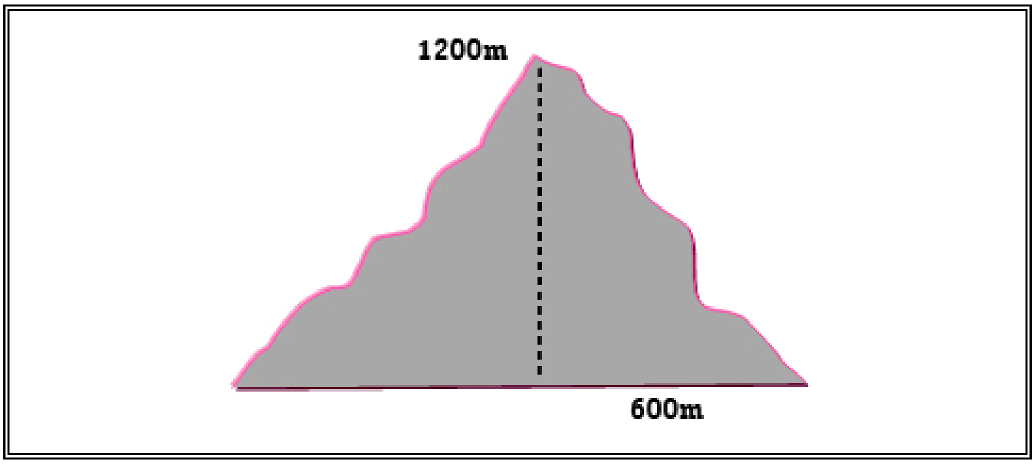
....

....

5. The downward gradient in degrees...

6. Determine the average mountain downward gradient in % on that side of the mountain on which the base is 600 m distant from the summit in horizontal direction?

Figure (10)



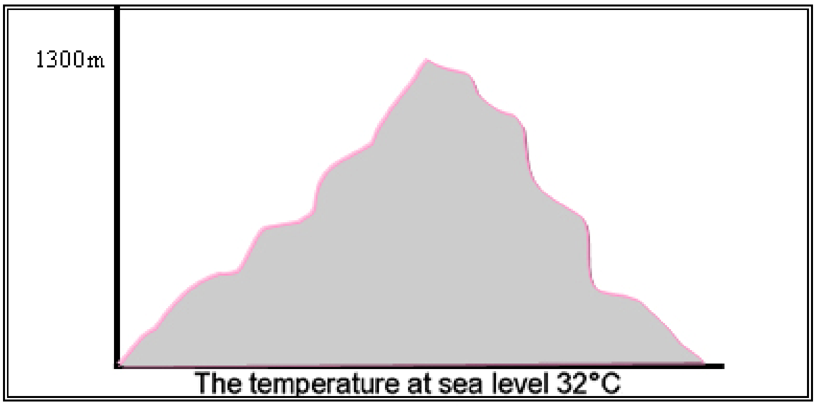
....

....

Exercise (22) Weather, climate, air pressure, dry-adiabatic, proportionality, relation, equivalence and speed

1. The temperature on sea level is at 32°C. Compute the temperature on the mountain summit in figure11 (dry-adiabatic).

Figure (11)



……
……

3. What does the term "equivalence" mean?
……

4. Give one example for:

Proportion………………………………………………………………………………………

Relation…………………………………………………………………………………………

Equivalence ……………………………………………………………………………………

Congruence ……………………………………………………………………………………

5. Compute the relationship of the following numbers.

1. 4/5 and 16

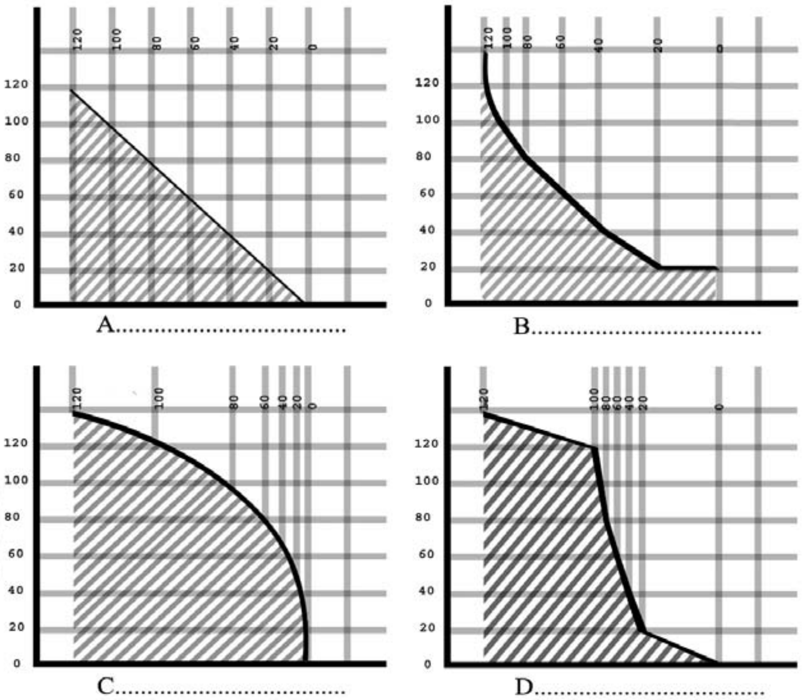
2. 2/3 and 5

3. 3/4 and 18

Exercise (23) Slope

1. Assign to the following slope profiles the designations a, b, c, d!

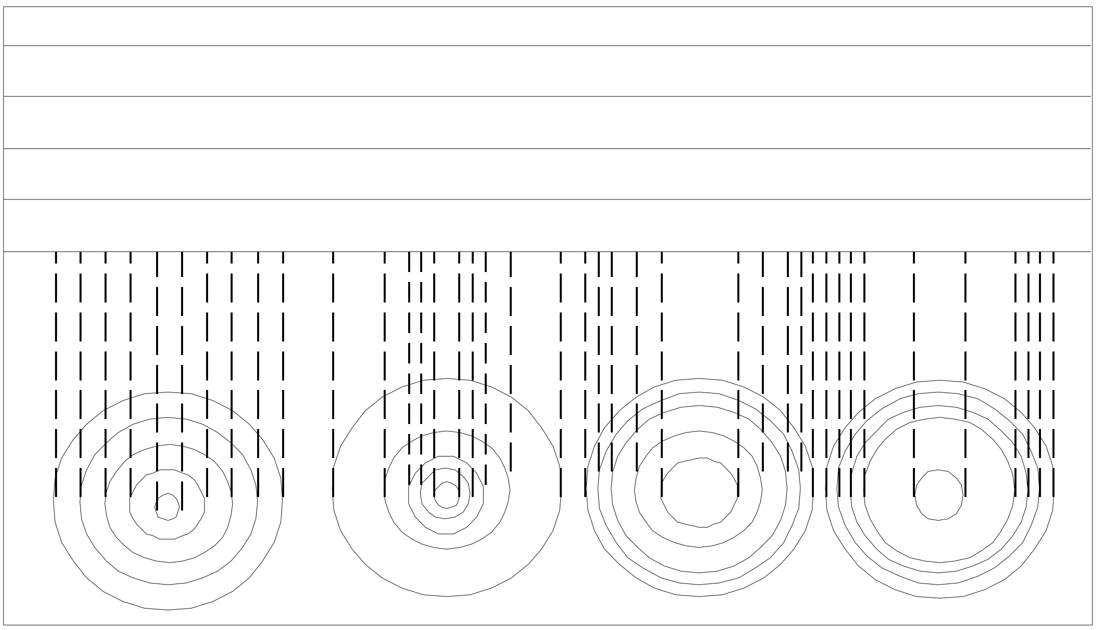
Figure (12)



a. Constant slope.
b. Stepped slope.
c. Hollow slope.
d. Bulged slope.

2. Draw the slope profiles into the following diagrams!

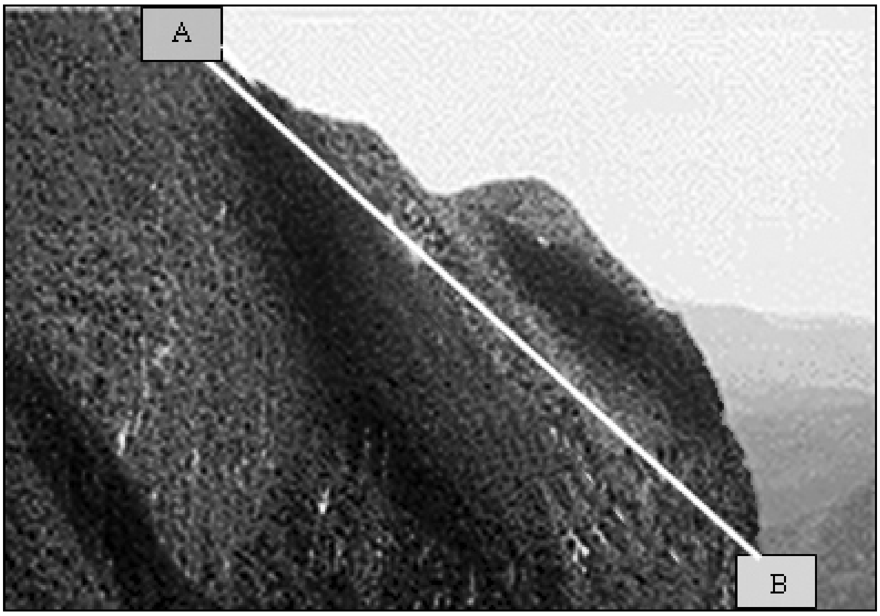
Figure (13)



Exercise (24)

Draw the inclination profile of the visible part of the mountain in the following figure from A to B!

Figure (14)



....
....
....
....

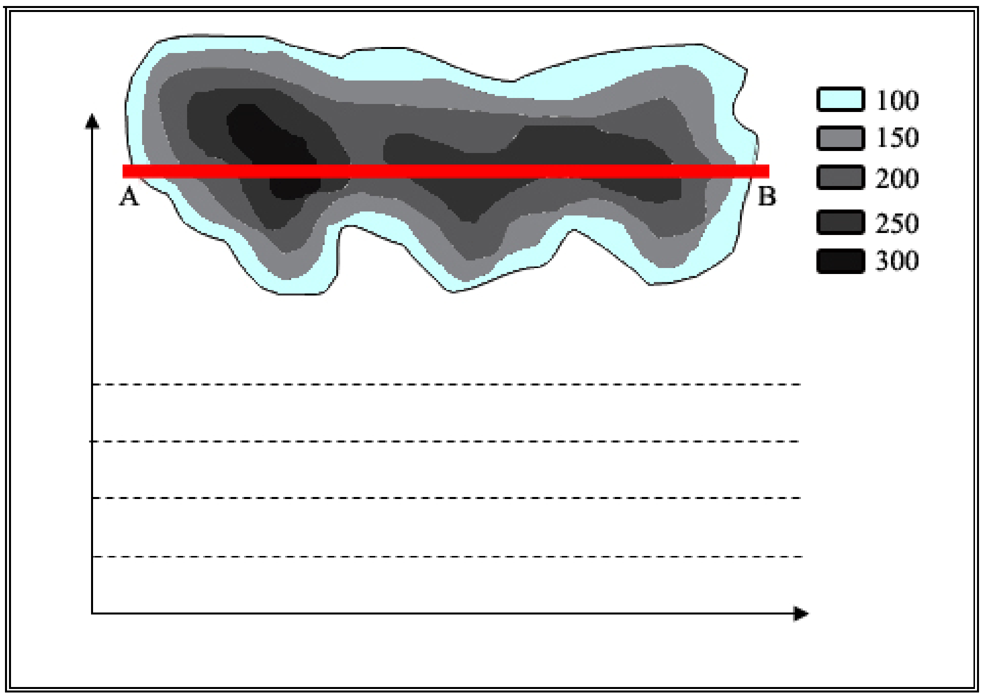
Exercise (25) The Profile

1. Draw the profiles between A and B in figure (15)!

2. Determine the height scale of the map in figure (15)!
   a. ≈ 1:10.000 □
   b. ≈ 1:20.000 □
   c. ≈ 1:30.000 □
   d. ≈ 1:40.000 □

3. What is the difference between maximum heights and minimum heights in the profile of figure (15)?
   ....
   ....

Figure (15)



<u>Exercise (26)</u>

<u>1. Columns of diagrams</u>

1. Birth rate (register considerably):

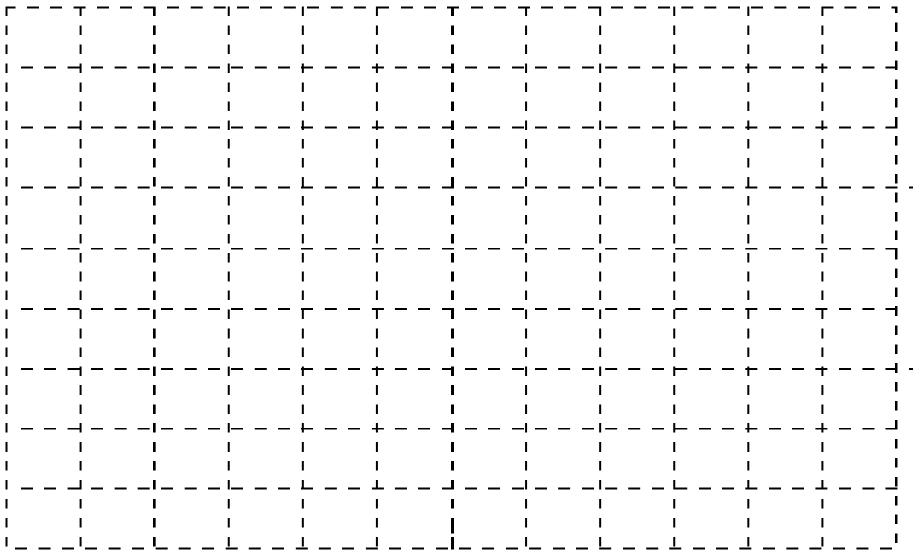
   1,0%

   0,9%

   0,8%

   0,7%

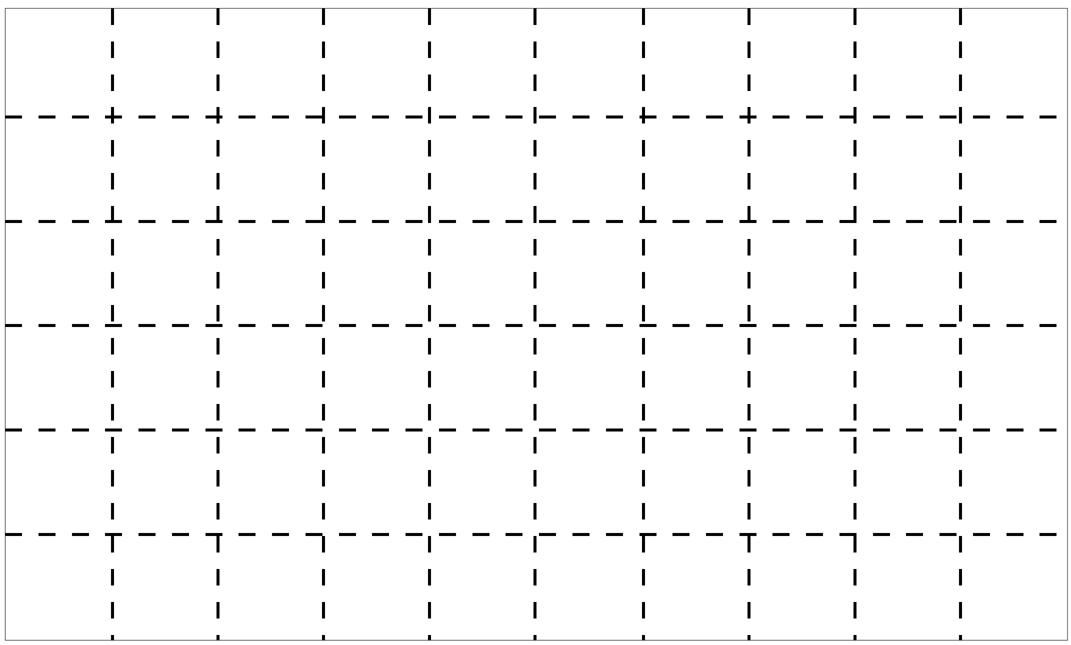
Figure (16)



<u>2. Economic sectors</u>

(Primary. 3%, Sec. 39%, Tert. 58%)

Figure (17)



Exercise (27)
3. Circle diagrams

3. What are the advantages and disadvantages of using the dividing circles for displaying data and different geographical phenomena?

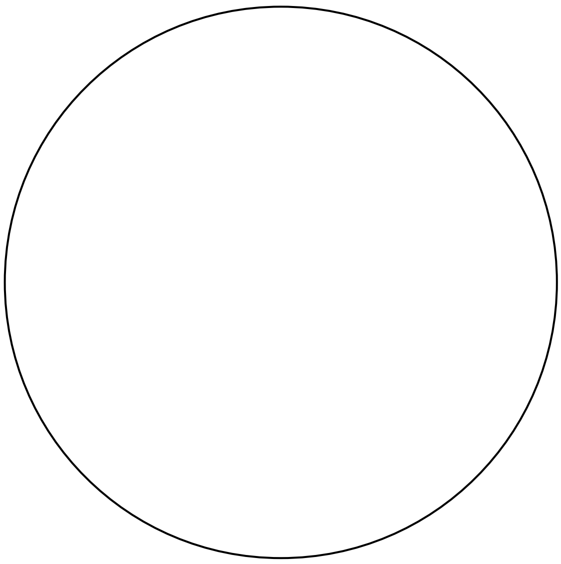
1.____

2.____

4. Distribute the following data on the circle diagram!

Number	1	2	3	4	5	6
Boys	13	17	15	18	12	25
Girls	11	20	13	23	10	23

Figure (18)



Exercise (28) Scale of a photograph, camera, heights and inclination

1. Compute the scale for a photograph, if the focus of the camera is 150 mm and the height of the airplane is 3000 m!

   a. 1:20.000. □
   b. 1:30.000. □
   c. 1:40.000. □
   d. 1:50.000. □

2. Compute the airplane height, if the Scale of the photography is 1:4500 and the focus of the camera is 150 mm!

   ………
   ………

3. How can we obtain the drawing scale of the air-photograph?

   ………
   ………

Exercise (29)

What are satellite pictures?

Satellite images are real images; they provide us with a vision and an accurate measure of the geographical information. When we see a satellite image we see that each pixel on the picture is a representation of a big part of the earth. This is done depending on the features of the data acquisition systems which cover different spaces of the earth surface.

High resolution: starting from 1 x 1 meter of surface
Middle resolution: between 20 x 20 meters and 250 x 250 meters
Small resolution: Starting from 250 x 250 meters

Figure (20) upper run of Nile in Egypt

Figure (21) lower run in Egypt

Exercise (30)

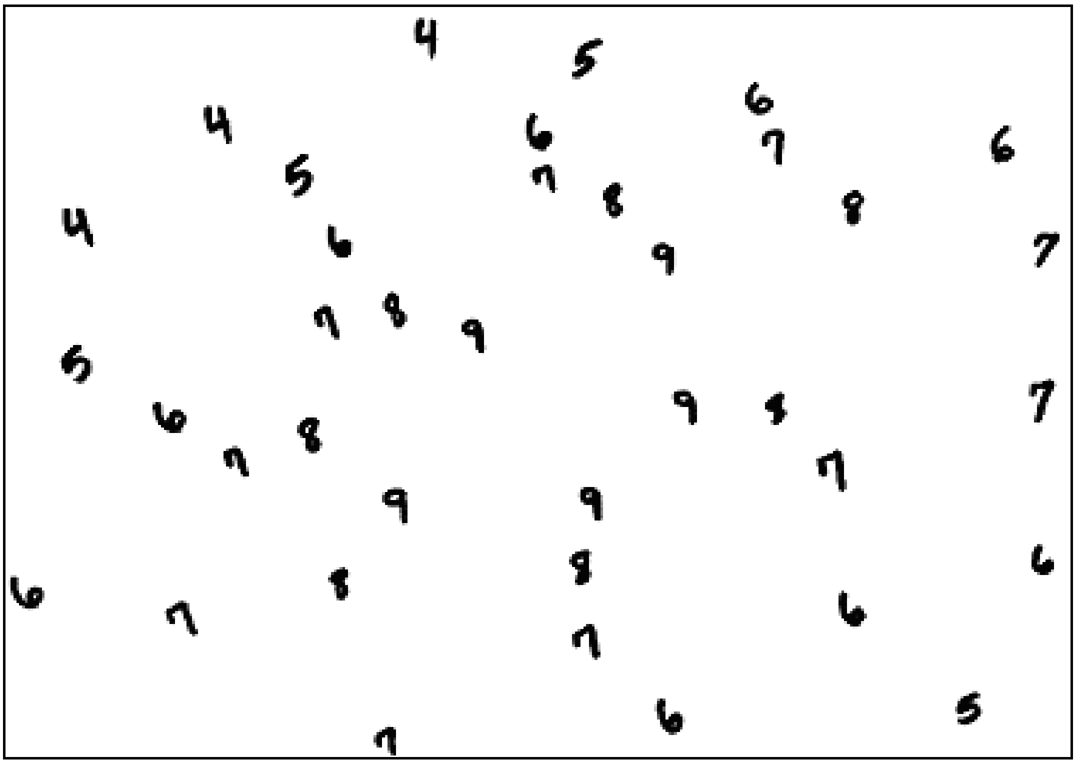
These images in exercise 29 were taken in 2003 by the mode sensor on the TETRA satellite of NASA. Not only the visible light (colour of channels: red, green, blue), but also different infrared ranges (e.g.: near infrared for vegetation, thermal infrared for temperature information) are recorded. In the false colour images the near infrared is shown, so that vegetable life can be seen more clearly.

Interpretation of a satellite photograph

1. Classification:	The scale:
2. Structuring:	
3. Description: (Registration the phenomena)	
4. Identification: the phenomena	
5. Evaluation (cross-linking of single phenomena)	

Exercise (31) Contours, proportion

1. Link between the equated ratios' numbers in the map below through which the geographical shape that we want to draw can be shown!



2. Which topographic figure do you see in the map?

....

....

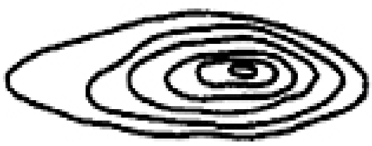
....

Exercise (32)

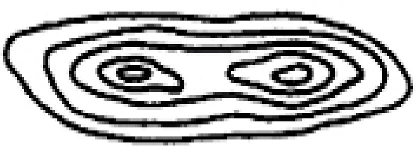
3. Draw a profile of the geographical forms over the summit parallel to the upper edge of the sheet!

A 

B 

C 

D 

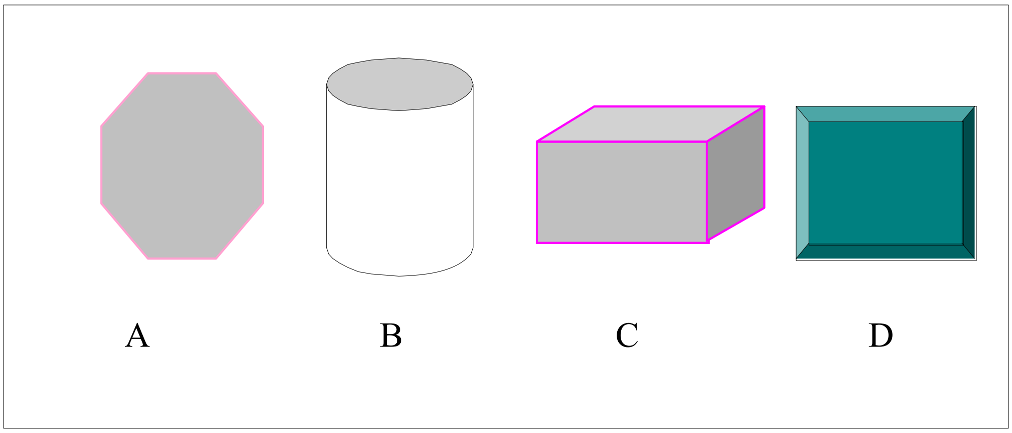
E 

Exercise (33)

1. Draw two different representatives of a vector:
   a) From a vector space of dimension 1
   b) From a vector space of dimension 2

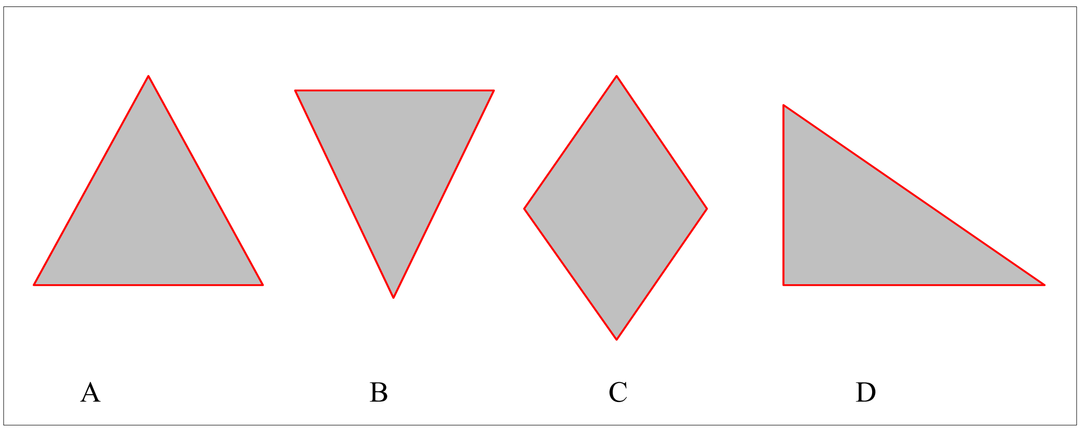
2. Which geometrical figure represents a cube?

Figure (23)



3. Which geometrical figure resembles the Matterhorn on the topographic map?

Figure (24)

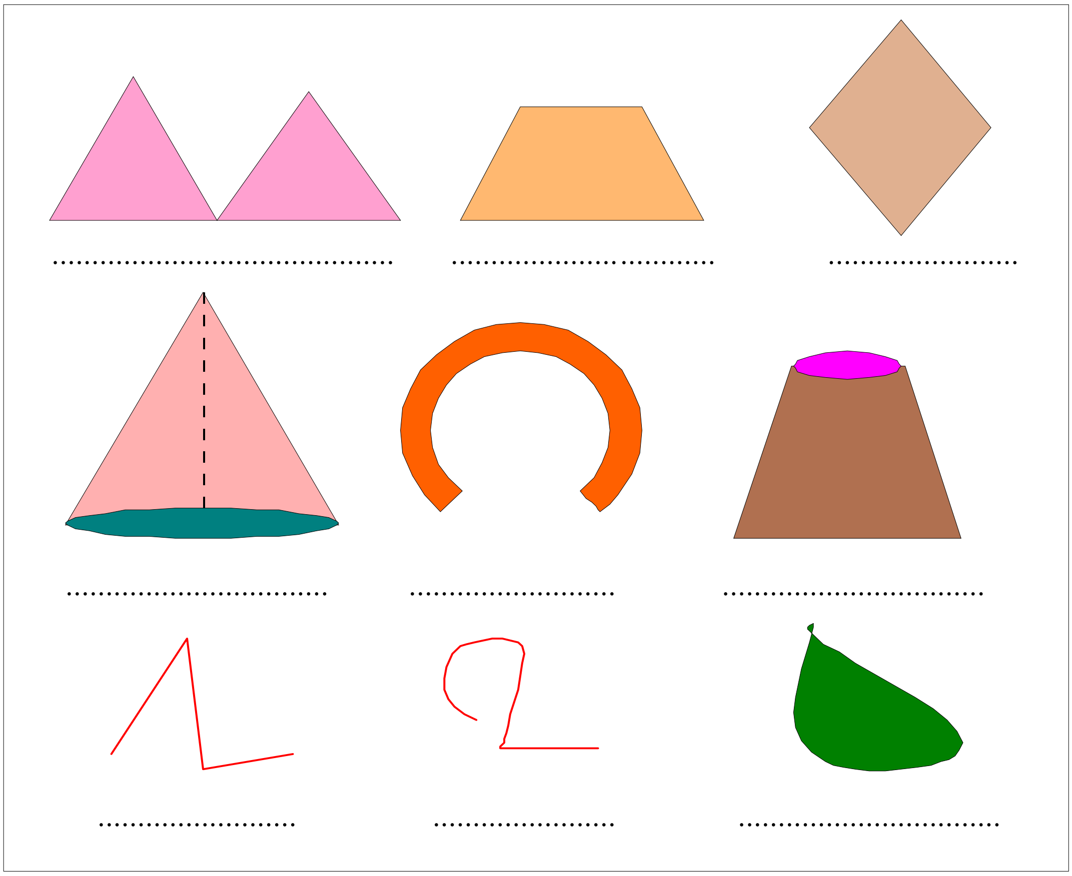


Exercise (34)

4. Draw secants on a circle!

5. Which geographical forms can be represented by the following geometrical forms!

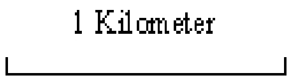
Figure (25)



Arbeitsblatt (1)

Maßstab:

1)



Bestimme die Maßstabszahl des Maßstabes, in dem der Kilometer dargestellt ist:

____

____

____

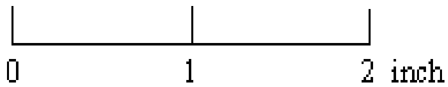
2)

Die engl. Meile ist im gleichen Maßstab dargestellt wie der Kilometer in 1).
Bestimme das Verhältnis zwischen engl. Meile und Kilometer:

____

____

3)

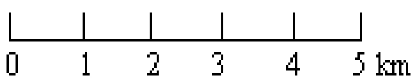


In Karten aus dem englischsprachigen Raum wird häufig 1 mile als 1 inch dargestellt. Bestimme die Maßstabszahl!

____

____

4)



Bestimme den Maßstab der nebenstehenden Strecke! (4).

____

____

Wieviel km sind bei diesem Maßstab 1 inch?

____

<u>Arbeitsblatt (2) Maßstabsdarstellung</u>

1.1)

Vorteil der Darstellung 1.1)

____

____

Nachteil der Darstellung 1.1)

____

____

1.2) Maßstab 1:50 000

Vorteil der Darstellung 1.2)

____

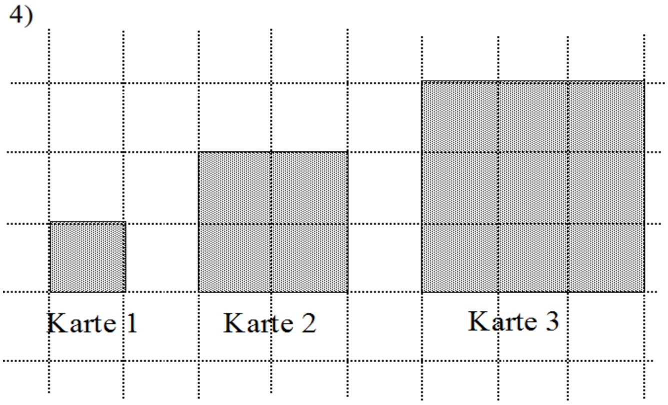
____

Nachteil der Darstellung 1.2)

____

Arbeitsblatt (3)

4)



In drei Karten mit verschiedenem Maßstab ist ein Linie Quadrat dargestellt!
Um welchen Faktor m ändert sich der Maßstab?

Von Karte 2 / zu Karte 1_________

Von Karte 3 / zu Karte 1_________

Von Karte 3 / zu Karte 2_________

5) Um welchen Faktor f nimmt der Flächeninhalt der Quadrate in 4) zu?

Von Karte 2 / zu Karte 1____________________

Von Karte 3 / zu Karte 1____________________

Von Karte 3 / zu Karte 2____________________

6) Der mathematische Zusammenhang zwischen f und m ist gegeben durch

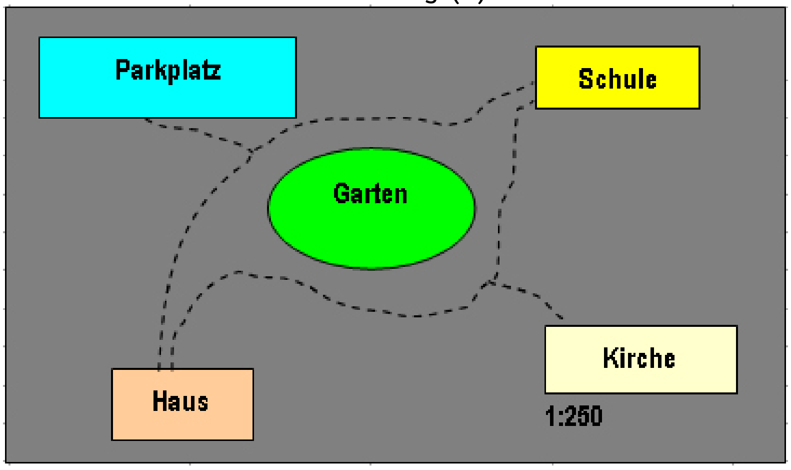
____

____

Arbeitsblatt (4) Distanz

1) Messe die Distanz in der Karte möglichst genau und bestimme daraufhin die Entfernung in der Realität! (Messung immer bis Eingang, bzw. Einfahrt)

Abbildung (1)

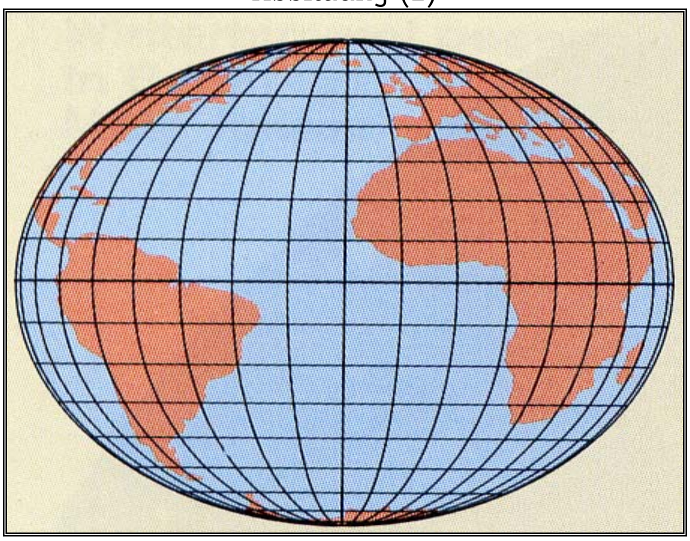


Haus - Schule mit Abstecher zur Kirche:
Karte:____________ Realität:__________________

Parkplatz - Kirche :
Karte:____________ Realität:__________________

2) Bestimme die Distanz zwischen 30°N und 45°N.

Abbildung (2)



2.1) in Kilometern ____

2.2) in engl. Meilen _______________________________________

Arbeitsblatt (5)

1) Die kürzeste Distanz zweier Punkte auf der Oberfläche der Erdkugel liegt auf:

____

2) Bestimme die Entfernung von zwei auf dem Äquator liegenden Punkten A_0 und B_0, die bei 16° W und 44° O liegen!

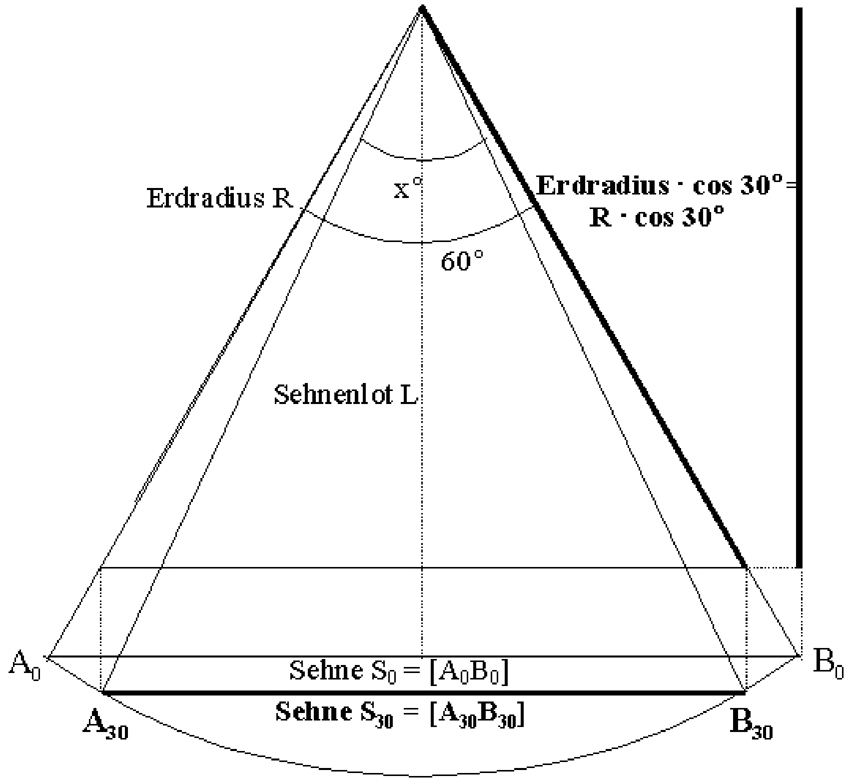
____

3) Bestimme die Entfernung von zwei auf 30° liegenden Punkten A_{30} und B_{30}, die bei 16° W und 44° O liegen!

____

Vorgehensweise:

Schritt 1: Bestimmung der Sehne zwischen A_{30} und B_{30}. Diese führt durch das Innere der Kugel!



S_0 = ____________________ Analoge Darstellung S_{30} =

Andere Darstellung von S_{30} : S_{30} = ______________________________

Schritt 2: Bestimmung des Winkels x:

____

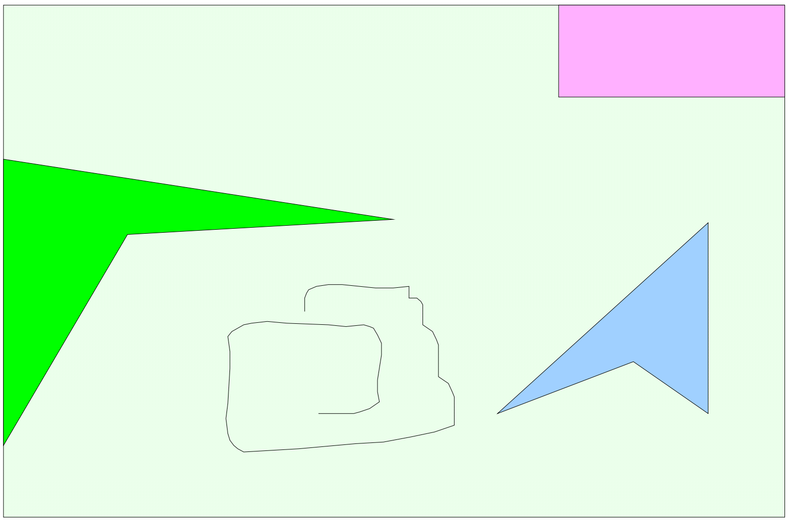
Schritt 3: Bestimmung der Länge des Bogenstücks $A_{30}B_{30}$:

____

Arbeitsblatt (6) Flächensignaturen und Flächen

1) Malen Sie diejenigen Objekte in der Karte farbig an, die eine eindeutig Signatur als geschlossene Flächen charakterisieren:

Abbildung (3)

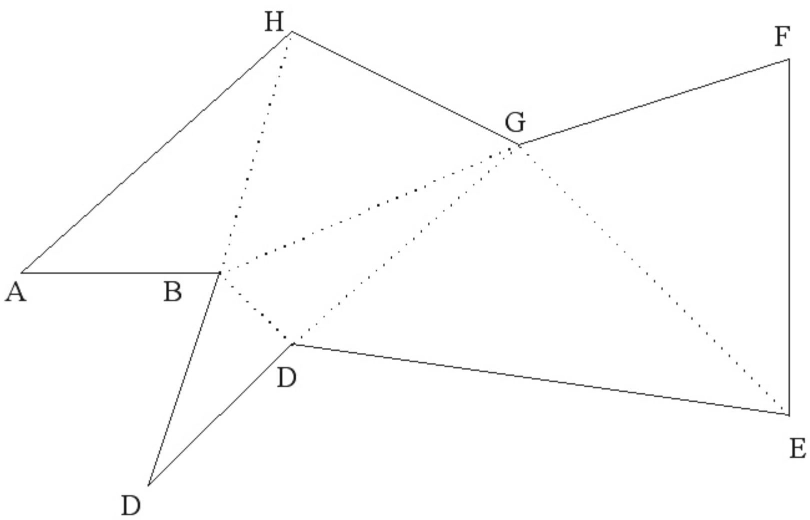


Kartenrand

2) Berechne den Flächeninhalt des folgenden Areals mit Hilfe der Heronischen Formel [JAMES, 1999, p 2]!

$$A_{\Delta} = \sqrt{s(s-a)(s-b)(s-c)}$$

$$S = \frac{a+b+c}{2}$$



Arbeitsblatt (7) Geographische Richtung in Grad

Abbildung (4)

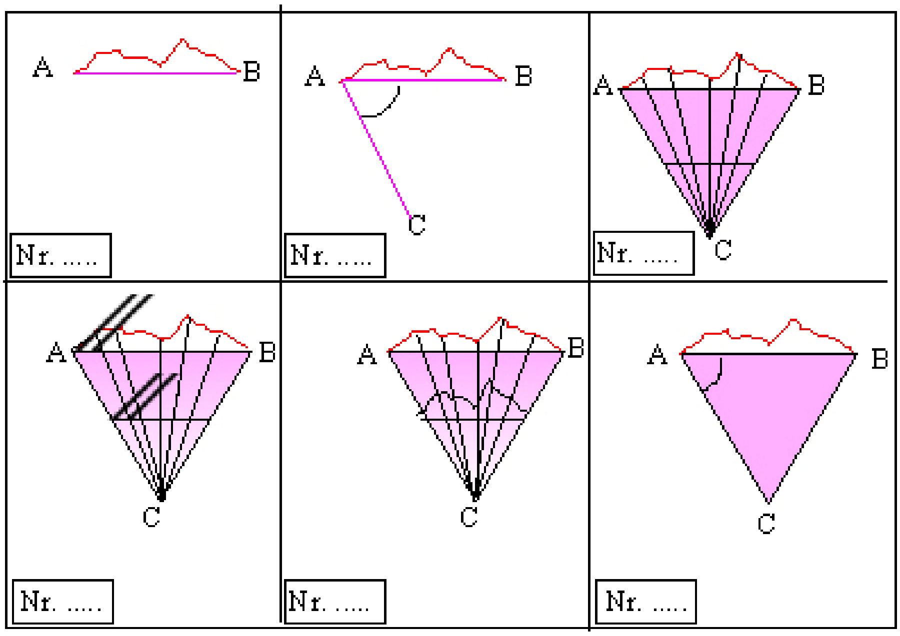
1. In welcher geographischen Richtung bewegen Sie sich von Lüneburg nach Lübeck (in Grad)?
....
....

2. Die Distanz zwischen dem Talkau und dem Lauenburg in der Wirklichkeit ist........................
....
....

Arbeitsblatt (8) Vergrößerung und Verkleinerung

1. Sortieren Sie die folgenden Figuren.

Abbildung (5)



2. Vergrößern Sie die folgende Figur auf das 1,5 fache.

Arbeitsblatt (9)

3. Es soll eine Karte mit dem Maßstab 1:50.000 in eine Karte mit dem Maßstab 1:25.000 umgezeichnet werden. Berechne den Vergrößerungsfaktor!

4. Es soll eine Karte mit dem Maßstab 1:50.000 in eine Karte mit dem Maßstab 1:100.000 umgezeichnet werden. Berechne den Vergrößerungsfaktor!

5. Eine Karte hat den Maßstab 1:100.000. Die Fläche soll auf 1/4 verkleinert werden. Berechne den neuen Maßstab!

6. Eine Karte hat den Maßstab 1:25.000. Die Fläche soll auf das Dreifache vergrößert werden. Berechne den neuen Maßstab!

Arbeitsblatt (10) Längengrad, Breitengrad, Zeit, Parallel, Geschwindigkeit und Vertikal.

1. Berechne die Distanz zwischen dem Äquator und dem Breitengrad 15° (in km).

____

____

____

2. Wenn wir nur den Längengrad für den Vergleich zwischen zwei Orten in der Karte oder in der Wirklichkeit benutzen wollen, können wir vergleichen:

   a. die Distanz. □
   b. die Meridiankonvergenz. □
   c. die Uhrzeit. □
   d. die Lage. □

3. Wenn es in London 9 Uhr (wahre Ortszeit) morgens ist, dann ist es in Al Riad (Saudi Arabien) (wahre Ortszeit) 12 Uhr Mittag. Auf welchem Längengrad liegt Al Riad?

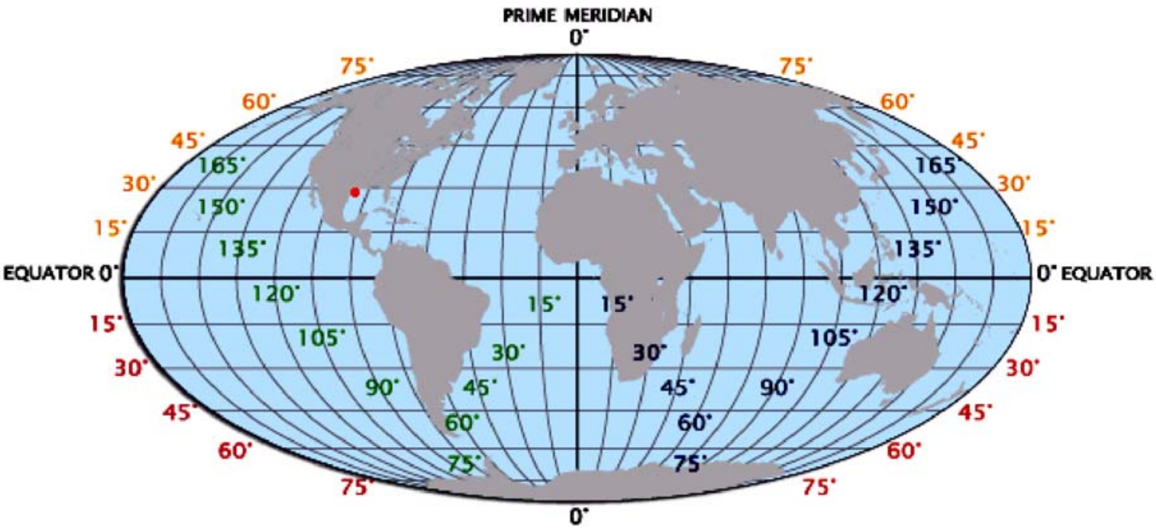
____

____

____

4. Welche Längengradlinien schneiden den Äquator in der folgenden Karte vertikal?

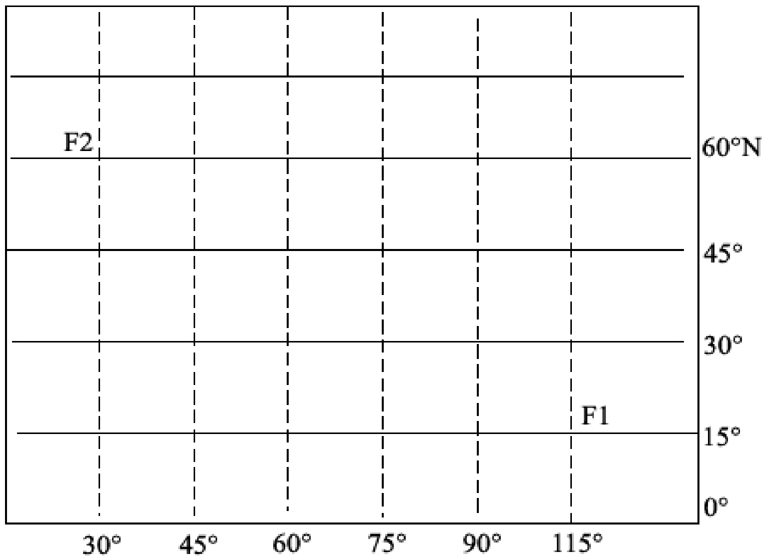
Abbildung (7)



Arbeitsblatt (11)

5. Gegeben sind die Orte F1 und F2 in der Karte? (Mercatorprojektion)

Abbildung (8)



Bestimme:

a) die Uhrzeitdifferenz.

b) die Differenz der Sonnenhöhe um 12 Uhr (WOZ).

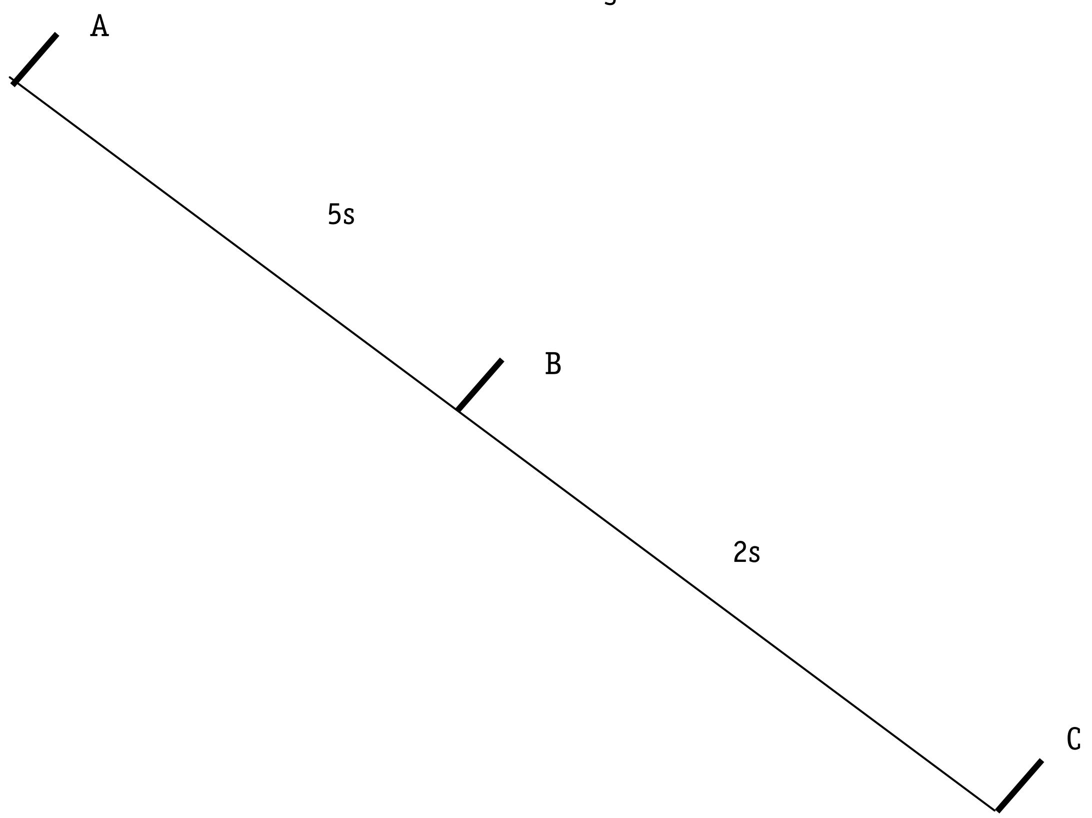
c) die Himmelsrichtung, die man in F1 einschlagen muss, um nach F2 zu kommen.

Frage: Welche der Aufgaben sind exakt zu lösen?

Arbeitsblatt (12)

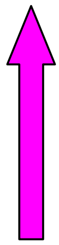
6. Ein Zug benötigt für die Strecke von Berlin nach München 8 Stunden und 30 Minuten, wenn er mit einer Durchschnittsgeschwindigkeit von 70 km/h unterwegs ist. Wie weit ist Berlin von München entfernt?

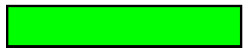
7. Bestimme den Durchschnitt der Geschwindigkeit!



Arbeitsblatt (13) Geographische Position, Distanz und Parallelität

1. Wie heißen die folgenden Symbole, die man auch in einer Karte wieder findet?



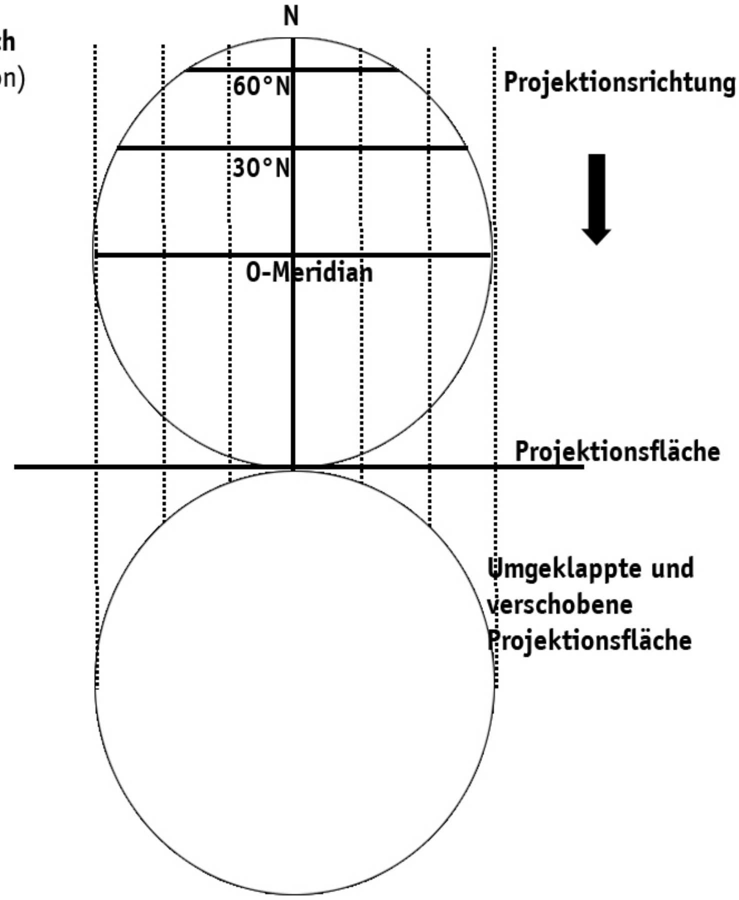


A ……………………………… B. ………………………… C. ………………….

2. Zeichne eine Strecke [F D] in Nordrichtung!

Arbeitsblatt (14) Kartenprojektion - Azimutale oder planare Projektionen

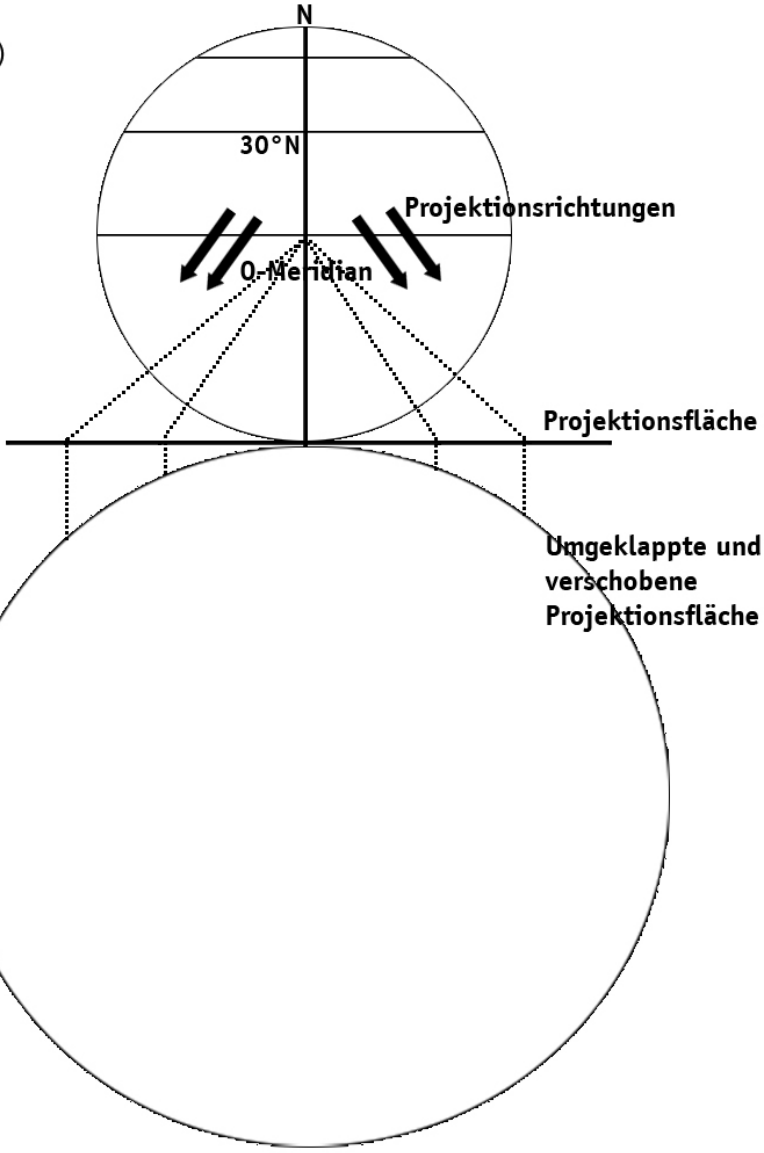
1. Orthographisch
(Parallellprojektion)



Aufgabe: Konstruiere in die umgeklappte Projektionsfläche:
- den Äquator, 30. und den 60. nördlichen Breitengrad, den Nordpol.
- die Meridiane 0°, 30°O, 60°O, 90°O°, 30°W, 60°W, 90°W°.

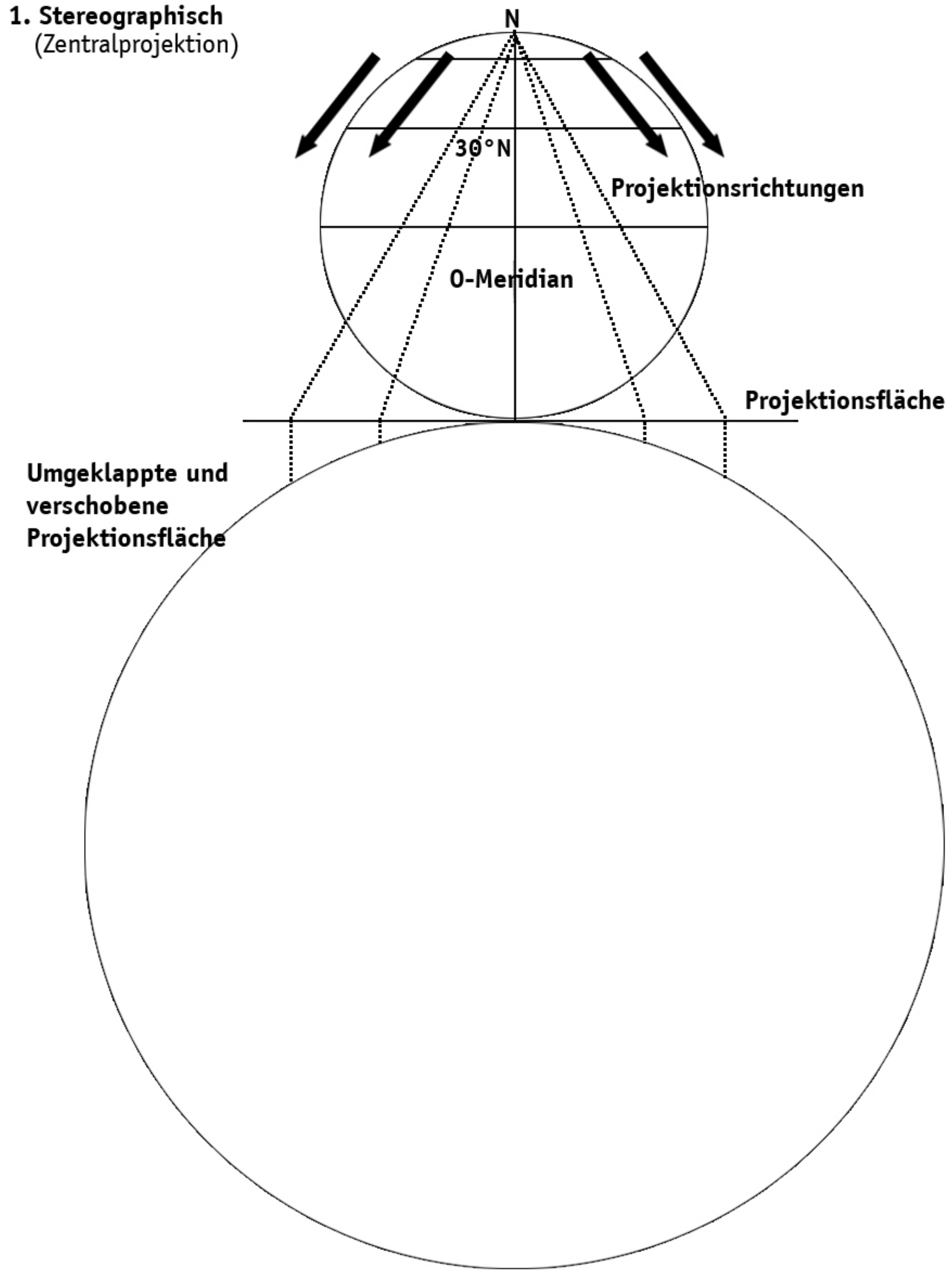
Arbeitsblatt (15) Kartenprojektion - Azimutale oder planare Projektionen

1. Gnomonisch
(Zentralprojektion)



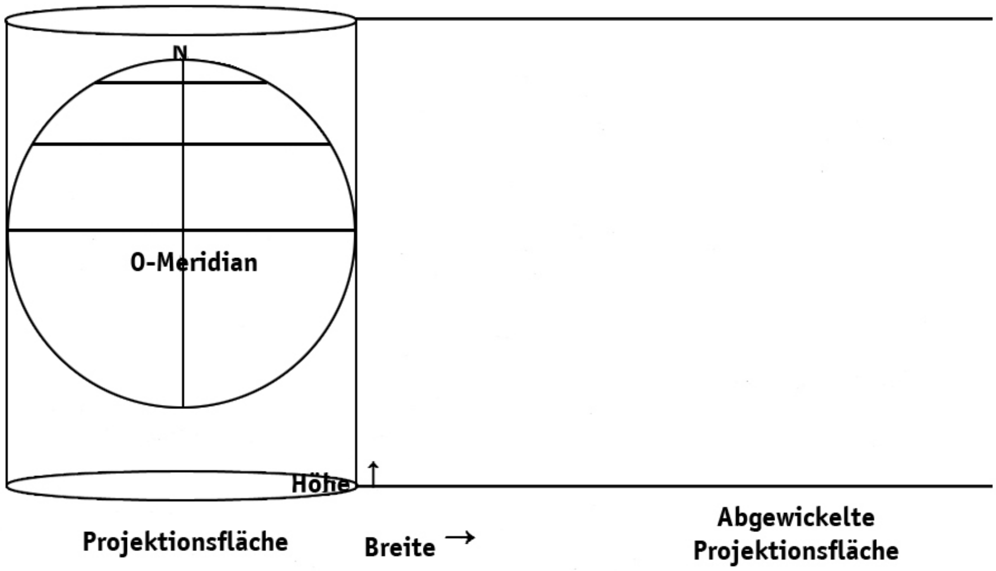
Aufgabe: Konstruiere in die umgeklappte Projektionsfläche:
- den 30. und den 60. nördlichen Breitengrad, den Nordpol.
- die Meridiane 0°, 30°O, 60°O, 90°O, 30°W, 60°W, 90°W.
- Was halten Sie von dem Versuch, den Äquator in die umgeklappte Projektionsfläche zu konstruieren?

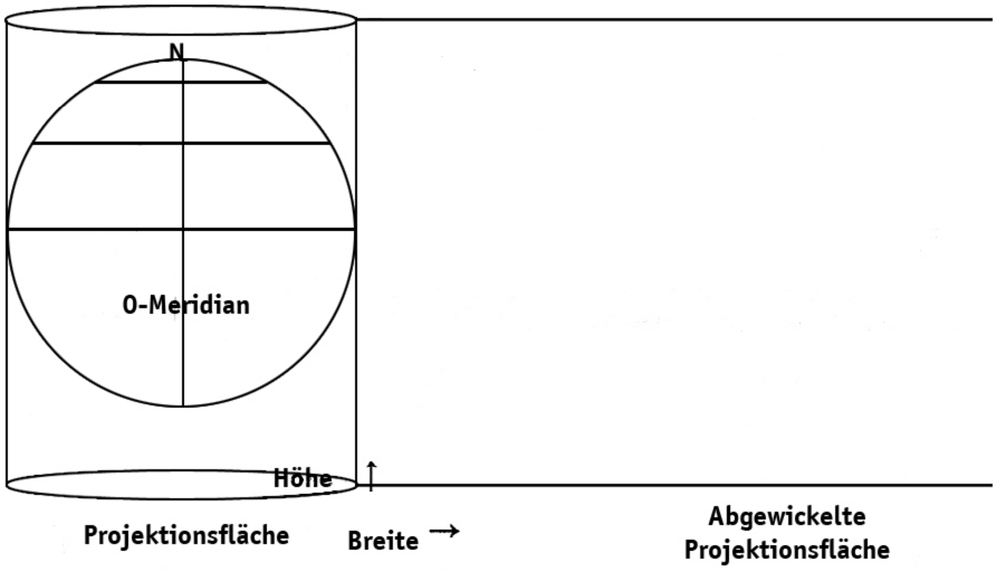
Arbeitsblatt (16) Kartenprojektion - Azimutale oder planare Projektionen



Aufgabe: Konstruiere in die umgeklappte Projektionsfläche:
- den 30. und den 60. nördlichen Breitengrad, den Nordpol.
- die Meridiane 0°, 30°O, 60°O, 90°O, 30°W, 60°W, 90°W°.

Arbeitsblatt (17) Kartenprojektion - Zylinderprojektionen



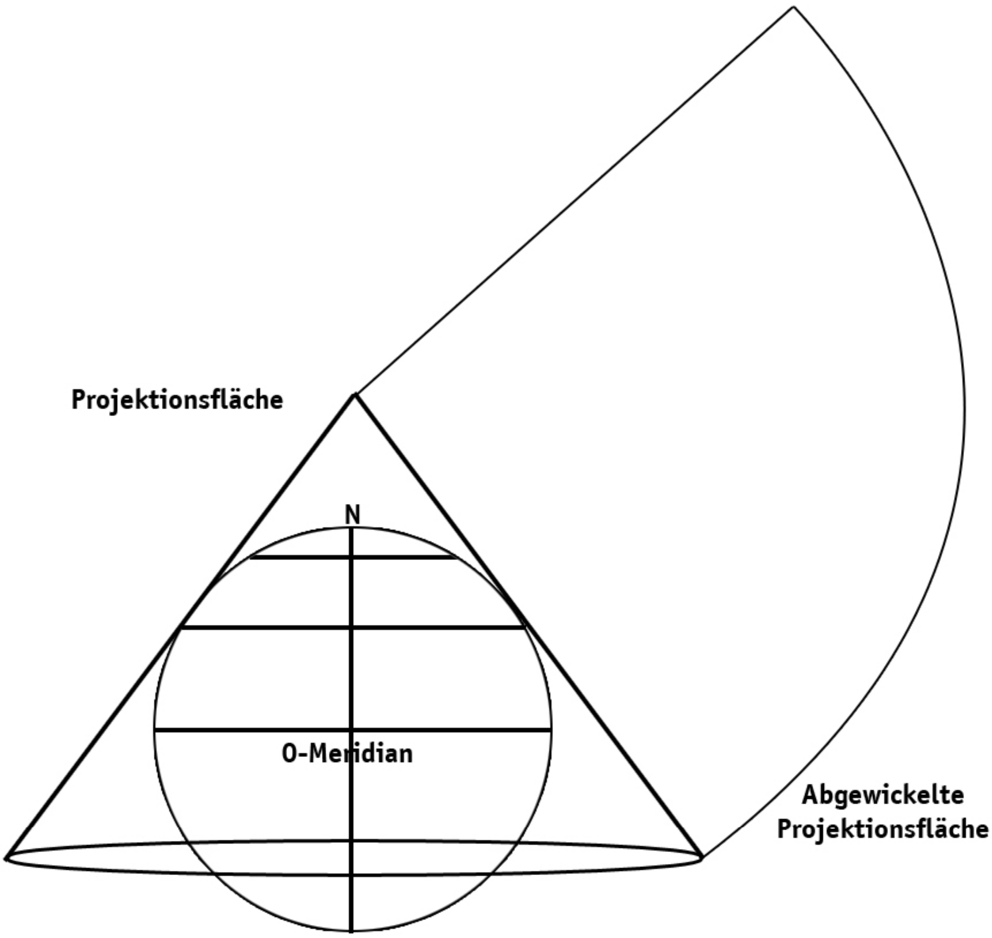


Skizziere in die beiden obigen Skizzen die wichigsten zwei Grundformen der Zylinderoprojektion!

Wie groß ist die Breite der abgewickelten Zylindermantelfläche?

____

Arbeitsblatt (18) Kartenprojektion - Kegelprojektionen



Wie werden die Meridiane und wie die Breitenkreise bei Parallel- und Zentralprojektionen dargestellt?

	Meridian	Breitenkreise
Parallel	---------------------------------	--------------------------------------
Zentral	---------------------------------	--------------------------------------

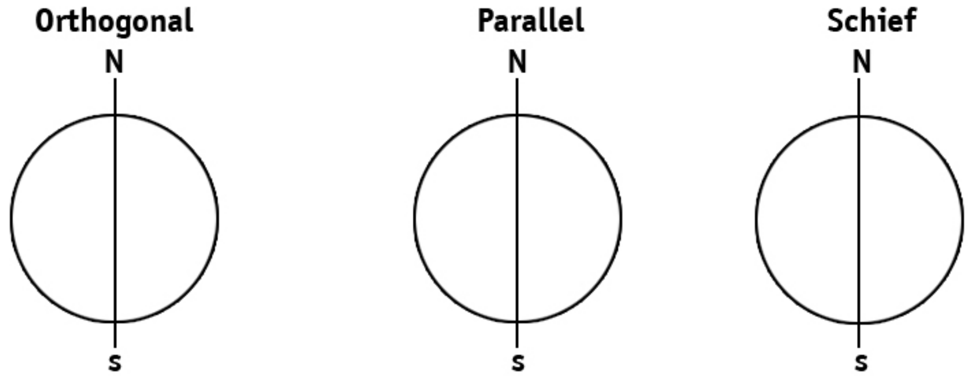
Welches Projektionszentrum ist nicht sinnvoll?

Arbeitsblatt (19) Kartenprojektion

1. Mögliche Stellungen der Erdachse zur ebenen Projektionsfläche (Azimutalprojektion):

orthogonal, parallel, schief

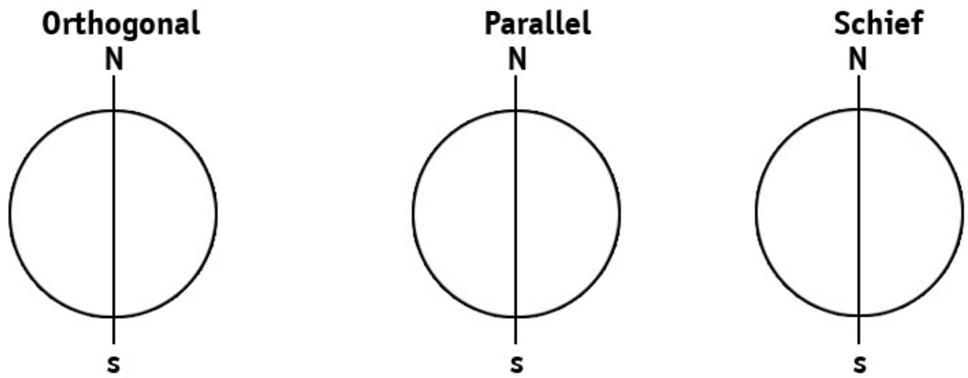
Zeichne die Projektionsfläche ein!



2. Mögliche Stellungen der Erdachse zur zylindrischen und zur kegelförmigen Projektionsfläche:

orthogonal, parallel, schief

Zeichne die Projektionsflächen ein!



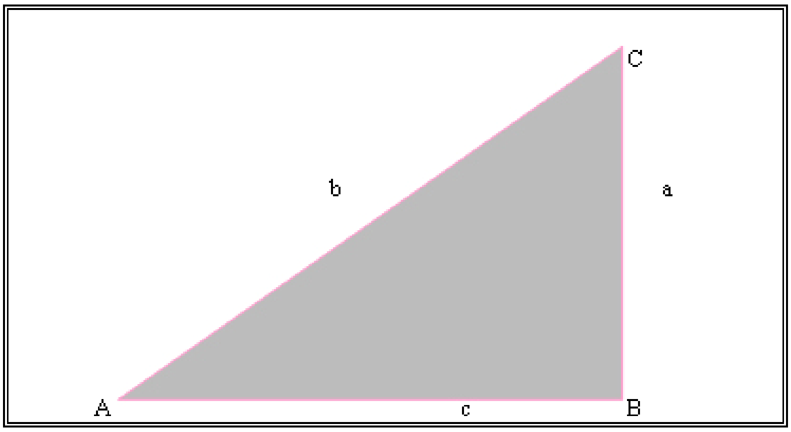
Arbeitsblatt (20) Kartenprojektion

Eignung der folgenden Projektionen:

	geeignet für	ungeeignet für
Azimutalprojektion		
Zylinderprojektion		
Kegelprojektion		

Arbeitsblatt (21)
4. Bestimme das Gefälle der Linie b in %:

Abbildung (9)

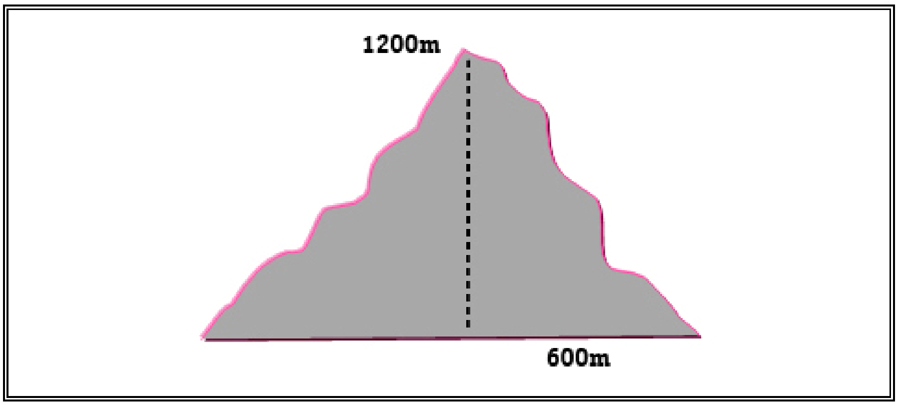


....
....
....

5. Das Gefälle in Grad ....
....

6. Berechne das durchschnittliche Berggefälle in %, auf der Seite des Berges, auf der der Fuß in der Waagerechten 600 m vom Gipfel entfernt ist.

Abbildung (10)

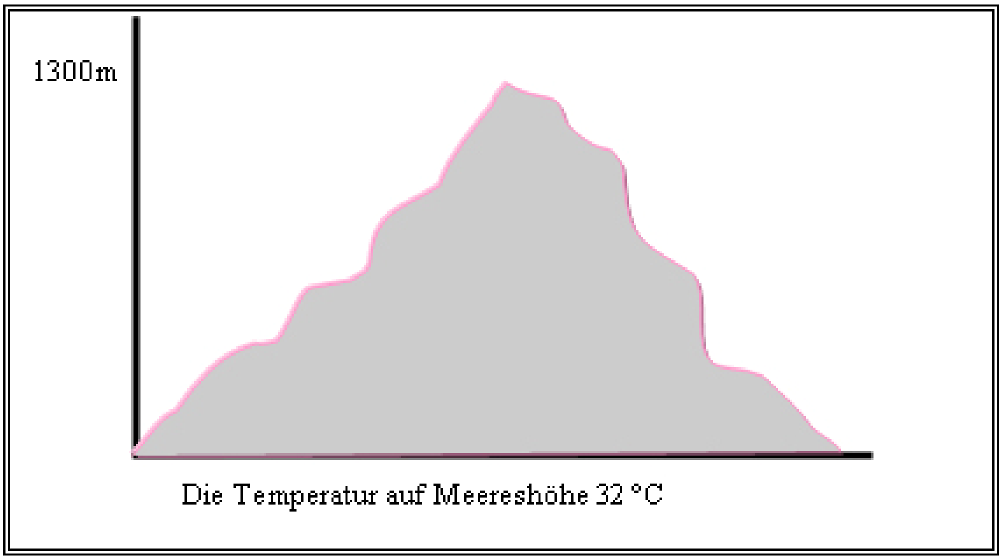


....
....

Arbeitsblatt (22) Wetter, Klima, Luftdruck, Trockenadiabatisch, Proportionalität, Relation, Äquivalenz und Geschwindigkeit

1. Die Temperatur auf Meereshöhe beträgt 32°C. Berechne die Temperatur, die im Mittel auf dem abgebildeten Berggipfel herrscht (trockenadiabatisch).

Abbildung (11)



....
....
....
....

3. Was bedeutet der Begriff Äquivalenz?
....
....

4. Nenne ein Beispiel für:
Proportionalität...

Relation...

Äquivalenz...

Kongruenz..

5. Berechne das Verhältnis folgender Zahlen.
1. 4/5 und 16

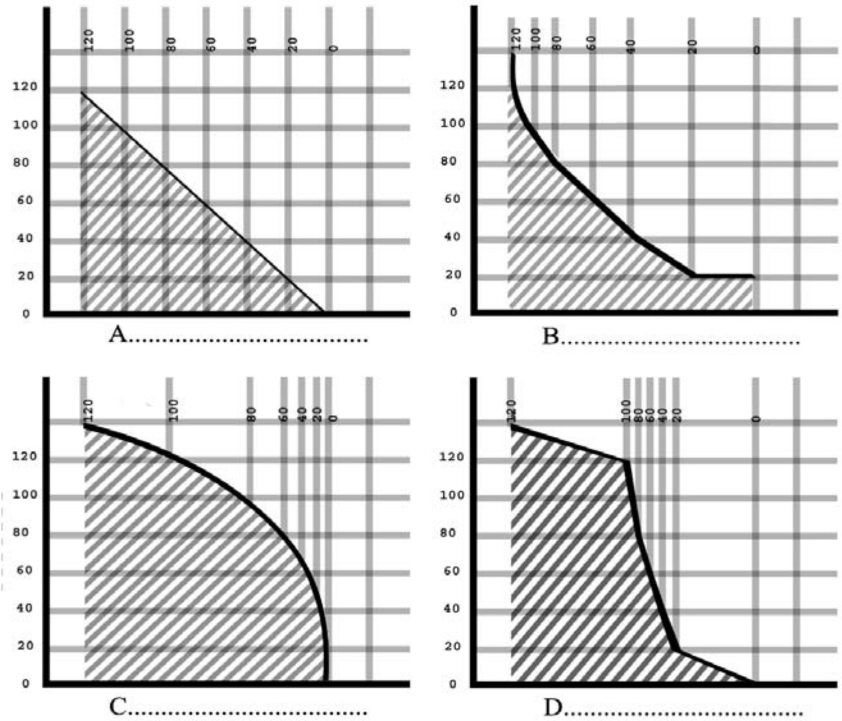
2. 2/3 und 15

3. 3/4 und 18

Arbeitsblatt (23) Gefälle

1. Ordnen Sie folgenden Gefälle-Profilen die Bezeichnungen a., b., c., oder d. zu!

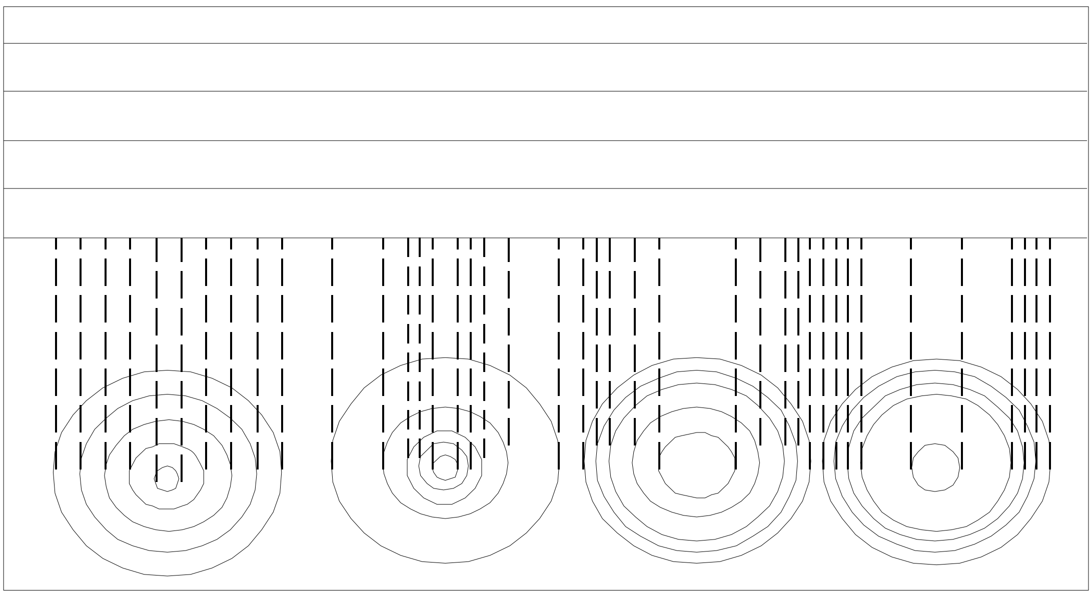
Abbildung (12)



a. Stetiges Gefälle.
b. Gestufter Hang.
c. Konkaver Hang.
d. Konvexer Hang.

2. Zeichnen Sie die Gefälleprofile in folgende Diagramme!

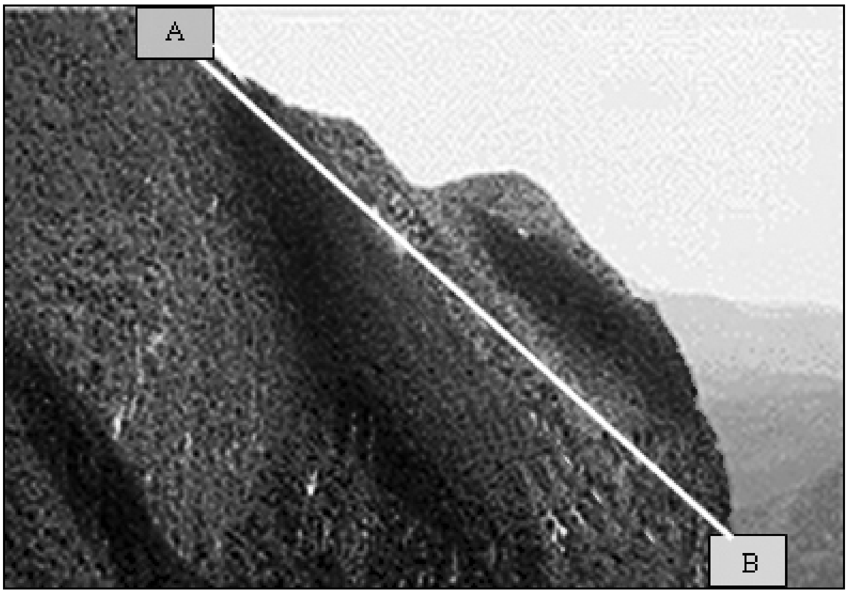
Abbildung (13)



Arbeitsblatt (24)

3. Zeichnen Sie Profile des sichtbaren Teils des Berggefälles auf dem folgenden Bild von A nach B!

Abbildung (14)



....
....
....
....

Arbeitsblatt (25) Die Profile

1. Zeichnen Sie die Profile zwischen A und B in dem Diagramm in Abbildung (15)!

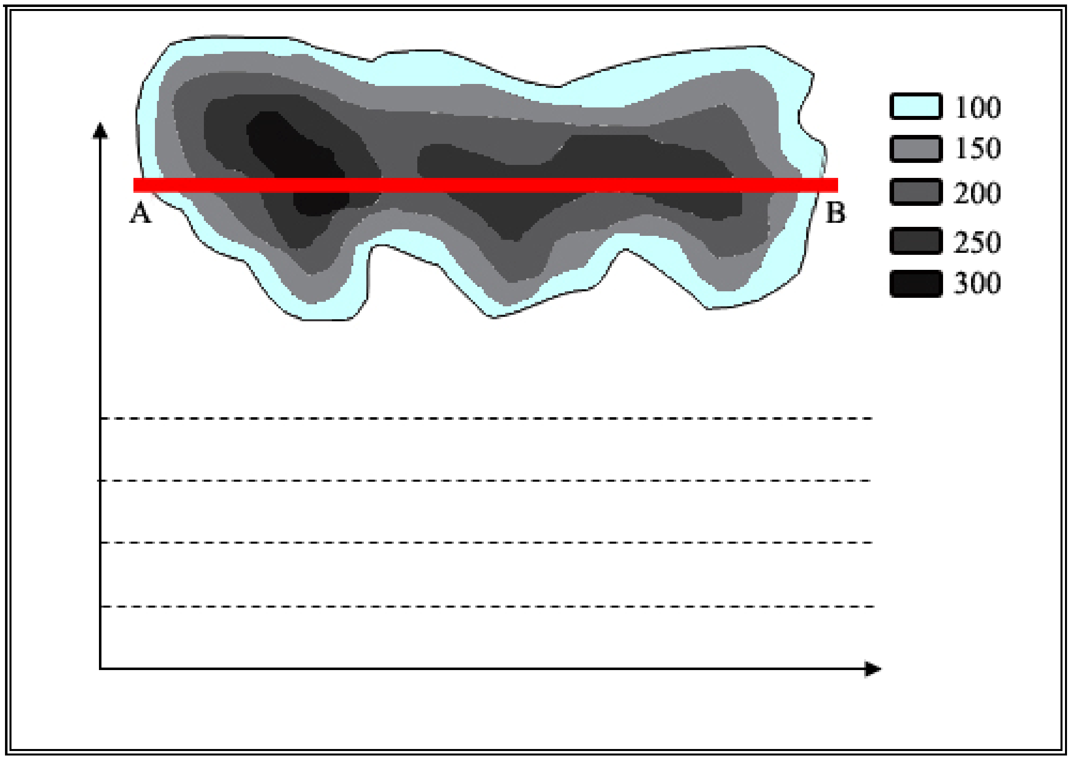
2. Bestimme den Höhenmaßstab der Karte in Abbildung (15).
   a. ≈ 1:10.000 □
   b. ≈ 1:20.000 □
   c. ≈ 1:30.000 □
   d. ≈ 1:40.000 □

3. Wie groß ist der maximale Höhenunterschied im Profil der Karte Abbildung (15)?

....

....

Abbildung (15)



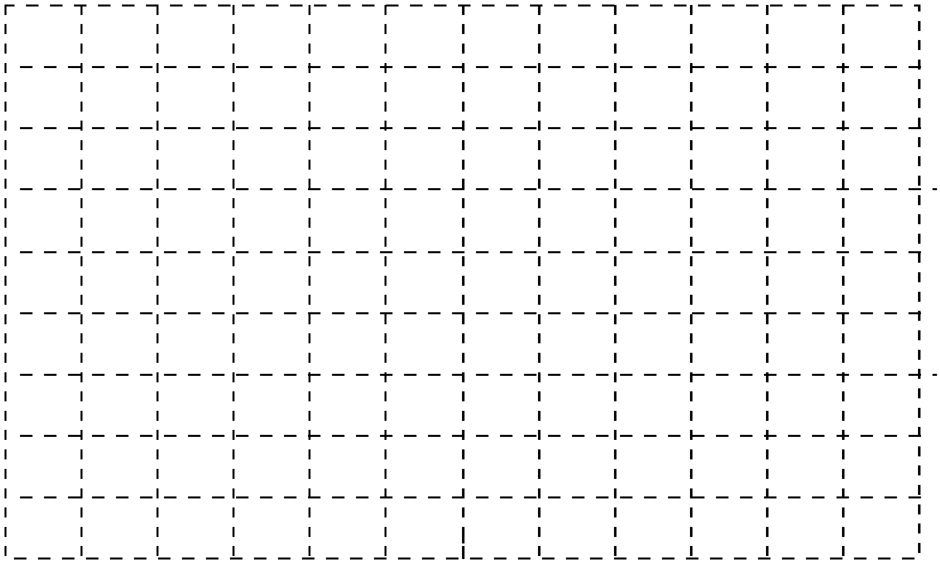
Arbeitsblatt (26)

1. Säulendiagramme

1. Geburtenrate (Trage sinnvoll ein):

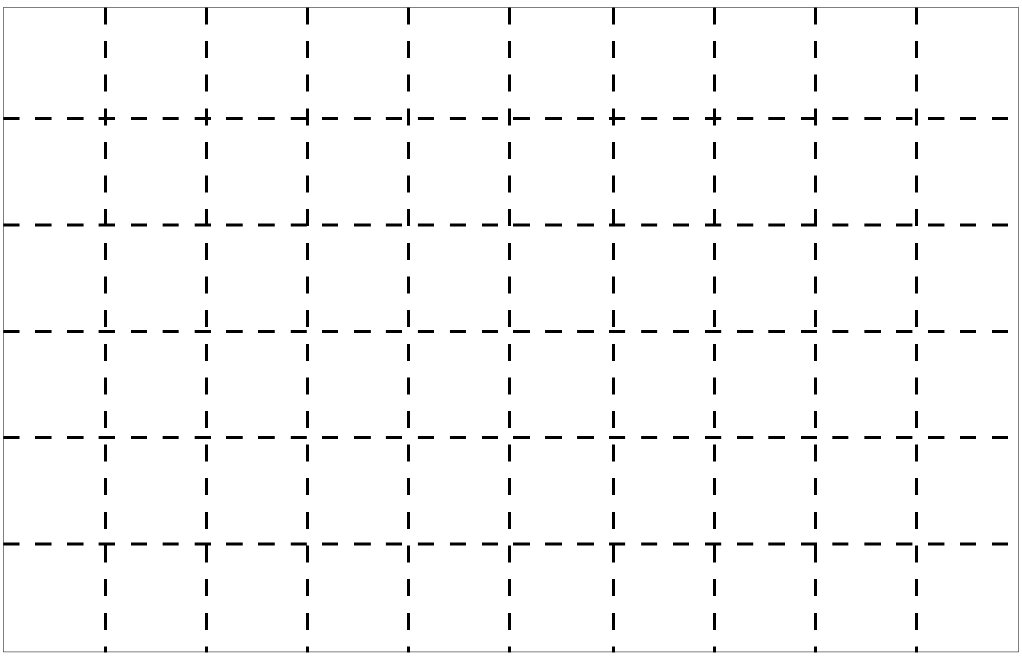
1,0%
0,9%
0,8%
0,7%

Abbildung (16)



2.Wirtschaftsektoren (primär. 3%, sek. 39%, tert. 58%)

Abbildung (17)



Arbeitsblatt (27)
3. Kreisdiagramme

3. Welche Vor- und Nachteile hat die Verwendung von Kreisdiagrammen:

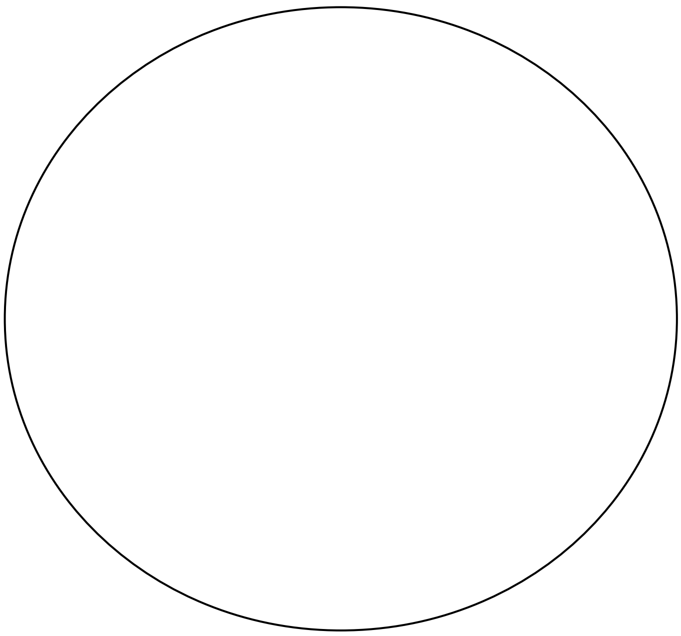
1. ______________________________

2. ______________________________

4. Verteile die folgenden Daten auf dem Kreisdiagramm!

Nummer	1	2	3	4	5	6
Boys	13	17	15	18	12	25
Girls	11	20	13	23	10	23

Abbildung (18)



Arbeitsblatt (28) Maßstab für eine Fotographie, Höhen und Neigung

1. Berechne den Maßstab für eine Fotographie, wenn die Brennweite für die Linse des Fotoapparates 150 Millimeter ist und das Flugzeug 3000 m hoch fliegt!
    a.1:20.000. □
    b.1:30.000. □
    c.1:40.000. □
    d 1:50.000. □

2. Berechne die Flugzeughöhe, wenn der Maßstab für die Fotografie 1:4500 ist und die Brennweite für die Linse des Fotoapparates 150 Millimeter ist!

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

3. Wie berechnet man den Maßstab für ein fotographisches Luftbild?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

Arbeitsblatt (29)

Was sind eigentlich Satellitenbilder?

Im Gegensatz zu Karten abstrahieren Satellitenbilder nicht. Sie verschaffen zwar einen Überblick, generalisieren aber nur in dem Maß, in dem ihre Auflösung beschränkt ist. D.h. jedes Pixel eines Satellitenbildes bildet einen Ausschnitt der Erdoberfläche ab. Je nach "Auflösung" des verwendeten Sensors, also der „Kamera“, bildet ein Pixel unterschiedliche quadratische Flächen ab:

hochauflösend: ab 1 x 1 Meter Fläche

mittlere Auflösung: zwischen 20 x 20 Meter und 250 x 250 Meter

geringe Auflösung. ab 250 x 250 Meter

Abbildung (20) Nile Oberlauf in Ägypten

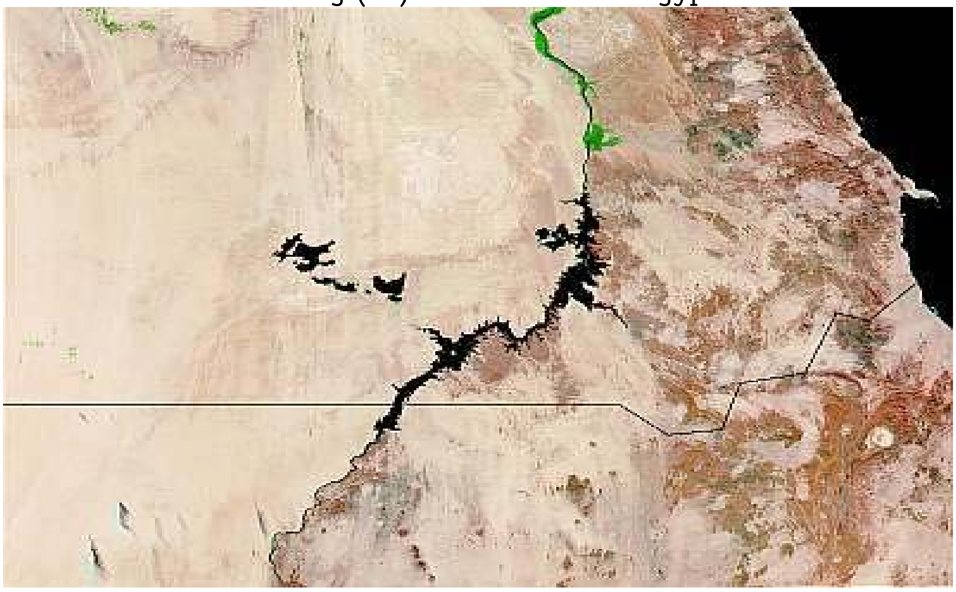


Abbildung (21) Unterlauf in Ägypten

Arbeitsblatt (30)

Diese Bilder in Arbeitblatt 29 wurden 2003 vom Modus-Sensor auf dem TETRA-Satelliten der NASA aufgenommen. Nicht nur das sichtbare Licht (Farbkanäle: rot, grün, blau), sondern auch verschiedene Infrarot-Bereiche (z.B.: nahes Infrarot für Vegetation, thermisches Infrarot für Temperaturinformationen) werden aufgezeichnet. In den Falschfarben-Bildern wird das nahe Infrarot mit abgebildet, sodass pflanzliches Leben deutlicher zu sehen ist.

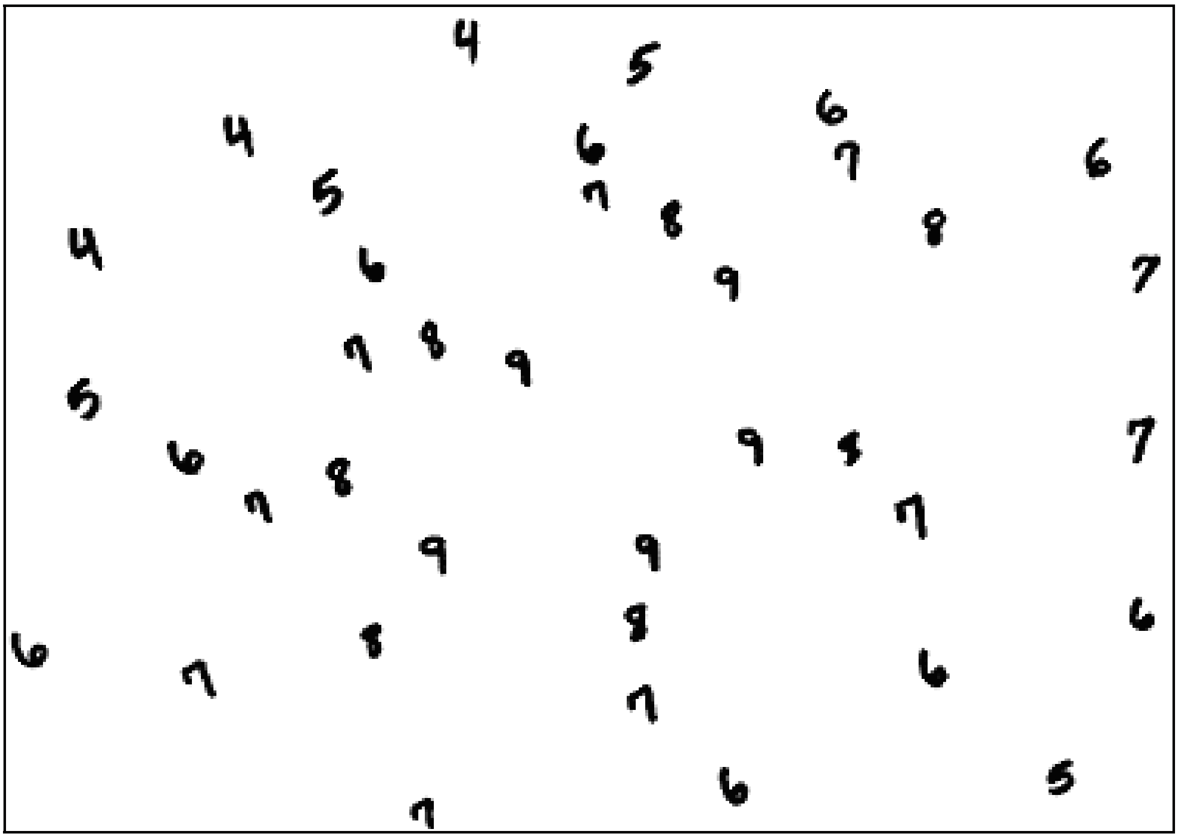
Interpretation eines Satellitenbildes

1. Einordnung:	Maßstab etwa:
2. Gliedern:	
3. Beschreibung: (Erfassen von Einzelphänomenen)	
4. Identifikation von Einzelphänomenen:	
5. Auswertung (Vernetzung von Einzelphänomenen):	

Arbeitsblatt (31) Höhenlinien, Portion und Proportion

1. Verbinden Sie die Zahlen gleicher Werte in der Karte, damit eine topographische Darstellung daraus entsteht!

Abbildung (22)



2. Welche topographische Figur sieht man in der Karte?

....

....

....

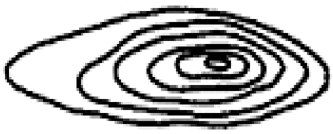
Arbeitsblatt (32)

3. Zeichnen Sie ein Profil der geographischen Formen über den Gipfel parallel zur Blattoberkarte!

A

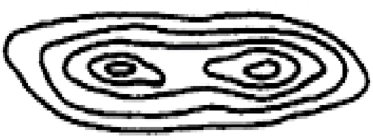
B

C



D

E

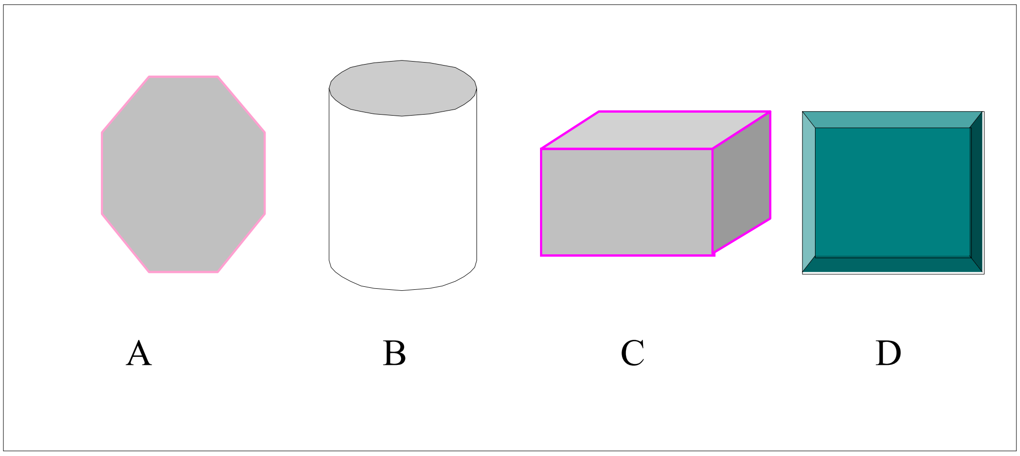


Arbeitsblatt (33)

1. Zeichnen Sie 2 verschiedene Repräsententanten eines Vektors:
   a) aus einem Vektorraum der Dimension 1
   b) aus einem Vektorraum der Dimension 2

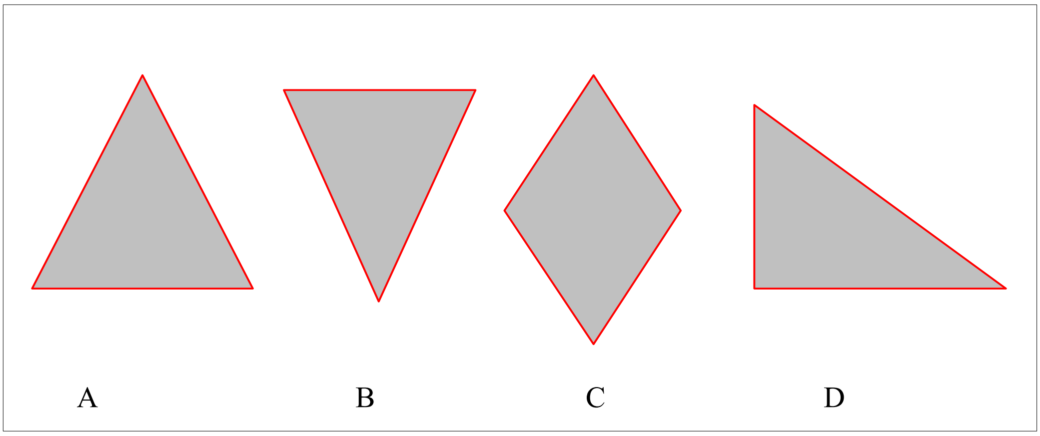
2. Welche geometrische Figur stellt einen Kubus dar?

Abbildung (23)



3. Welche geometrische Figur gleicht dem Matterhorn auf der topographischen Karte?

Abbildung (24)

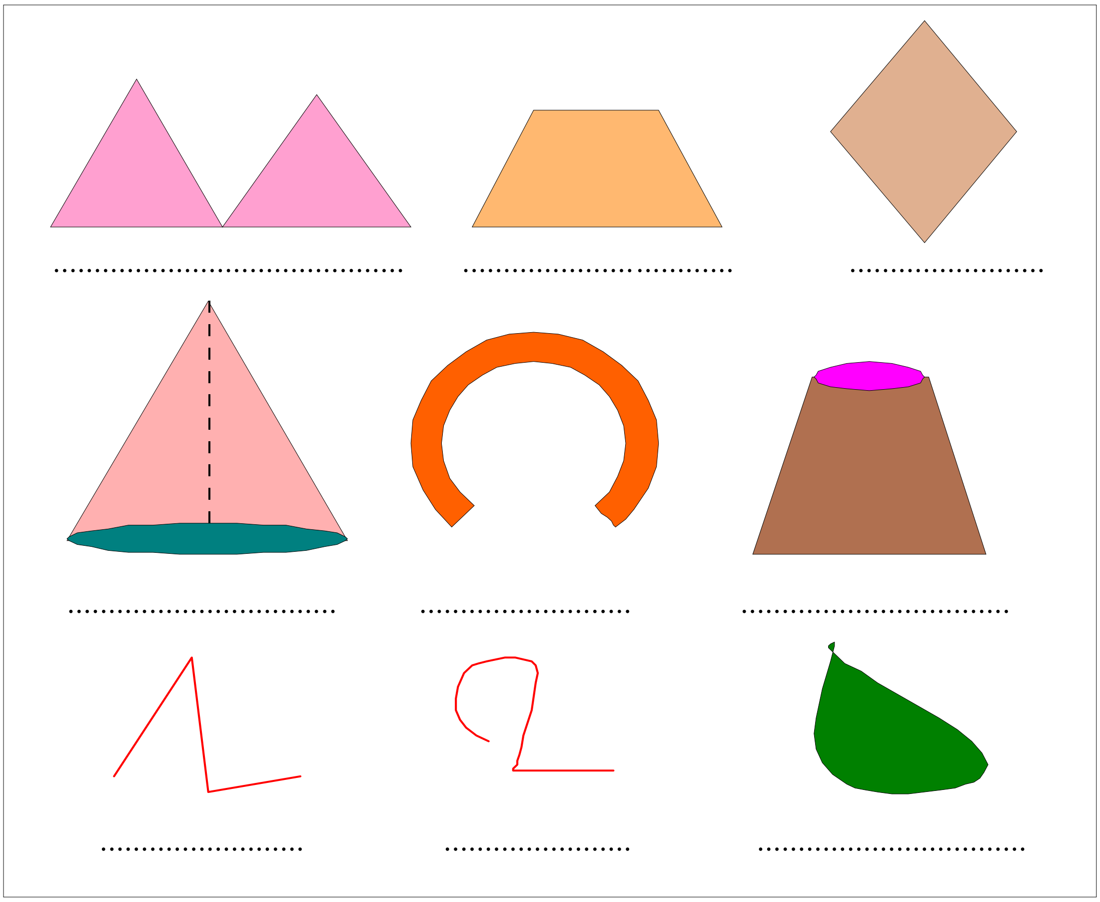


Arbeitsblatt (34)

4. Zeichnen Sie Sekanten zu einem Kreis!

5. Welche geographischen Formen können folgende geometrische Formen darstellen?

Abbildung (25)



Appendix (4)
Achievement test of the proposed program for the development of geo-math concepts and skills

Important note:

Please read this part before you start answering the test

Name: ....

Date: ....

Term: ....

Diploma: ...., LA: ....

Time duration: 30 minutes

Dear students of geography

This test aims at measuring how far students of geography possess the mathematical skills and concepts that are necessary for studying and mastering geography. Through the following programs, you can develop your mathematical basic skills and conception.

Please consider the following:
-There are three different questionnaires.

And now: Good luck!!

(1) What do the following concepts mean?

(a) Map scale

(b) Measurement

(c) Geographical position

(d) Vector

(e) Parallelogram

(f) Degree of longitude

(g) Direction

(h) Projection

(i) Downward gradient

(j) Slope inclination

(k) Climates

(l) Pressure

(m) Volume

(n) Profile

(o) Heights

(p) Angle of inclination

(q) Axis coordinates

(r) Secant

(s) Cubes

(t) Conical

----

(2) Which statements are correct, and which are incorrect?

No.	Statements	Correct or incorrect
1	The surface scale is a measure in the form of fraction which explains the percentage between the map and reality and can be in the form of kilometers or miles and centimeters, like this figure 1:10.000 or $\frac{1}{100}\,or\,\frac{1}{10.000}$	
2	The distance between the equator and the north pole amounts to 90°, approximately 400 km².	
3	One can calculate time differences between places through calculating the degrees of latitude.	
4	When the cities of New Orleans and Houston in the USA are located in a latitude of 30° and the distance between the two cities on the map is 5° degrees of longitude, then the distance between them in reality will be either 300 miles or 482 km.	

No.	Statements	Correct or incorrect
5	If you want to magnify a map scale is 1:100.000, the new scale should be 1:25.000.	
6	The high value coordinate is always parallel in the Mercator-projection to the degree of longitude and is shown in the following shape: $\uparrow$	
7	The following mathematical shape means a stable distance $\longrightarrow$	
8	If you want to calculate the angle of inclination, you must know the projection surface on the horizontal level.	
9	One determines the climate for a day, week, or month through the use of temperature, wind, air pressure, and rain.	
10	One can recognize the concave downward through the closeness of the height lines on the top which, then, get further from each other towards the bottom or the base.	
11	The Diagrammatic Triangle is used for clarifying different phenomena as the raw scores are represented in percents as shown in the divided diagrammatic circles.	
12	“Focus distance” means the distance between centres and figure situations.	
13	The “Contour” refers to a line (an orthogonal line) drawn on a map connecting points of equal height to the downward gradient lines.	
14	A “Secant” refers to any line that links the centre of a circle with any point on this circle.	
15	“Symmetrically” and “vertically” have the same meaning.	
16	By the baseline and height, one can determine the parallelogram surface.	
17	Proportionality” means the equivalence of two conditions to a constant factor e.g.: $\frac{A}{B} = \frac{C}{D} \bullet const$	
18	The integers and fractions are divided by the real numbers to calculate the average.	
19	The compass needle always indicates the direction to the magnetic north pole.	
20	The statistics can be explained by circle diagrams.	

(3) Choose he correct answer:

(1) The degrees of longitude shown on the map:

a. are parallel lines. □ c. are always lines vertical to the equator. □

b. are always curved lines. □ d. are never closed lines. □

(2) If in Greenwich it is exactly 1 h p.m. (local time) and in Melbourne (Australia) it is exactly 10 h p.m. (local time), on which degree of longitude is Melbourne's position?

a. 150° West. □ c. 135° West. □

b. 150° East. □ d. 135° East. □

(3) The tropic of cancer lies on 23,5° degrees north of the equator and the tropic of Capricorn lies on 23,5° degrees south of the equator, this means?

a. both tropics have exactly the same length. □

b. the tropics' inclination to the earth's axis is 23,5°. □

c. the tropics' inclination to the ecliptic (plane of the Earth's orbit) is 66,5°. □

d. the tropics' inclination to the ecliptic (plane of the Earth's orbit)is 23,5°. □

(4) The distance between the equator and 1° of latitude amounts approx. 111 km. How many miles are 111 km?

a. 92,9 miles. □ c. 85,8 miles. □

b. 69,4 miles. □ d. 73,8 miles. □

(5) The scale of an aerial photograph:

a. Objective focal length • flight altitude. □

b. Objective focal length / flight altitude. □

c. Flight height + objective focal length. □

d. Flight height – objective focal length. □

(6) Suppose that you want to magnify a map whose drawing scale is 1:25,000 and the area magnification coefficient is 3, what will the magnification area of 250 meters be on the map?

a. 2 cm. □ c. 4 cm. □

b. 3 cm. □ d. 5 cm. □

(7) The sun rises

a. In December: in Germany in the southeast, in Australia in the northeast. □

b. In December: in Germany in southeast, in Australia in the southeast. □

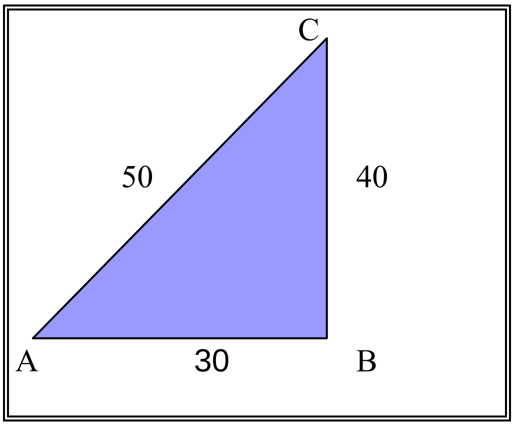
c. At the equator always in the east. □

d. In June: in Australia in the southeast. □

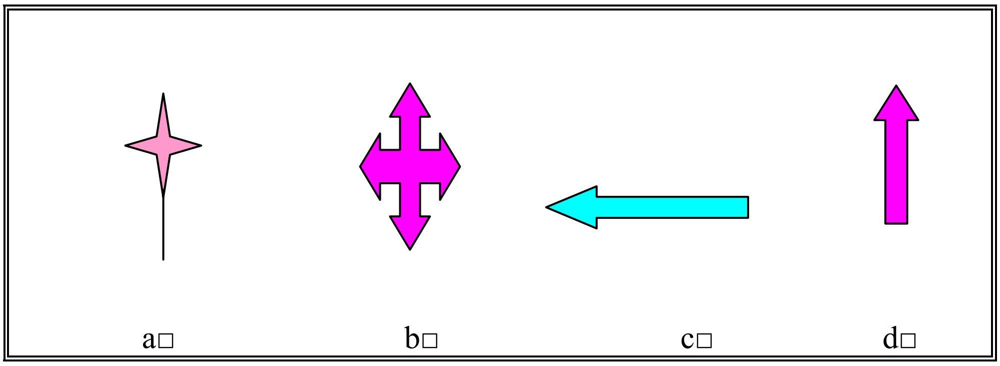
(8) In triangle ABC are: $\overline{AB}$ = 30m, $\overline{AC}$ = 60m, $\overline{BC}$ = 40m. What is the inclination of $\overline{CA}$?

a. ≈39%. ☐ c. ≈125%. ☐

b. ≈80%. ☐ d. ≈53%. ☐



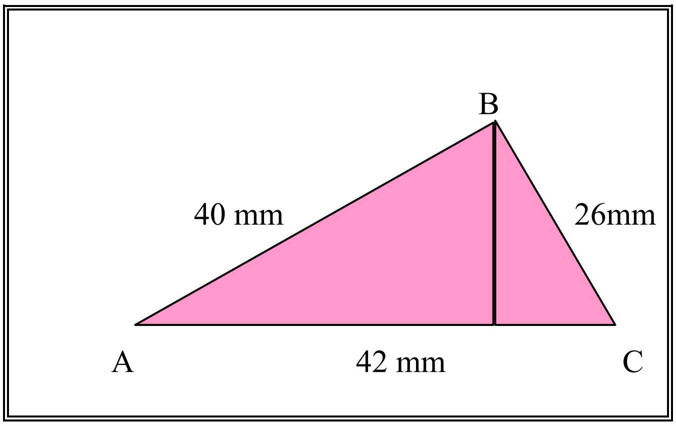
(9) Which signature shows the north direction in a map?



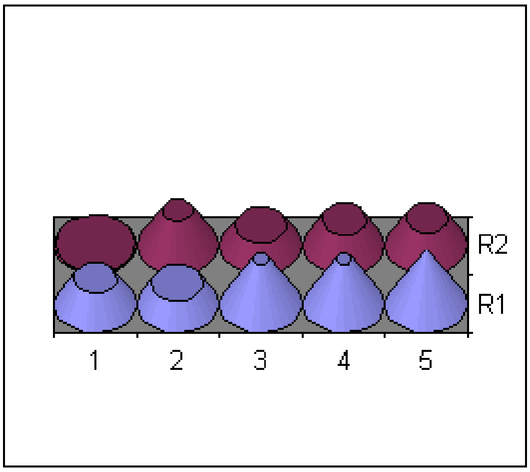
(10) In triangle ABC are: $\overline{AB}$ = 40mm, $\overline{AC}$ = 42mm, $\overline{BC}$ = 26mm. How large is the area?

a. 504 mm^2. ☐ c. 520 mm^2. ☐

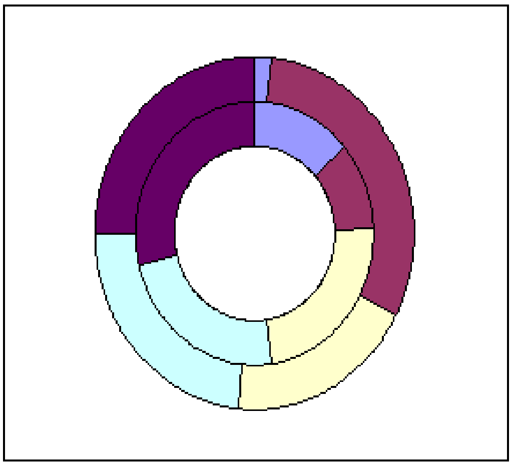
b. 512 mm^2. ☐ d. 532 mm^2. ☐



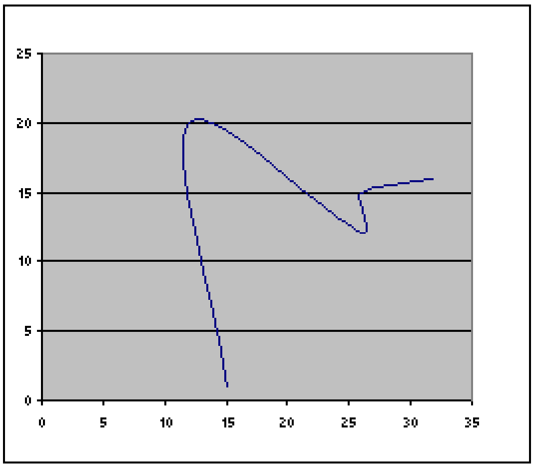
(11) Which of the following diagrams is based on polar coordinates?



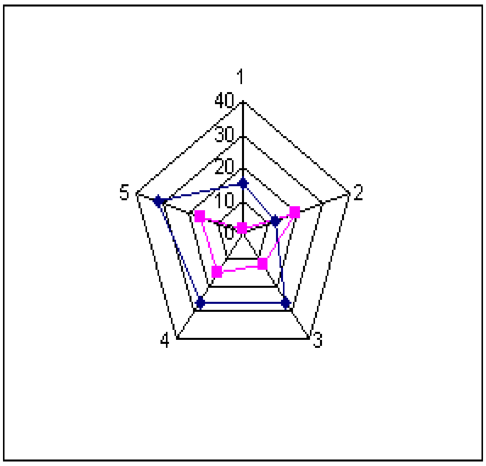
a □



b □



c □



d □

Wichtiger Hinweis:

Bitte lesen Sie diese Seite, bevor Sie mit dem Test beginnen

Name:...................

Datum:...............

Semester............,Diplom........., LA:..........., Fächerverbindung:.........

Testdauer: 30 Minuten

Liebe Studierende des Faches Geographie:

Dieser Test ist für Studierenden der Geographie: Durch die folgenden Programme können Sie Ihre mathematischen Grundfertigkeiten und Kenntnisse testen.

Bitte beachten Sie Folgendes:
- Sie haben drei verschiedene Fragebögen.

Und nun: Viel Spaß und Erfolg bei Ihrem Test!

1. Was bedeuten die folgenden Wörter:

(a) Maßstab

(b) Vermessung

(c) Geographische Position

(d) Vektoren

(e) Parallelogramm

(f) Längengrad

(g) Richtung

(h) Projektion

(i) Gefälle

(j) Hangneigung

(k) Klimate

(l) Druck

(m) Volumen

(n) Profil

(o) Höhen

(p) Neigungswinkel

(q) Achsenkoordinate

(r) Sekante

(s) Kubus

(t) Konisch

----

2. Welche Aussagen sind richtig und welche falsch?

Nr.	Die Aussagen	richtig oder falsch
1	Der Flächenmassstab stellt beim Messen in der Karte den Bezug zur Realität in Kilometer, Meilen oder Zentimeter her, wie diese Figur 1:10.000 oder $\frac{1}{100} or \frac{1}{10.000}$	
2	Die Distanz zwischen Äquator und Nordpol beträgt 90°, das heißt ungefähr 4000 km^2.	
3	Man kann die Uhrzeit mit Hilfe der Breitengrade bestimmen.	
4	Wenn New Orleans (U.S.A) und Houston (U.S.A) auf dem 30. Breitengrad liegen und der Abstand der beiden Städte 5° Längengrade beträgt, dann ist die Distanz zwischen beiden rund 300 Meilen oder 480 km.	
5	Wenn Sie eine Karte mit dem Maßstab 1:100.000 vergrößern möchten, kann der neue Maßstab 1:25.000 sein.	
6	Die Hochwert-Koordinate ist in der Mercator-Projektion immer parallel zum Längengrad und zeigt wie dieses Zeichen $\uparrow$	
7	Das folgende Zeichen bedeutet Distanz $\longrightarrow$	
8	Wenn Sie den Neigungswinkel errechnen wollen, müssen Sie die Projektionsfläche auf der horizontalen Ebene kennen.	
9	Das Klima bestimmt man aus dem Tages-, Wochen, und Monatsdurchschnitt von Temperatur, Wind, Luftdruck, Feuchtigkeit und Niederschlag.	
10	Das konkave Gefälle erkennt man in der Karte durch geringe Höhenlinienabstände im oberen Bereich des Hanges und durch große Höhenlinienabstände im unteren Bereich.	
11	Das Dreiecksdiagramm der Verteilung von Prozentzahlen stellt man durch gleichmäßige Verteilung über den Kreis dar.	
12	In einer Weltkarte können Längen - und Breitenkreise längentreu wiedergegeben werden.	
13	Die Höhenlinie bedeutet eine orthogonale Linie zu den Gefällelinien.	
14	Sekante nennt man die Linie zwischen dem Kreismittelpunkt und jedem Punkt auf diesem Kreis.	
15	Symmetrisch und vertikal haben die gleiche Bedeutung.	
16	Durch die Grundlinie und Höhe kann man die Parallelogrammfläche bestimmen.	
17	Proportionalität bedeutet bis auf einen konstanten Faktor die Gleichwertigkeit zweier Verhältnisse, wie z. B.: $\frac{A}{B} = \frac{C}{D} \bullet const$	
18	Eine Gesamtheit von Zahlen geteilt durch die Anzahl der Zahlen ergibt den Durchschnitt.	
19	Die Kompassnadel zeigt immer die Richtung zum magnetischen Nordpol an.	
20	In einer Statistik können Prozentwerte in einem Kreisdiagramm dargestellt werden.	

3.Wählen Sie die richtige Antwort:

1. Längengrade in der Karte:
   - a. können parallele Linien sein. □
   - b. sind stets gekrümmte Linien. □
   - c. sind stets zum Äquator vertikale Linien. □
   - d. sind niemals geschlossene Linien. □

2. In Greenwich ist es genau 1 Uhr Vormittages (wahre Ortzeit) und in Melbourne (Australien) ist es genau 10 Uhr Vormittages (Wahre Ortzeit) Auf welchem Längengrad liegt Melbourne?

a. 150° westlich.	□	c. 135° westlich.	□
b. 150° östlich.	□	d. 135° östlich.	□

3. Der Nördliche Wendekreis liegt auf 23,5° nördlich des Äquators und der Südliche Wendekreis liegt auf 23,5° südlich des Äquators. Das bedeutet?
   - a. Nördliche Wendkreis hat genau die gleiche Länge wie der südliche Wendekreis. □
   - b. Wendkreise sind 23,5° zur Erdachse geneigt. □
   - c. Wendekreise sind 66,5° zur Ekliptik (Erdbahnebene) geneigt. □
   - d. Wendkreise sind 23,5° zur Ekliptik (Erdbahnebene) geneigt. □

4. Die Distanz zwischen dem Äquator und 1° nördliche. Breite beträgt ca. 111 km. Wie viele Meilen sind das?

a. 92,9 Meilen.	□	c. 69,4 Meilen.	□
b. 85,8 Meilen.	□	d. 73,8 Meilen.	□

5. Der Maßstab für ein fotographisches Luftbild ist?
   - a. Objektivbrennweite . Flughöhe. □
   - b. Objektivbrennweite / Flughöhe. □
   - c. Flughöhe + Objektivbrennweite. □
   - d. Flughöhe – Objektivbrennweite. □

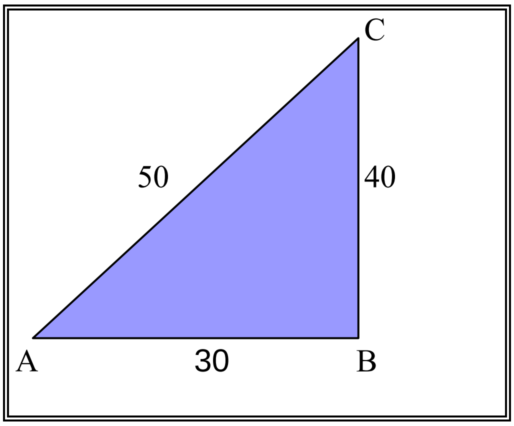
6. Sie möchten eine Karte 1:25000 auf das Dreifache vergrößern. Wie groß sind in der vergrößerten Karte 250m?

a. 2 cm.	□	c. 4 cm.	□
b. 3 cm.	□	d. 5 cm.	□

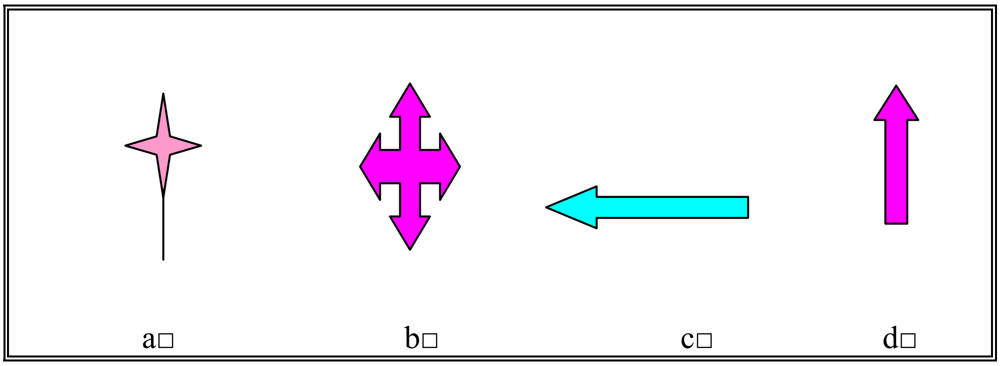
7. Die Sonne geht auf
   - a. Im Dezember in Deutschland im SO, in Australien im NO. □
   - b. Im Dezember in Deutschland im SO und in Australien im SO. □
   - c. Am Äquator immer im O. □
   - d. Im Juni in Australien im SO. □

8. Im Dreieck ABC ist $\overline{AB}$= 30m, $\overline{AC}$= 60m und $\overline{BC}$= 40m. Wie groß ist das Gefälle von $\overline{CA}$?

a. ≈39%. □ c. ≈125%. □
b. ≈80%. □ d. ≈53%. □

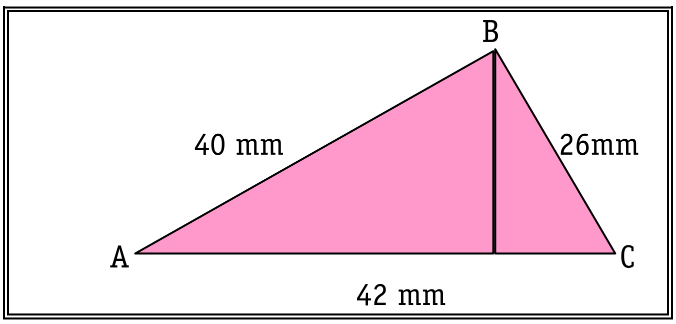


9. Welche Signatur zeigt die Nordrichtung auf der Karte?

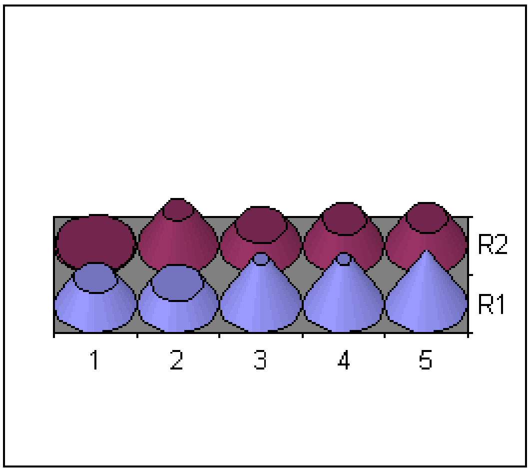


10. Im Dreieck ABC ist $\overline{AB}$= 40mm, $\overline{AC}$= 42mm und $\overline{BC}$= 26m. Wie groß ist Flächeninhalt?

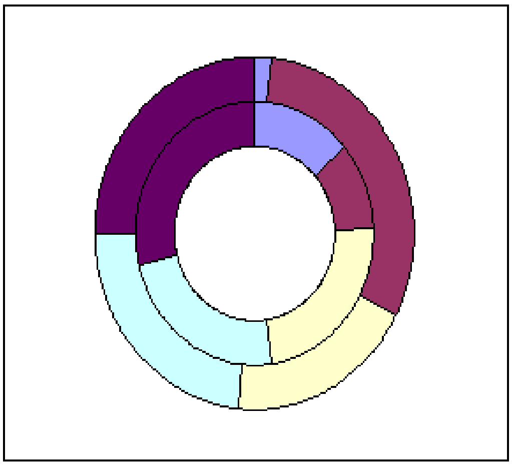
a. 504 mm^2. □ c. 520 mm^2. □
b. 512 mm^2. □ d. 532 mm^2. □



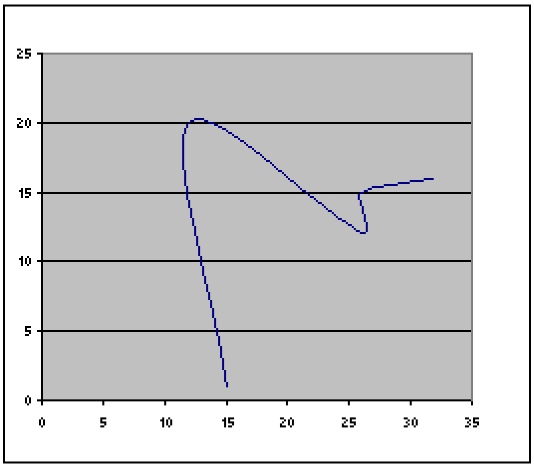
11. Welches der folgenden Diagramme beruht auf Polarkoordinaten?



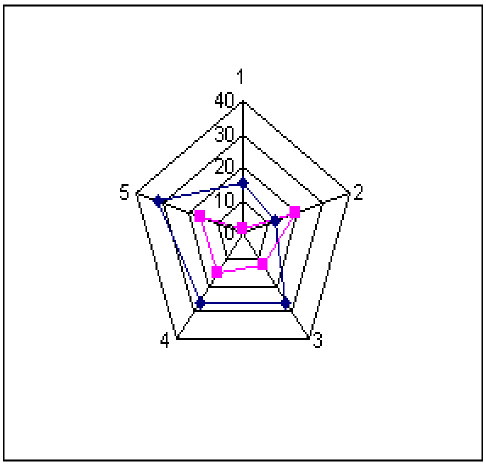
a □



b □



c □



d □

Appendix (5)
The student's raw scores in the math skills test

	The questions																																			
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0	28
2	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1	32
3	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	29
4	1	1	1	0	1	1	1	0	1	1	0	1	1	0	0	1	0	0	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1	0	1	1	23
5	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	31
6	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	0	1	1	29
7	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	1	0	0	24
8	1	1	1	1	0	0	1	1	1	1	1	0	0	0	1	0	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	1	0	1	24
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0	1	30
10	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	32
11	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	1	1	1	0	0	1	1	0	1	1	1	1	21
12	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	0	0	1	1	1	0	0	26
13	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	26
14	0	0	0	0	1	1	1	0	1	1	0	0	0	1	1	0	1	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	1	1	0	0	21
15	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	1	1	0	1	1	1	1	1	0	0	1	1	26
16	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	30

No. Means number of student and total means total of points

Supplementary appendix (5) The raw scores of the math skills test

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
17	1	1	0	1	1	0	1	1	0	1	0	0	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	1	25
18	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	1	1	0	25
19	0	0	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	26
20	0	0	1	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	25
21	1	1	0	1	0	0	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	26
	17	16	17	14	18	17	18	14	14	15	14	15	15	17	17	15	15	15	15	16	17	14	15	15	14	18	14	15	15	18	15	14	14	14	15	16	

Calculated facility value for students' scores of math skills test

Students numbers	Total degree	Correct answers	Incorrect answers	Facility value	Difficulty value
1	36	28	8	, 77	, 23
2	36	32	4	, 88	, 12
3	36	29	7	, 80	, 20
4	36	23	13	, 63	, 37
5	36	31	5	, 86	, 14
6	36	29	7	, 80	, 20
7	36	24	12	, 66	, 34
8	36	24	12	, 66	, 34
9	36	30	6	, 83	, 17
10	36	32	4	, 88	, 12
11	36	21	15	, 58	, 42
12	36	26	10	, 72	, 28
13	36	26	10	, 72	, 28
14	36	21	15	, 58	, 42
15	36	26	10	, 72	, 28
16	36	30	6	, 83	, 17
17	36	25	11	, 69	, 31
18	36	25	11	, 69	, 31
19	36	26	10	, 72	, 28
20	36	25	11	, 69	, 31
21	36	26	10	, 72	, 28

$$\text{By test statistics} = \frac{\text{Correct answers}}{\text{Correct answers + incorrect answer}}$$

Calculated facility value for math skills test score of the guess value

Students numbers	Total Score	Correct answers	Incorrect answers	Facility value from the guess	Students numbers	Total Score	Correct answers	Incorrect answers	Facility value from the guess
1	36	28	8	, 70	**12**	36	26	10	, 62
2	36	32	4	, 85	**13**	36	26	10	, 62
3	36	29	7	, 74	**14**	36	21	15	, 44
4	36	23	13	, 51	**15**	36	26	10	, 62
5	36	31	5	, 81	**16**	36	30	6	, 77
6	36	29	7	, 74	**17**	36	25	11	, 59
7	36	24	12	, 55	**18**	36	25	11	, 59
8	36	24	12	, 55	**19**	36	26	10	, 62
9	36	30	6	, 77	**20**	36	25	11	, 59
10	36	32	4	, 85	**21**	36	26	10	, 62
11	36	21	15	, 44					

$$\text{By test statistics} = \frac{\text{Correct answers} - \dfrac{\text{Incorrect answers}}{\text{1- Alternative}}}{\text{Correct answers + incorrect answers}}$$

Appendix (6)
The raw scores of the math concepts test

Supplementary appendix (6)The raw scores of the math concepts test

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	T
17	1	1	0	1	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1	0	0	1	1	0	0	1	0	1	1	1	0	1	1	0	27
18	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	29
19	0	0	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	0	1	0	1	1	1	1	0	27
20	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	0	0	1	0	1	1	0	0	1	0	1	1	1	24
21	1	1	0	1	1	0	1	0	1	1	1	1	1	1	0	0	1	0	1	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1	0	1	1	1	25
	18	16	17	14	19	17	17	14	16	14	15	15	16	17	15	15	15	16	16	17	15	18	15	15	14	16	19	14	15	15	16	15	17	17	16	16	13	16	16	17	

Calculated facility value for students' scores of math concepts test

Students numbers	Total Scores	Correct answers	Incorrect answers	Facility value	Difficulty value
1	40	35	5	, 87	, 13
2	40	30	10	, 75	, 25
3	40	34	6	, 85	, 15
4	40	25	15	, 62	, 38
5	40	36	4	, 90	, 10
6	40	26	14	, 65	, 35
7	40	34	6	, 85	, 15
8	40	28	12	, 70	, 30
9	40	36	4	, 90	, 10
10	40	37	3	, 92	, 8
11	40	27	13	, 67	, 33
12	40	33	7	, 82	, 18
13	40	28	12	, 70	, 30
14	40	28	12	, 70	, 30
15	40	30	10	, 75	, 25
16	40	29	11	, 72	, 28
17	40	27	13	, 67	, 33
18	40	29	11	, 72	, 28
19	40	27	13	, 67	, 33
20	40	24	16	, 60	, 40
21	40	25	15	, 62	, 38

$$\text{By test statistics} = \frac{\text{Correct answers}}{\text{Correct answers + incorrect answer}}$$

Calculate facility value for math concepts test scores of the guess value

Students numbers	Correct answers	Incorrect answers	Facility value from the guess	Students numbers	Correct answers	Incorrect answers	Facility value from the guess
1	35	5	, 83	**12**	33	7	, 76
2	30	10	, 66	**13**	28	12	, 60
3	34	6	, 80	**14**	28	12	, 60
4	25	15	, 50	**15**	30	10	, 66
5	36	4	, 86	**16**	29	11	, 63
6	26	14	, 53	**17**	27	13	, 56
7	34	6	, 80	**18**	29	11	, 63
8	28	12	, 60	**19**	27	13	, 56
9	36	4	, 86	**20**	24	16	, 46
10	37	3	, 90	**21**	25	15	, 50
11	27	13	, 56				

$$\text{By test statistics} = \frac{\text{Correct answers} - \dfrac{\text{Incorrect answers}}{\text{1- Alternative}}}{\text{Correct answers + incorrect answer}}$$