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RELATIONSHIP OF SOFT SKILLS IN THE DIFFERENTIAL CALCULUS LEARNING UNIT. CASE: CECYT 16 "HIDALGO"

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Abstract: Soft skills affect the way of acting and working to adapt to the context and the objectives pursued, hence their importance. These are learned in the family environment and are developed with practice in society, that is, they adapt and transform to help face challenges according to the evolving cultural environment. They allow adjusting to changes and facing them in the school environment, with an attitude open to learning, change and continuous improvement; the central point of this research is to know how soft skills strengthen the development of mathematical thinking in high school students. The qualitative research with case study conducted in the differential calculus learning unit at CECyT 16 "Hidalgo", shows that beyond the logical-mathematical knowledge, these interpersonal skills allow students to address challenges effectively and completely, where: abstract learning, understanding of concepts, solving exercises, applying theorems and/or properties, solving everyday problems induce teamwork, creativity and adaptation to change; leadership and decision making are some roles in which schoolchildren work day by day in the classroom. For the IPN (National Polytechnic Institute), soft skills are a complement to the technical training of its students, fostering an integral development and critical thinking that questions arguments with foundations.
Keywords: Soft skills, teamwork, problem solving, decision making.

INTRODUCTION

Soft skills are a set of competencies that have adopted various names such as interpersonal and socioemotional, these facilitate effective interaction between individuals. School is the way to prepare future professionals, where education at a national level faces challenges due to international policies, this requires training citizens who can perform successfully in work and academic situations, regardless of the country or cultural context in which they are. The National Polytechnic Institute (IPN) has recognized the growing importance of soft skills in the integral formation of its students, since beyond the technical knowledge of each career, these skills allow the formation of competent and adaptable professionals in a changing world of work, increasingly competitive and interconnected.

The learning of mathematics provides us with fundamental and essential foundations for the development of all people and exists throughout life, from childhood to old age. The capacity of these processes depends on the motivations, opportunities and circumstances that each individual finds within his or her family, cultural and social environment. In high school, they are the solid foundation on which other disciplines are built, regardless of the area of knowledge.

Adolescents experience social and emotional changes typical of youth and face challenges in the area of mathematics, which can influence both their academic performance and their perception of this learning unit. These challenges are multifaceted and multifactorial, they can be approached from various perspectives that can positively or negatively affect cognitive ability, emotional well-being, motivation, which directly affects academic performance, generating anxiety when facing mathematics. This anxiety can be caused by academic pressure or previous negative experiences with the subject. The belief that mathematics is difficult or irrelevant can demotivate students; to change this perception it is crucial to foster a positive attitude towards mathematical learning. Therefore, it is important to develop, enhance and reinforce soft skills to address these problems through the practice of positive social relationships and a nurturing environment that helps to improve emotional and social skills in education.

The study of Mathematics is considered a fundamental area within the school curriculum, but it is regularly considered complex and abstract, given its importance in the process of analysis and decision making, it allows developing aspects such as: creativity, critical reasoning and the ability to analyze and synthesize (Guerrero, 2015). The IPN is a public institution that trains students from high school to postgraduate level in different areas of knowledge, within the framework of the competency-based model that is taught in high school regardless of the branch of preparation in all semesters and in the seven careers offered "there is mathematics" using the same curriculum for all of them.

The types of mathematics that are learned in the six semesters mentioned above are offered according to the current study programs, they are from the area of basic scientific, humanistic and technological training, but of different levels of complexity, they are mandatory and are applied in the physical-mathematical sciences, social-administrative sciences and medical-biological sciences. This type of knowledge fosters logical thinking, in problem solving, regardless of its future application, since it is designed at the general high school level, without considering the next level of studies, its function at this level is that adolescents can analyze data, make informed decisions and critically evaluate information. By overcoming mathematical challenges, adolescents develop greater confidence in their abilities.

The approach of the curricula to deal with these everyday problems is established in such a way that it expresses an approach of deductive and inductive procedures to solve problems, and in the competencies perceptual knowledge is mobilized: observation and spatial relationship, communication: oral and written, and graphic in the learning unit there is the elaboration of conjectures, abstraction from the situation. The use of knowledge and skills is also present in problem solving in mathematics, which allow students to develop and complete techniques by identifying problems, processing them and obtaining results and communication skills through various means of mathematical expression such as natural, symbolic and graphic language, the use of tables and diagrams, as well as mathematical notation. The theoretical basis of soft skills in education lies in the relevance of these skills for the integral development of students, the successful relationship with academic and personal achievement and the need for their development through educational technology.

THEORETICAL FRAMEWORK

Galileo referred to mathematics as the alphabet with which the universe had been written because it was the key to deciphering and interpreting the world around us. With the apogee of artificial intelligence and its entire digital ecosystem, unimaginable things have been achieved in just a few years. However, for some students mathematics should be exciting, but they find it tedious (if not, dreaded). The world has changed but the way mathematics is taught has not (repetition of procedures) and the importance of soft skills in the learning and application of mathematics is a relatively recent concept in the history of education. For a long time, mathematics was conceived as a purely technical discipline, focused on the acquisition of knowledge and the mastery of algorithmic procedures, hence the importance of combining mathematical and soft skills to improve performance and prepare young people for an adaptive future.

The social skills that every human being may possess are the inner part that accompanies the individual from birth, not all of them are manifested in the same way, but they are indispensable for the achievement of goals and objectives. A study indicates that students

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with a high level of social skills tend to have outstanding academic performance in mathematics, for example, 43% of students with high social skills achieved outstanding academic performance in various mathematical dimensions, while those with low skills showed low performance (Rueda, 2016).

ESFM (2024), mentions that soft skills such as teamwork, communication and emotional intelligence are essential to address mathematical problems in a collaborative and creative way, being the basis of an integral development.

In earlier times, mathematics education focused on content, with emphasis on teaching concepts, formulas and algorithms and with repetitive practice underwent a large number of exercises to mechanize procedures and success was measured through standardized tests to solve routine problems.

Mathematics, too, can serve to inspire creativity and critical thinking. In fact, there is evidence that learning soft skills in mathematics can change attitudes toward the subject: the repetitive repetition of tasks has led to problem solving and decision making becoming increasingly dependent on interpersonal skills (Profuturo, 2021).

Currently, the labor market demands professionals with skills beyond technical knowledge and abilities, where soft skills are increasingly appreciated in all fields, including STEM disciplines. Various brain studies have revealed the importance of emotions, social relationships and context in learning processes (Garcia, 2012).

The use of technological tools in the teaching of mathematics has allowed the development of collaborative and creative activities, where the current trend in mathematics education is to promote the resolution of real, everyday, open and contextual problems that require the use of various cognitive and socioemotional skills, allowing students not only to solve problems, but also to collaborate and communicate effectively with peers.

Soft skills are a set of personal attributes that complement the technical or hard skills, which are fundamental for the integral development of students; some theories are:

-Vygotsky's sociocultural theory, emphasizes the importance of interactions between individuals in the development of social and emotional skills.

-Social learning theory, here interpersonal skills are developed through observation, imitation and practice.

Emotional intelligence theory, according to Daniel Goleman, states that emotional intelligence encompasses skills such as self-awareness, emotional control and empathy, and is essential for success both personally and professionally.

Education as an expression of social relations is conditioned, above all, by economic and political circumstances. In the Americas, one of the influential factors to take into account in the study of education is the socioeconomic environment of poverty in which they develop, since some families belonging to the place prevent the use of study and opportunities.

In Mexico, the Educational Reform (New Educational Model) is an update of the national curriculum that emphasizes the development of socioemotional skills along with traditional academic skills. For example, subjects such as "Civic and Ethical Formation" have been introduced, which promote self-regulation, empathy and conflict resolution.

On the other hand, the Ministry of Public Education (SEP) has implemented Competencies for Life programs as part of its approach to prepare students with practical skills to face real-world challenges, including effective communication and problem solving.

These strategies and programs are designed to incorporate soft skills into the formal education system, recognizing their relevance

to students' personal and professional success in a constantly evolving environment.

Soft skills in Mexico can be known in different ways, such as: soft skills, life skills, social-emotional skills and/or social skills. These skills are important to successfully face the demands and challenges of daily life in any daily and cultural environment; the relevance of these skills has been recognized and promoted in various sectors, including education and employment, as they are related to personality and emotional intelligence, which are essential for interaction and good development mainly in the labor field.

METHODOLOGY

The research is based on a qualitative methodology, since it focuses on gathering information from the experiences and perceptions of students and teachers while participating in classroom classes corresponding to the learning units of the technological professional field in different disciplines. The period analyzed January 2024 - June 2024 where the purpose was to analyze the relationship of soft skills that were consolidated during the process of the development of the Differential Calculus learning unit (fourth level high school mathematics), using field diaries provided by selected groups with student informants. The aim was to keep the information obtained as faithful as possible to reality, guaranteeing an adequate understanding of the development and teaching of soft skills in mathematics by identifying the activities that were carried out to improve academic performance in learning in the different areas of knowledge: medical--biological, physical-mathematical and social-administrative.

The research approach is non-experimental, explanatory and descriptive, as it seeks to understand reality by identifying deep and significant qualities of the actors. It is a social research that addresses a situation, an environment or a cultural group, but it requires a methodological organization (Avalos, 2017)

SAMPLE

The study subjects were control groups of fourth-semester fourth-semester students of the following technical careers at the upper secondary level: Nursing Technician (4EM3) and Clinical Laboratory Technician (4LM4) from the medical-biological area; Technician in Machines with Automated Systems (4MM4), Technician in Industrial Processes (4PM1) from the physical-mathematical area; Technician in Administration (4AM1) and Technician in International Commerce (4CM2) from the social-administrative area; in the school cycle 24-2 (January-June 2024), their ages range from 16 to 20 years old, with a population between 30 to 35 students enrolled in the school cycle.

The context of this study is a foreign center of the IPN, located in the state of Hidalgo between the neighboring municipalities of San Agustín Tlaxiaca and Santiago Tlapacoya, being a public and bivalent high school with a competency-based educational model, named Centro de Estudios Científicos y Tecnológicos No. 16 "Hidalgo" (CECyT 16 Hidalgo), in the country of Mexico. This campus has the characteristic of being multidisciplinary with technical careers in the three areas of knowledge and seven terminal career options, i.e. technicians in: Nursing, Clinical Laboratorist, Industrial Maintenance, Industrial Processes, Machines with Automated Systems, International Trade and Administration.

INSTRUMENTS

Data were collected with field diaries of the informants (students) and their workbooks that belong to the same sample group, noting in notebooks the precise data when they were taking the class, developing their integrative project, carrying out activities in

a collaborative manner, performing exercises and expositions of the topics, going to the blackboard; They wrote down what they did when they had the math class and how the teacher integrated the knowledge to reach competence with the proposed learning outcomes (RAP) in the syllabus, as well as the complementary activities carried out in the inverted classroom.

ANALYSIS

For the research, a review of various texts was carried out to incorporate a matrix to support the observation (TABLE 1) and data were collected with a phenomenological design, which was the filling of field diaries of the curricula of the three areas of knowledge, where photos, stories, reflections and coincided during the semester in the development of activities were taken, from there it was identified how the soft skills are related to the development of mathematical competencies and benefit during the school period.

Column 1 incorporates the relationship or role played, that is, role or function of something that fulfills a fact, being a set of repetitive behaviors during classes, therefore, are the activities that are performed in the classroom when working differential calculus.

Column 2 according to the classification (etymology: sort by classes) of the soft skills table (APPENDIX 1), a discernment was made of which soft skills are instituted with the activities performed in the learning unit.

Column 3 with field diaries and from the current syllabus, the teaching activity is chosen by the teacher.

Column 4 evidence from student evidence portfolio.

RELATIONSHIP	SOFT SKILLS	TEACHING ACTIVITY OF THE CURRENT SYLLABUS	EVIDENCE

RESULTS

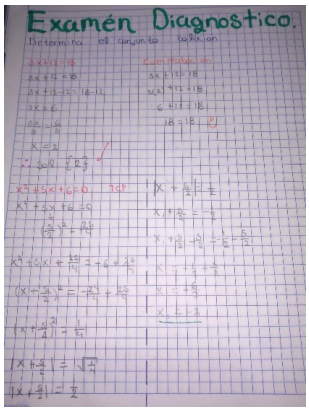
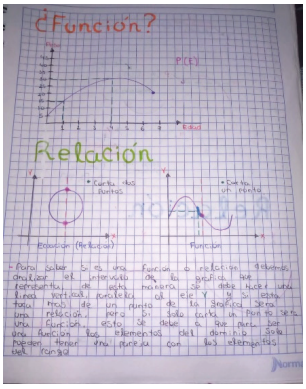
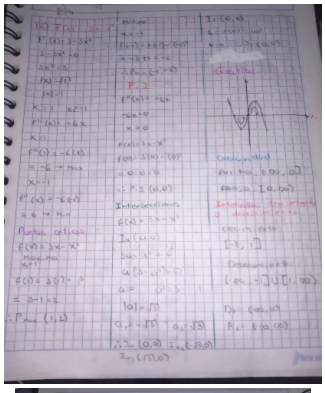
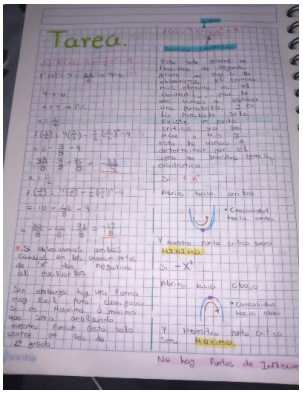
When we think of mathematics, the first things that come to mind are numbers, equations and theorems. However, mathematics is not reduced to that, you also have to solve mathematical problems and this requires a set of skills that go beyond theoretical knowledge, known as soft skills.

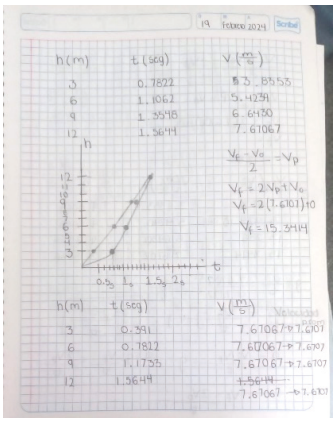
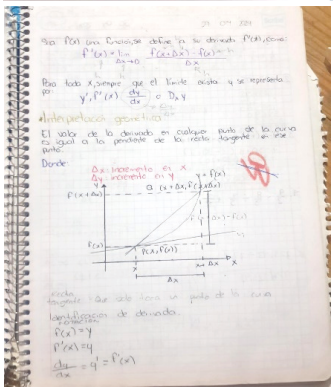
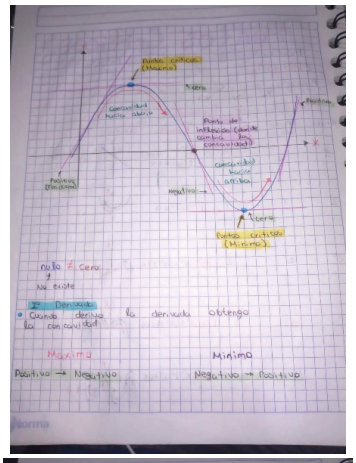
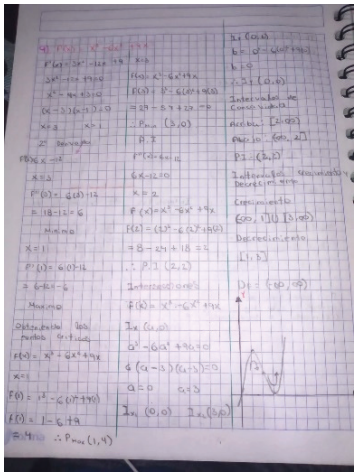
At the high school level, mathematics, depending on the level, becomes an increasingly abstract and challenging discipline where mathematical skills such as: perception, logic, reasoning, abstraction and problem solving become a challenge. However, success at this stage does not depend solely on the ability to solve equations or apply formulas as these skills are essential to the mastery of mathematical concepts and are developed through practice and interaction with complex mathematical problems. The focus on soft skills, such as teamwork and communication, tend to perform better in mathematics, as they can collaborate effectively in problem solving and communicate their reasoning clearly.

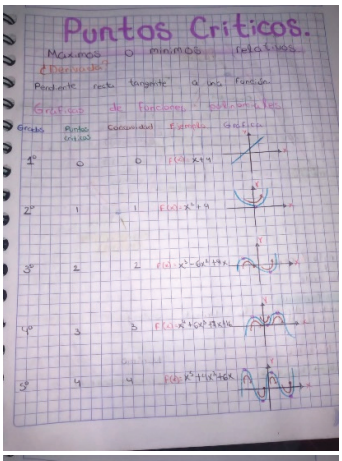
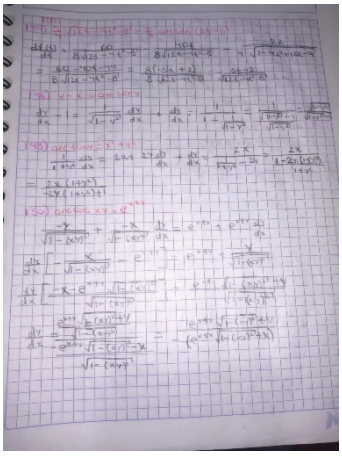
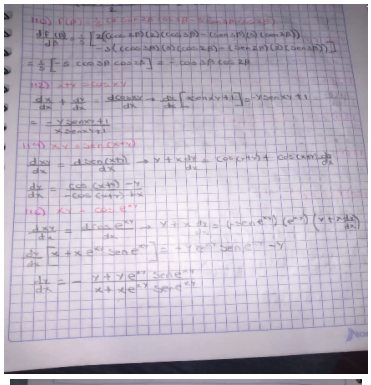
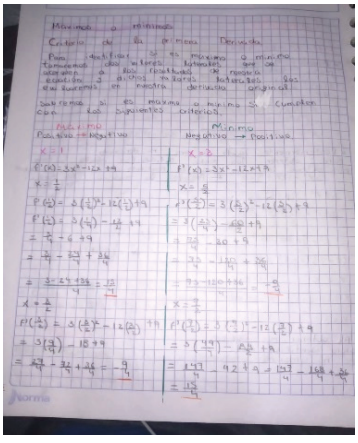
Soft skills allow students to go beyond memorizing procedures to develop a deeper understanding of mathematical concepts by analyzing problems, evaluating different scenarios, and justifying answers; thus students develop critical thinking skills that are useful in any field.

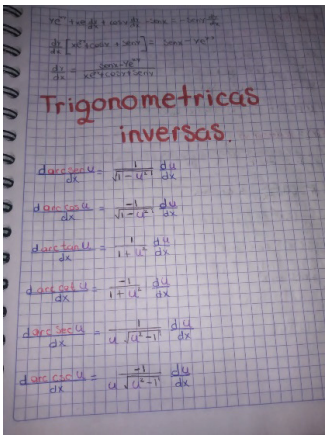
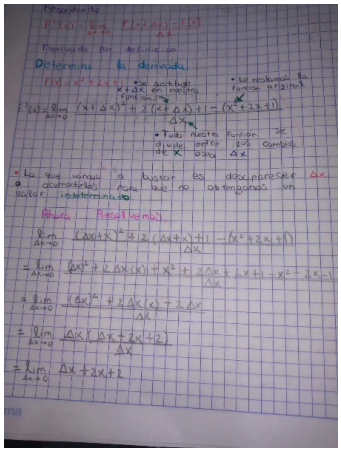
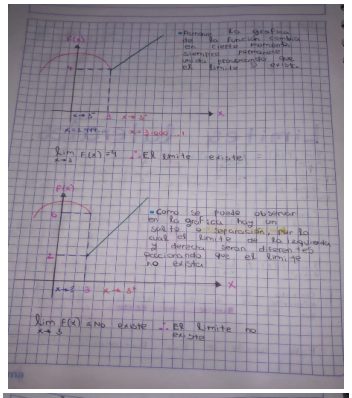
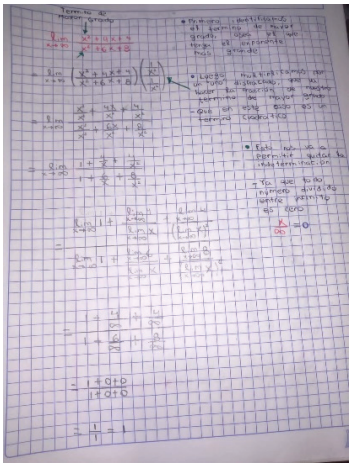
Mathematics is not only a rigorous discipline, but also a space for exploration and generation of innovative ideas, proper decision making in teamwork because facing mathematical challenges requires patience and determination and thus changing strategies to address everyday problems of the context.

The curriculum based on the IPN competency-based model validated by DEMS-IPN (Dirección de Educación Media Superior) mentions that the overall time assigned is 90 hrs/semester; taught in 5 hrs/week for 18 weeks, in that sense the General Competency set

DIFFERENTIAL CALCULUS			
RELATIONSHIP	**SOFT SKILLS**	TEACHING ACTIVITY OF THE CURRENT SYLLABUS	EVIDENCE
Learning and understanding abstract concepts	• **Information search and management:** It encourages the search for new knowledge and the exploration of ideas with the use of previous knowledge. • **Persistence and optimism**: Allows overcoming obstacles and maintaining motivation in the face of complex problems. • **Flexibility:** Facilitates adaptation to different approaches and consideration of multiple perspectives and solutions.	° Diagnostic test to evaluate previous knowledge and to establish meaningful connections with the learning proposal. ° Definition of function. ° Notion of limit and its theorems. ° Analyzes the definition of derivative and interprets it as a process of variation.	 
Troubleshooting	• **Critical thinking:** Allows evaluating information, identifying patterns and making informed decisions. • **Creativity:** Facilitates the generation of new ideas and the search for new and innovative solutions. • **Communication:** Allows explaining the problem-solving process clearly and concisely, both orally and in writing.	° Articulates knowledge from different fields and establishes relationships between them and their daily life. ° Calculate the maxima and minima of proposed problems and interpret the results. ° Solve problems by applying derivative formulas to describe the characteristics of a function.	 

Teamwork	• **Teamwork:** Facilitates collaboration with others to solve complex problems and share knowledge. • **Empathy:** Admits to understanding the perspectives of others and building trusting relationships. • **Leadership**: Allows guiding others in solving problems and making collective decisions for a common purpose.	° Solve the problem with the use of derivatives to contextualize the problem of the classroom project. ° Assumes a constructive attitude congruent with knowledge in different work teams.	 
Critical thinking	• **Sitematization:** Discovering the essence of a problem, identifying its key components and underlying relationships. • **Decision-making:** Justifying reasoning, and following rules and steps allows developing the ability to distinguish between valid and false arguments.	° Methodology for the derivation of explicit and implicit functions. ° Describes the methodological process for the graphical representation of an algebraic function. ° Explain the physical and geometrical interpretation of the first and second derivatives. ° Order information according to categories, hierarchies and relationships.	 

Creativity	• **Adaptive management:** Ability to think in different ways and generate new ideas is essential to find innovative solutions. • **Visualization:** Spatial visualization and the ability to represent ideas graphically.	° Graphical representation of functions and their behavior. ° Methodology for solving optimization problems with transcendental functions. ° It proposes ways to solve problems, defining a course of action of specific steps.	 
Adaptation to change	• **Curiosity:** The desire to learn and explore new ideas is fundamental to adapting to change. • **Perseverance:** Ability to maintain motivation and effort despite difficulties. • **Resilience:** Recovering from failures and learning from mistakes. • **Adaptability:** Adjusting to new situations and changing approach when necessary.	° Applies the derivative as a ratio of change to solve problems ° The result obtained is congruent with the development of the process: Data, formula, development, substitution and result. ° Defines goals and monitors its knowledge building processes	 

Decision making	• **Self-knowledge:** Belief in one's own mathematical abilities to face challenges with determination. • **Curiosity:** Learning and exploring new ideas drives us to look for solutions beyond the obvious. • **Adaptability:** Adapting to new situations and changing approach when necessary. • **Metacognition:** Monitoring and regulating learning.	° Analyzes the definition of derivative and interprets it as a process of variation. ° Use the form to derive algebraic, logarithmic, exponential, trigonometric functions.	 
Frustration management	• **Autonomous learning:** Learning independently, applying new knowledge to real situations. • **Persistence:** Recognizing and understanding one's emotions, especially frustration. • **Tenacity:** Regulating emotions and avoiding impulsive reactions. • **Organization:** Focus on solutions. • **Resolving doubts**: Ask for help when necessary.	° Develop specific strategies for problem solving, looking for patterns and relationships between the derivative exercises and the formulas to be applied. ° Proposes exercises involving derivatives of transcendental functions. ° Establish clear objectives that lead to continuous improvement, building on the mathematical knowledge base. ° Follows instructions and procedures in a thoughtful manner, understanding how each of your steps contributes to the achievement of your objective.	 

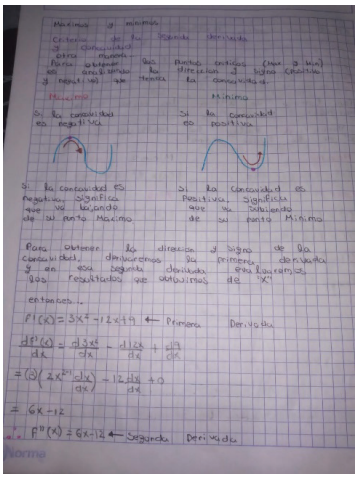
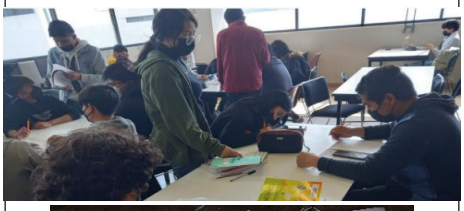
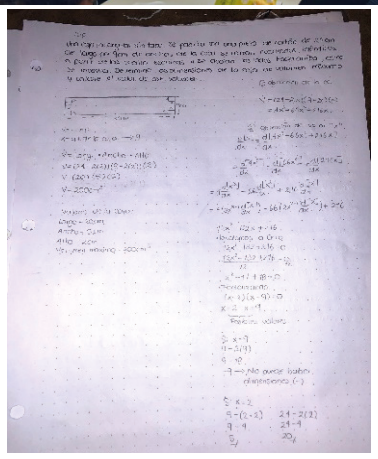
Mathematical communication	• **Oral and written expression:** Ability to communicate mathematical ideas clearly and concisely, to explain concepts, justify reasoning and collaborate with others. • **Diversity**: Understanding others' ideas and being able to build on them is essential for collaborative learning and group problem solving.	° Debates, discussion, solution, and expositions of the different exercises proposed in the classroom or in the inverted classroom. ° Expresses ideas and concepts through graphic representations.	
Application in real contexts	• **Mathematical modeling**: Translating real-world problems into mathematical models and applying the appropriate knowledge and tools. • **Abstract thinking**: Understanding of abstract mathematical logical concepts and their relation to real phenomena. • **Adaptability**: Adjusting mathematical solutions to the needs of different contexts.	° Solve a problem involving the use of the derivative related to optimization and the use of the differential (Classroom Project). ° Understands the use of the derivative in relation to its environment and proposes mathematical solutions based on optimization to improve processes or specific things. ° It exposes general rules to determine the algebraic functions that represent the problematic situation to be optimized.	 

Table 1: Roles of soft skills in mathematics

Source: Zepeda, Cardozo, & Cortés (2019), Youth Business International (2019), UNESCO (2021), Gómez. A. et al (2015). Own creation

by the program is: "Solves problems related to the variation of functions, based on the concept of the derivative, in theoretical and real situations in their academic, social and global environment", being located at the fourth level of the curriculum.

The purpose is to prepare students to develop competencies in the solution of various problems of variation and speed in geometric and physical situations, related to the three branches of knowledge that involve algebraic, geometric and trigonometric concepts (DEMS, 2008, p. 2).

Mathematics represents an elegant way of interpreting an extraordinary and powerful game: it is precise and consistent, with no margin for error. It is the language that describes our world and a tool for reasoning logically and elegantly on a daily basis (Garcia, 2022).

CONCLUSIONS

A student learns in the classroom to develop his or her soft skills in mathematics by identifying patterns in a sequence of numbers and formulas, beyond simply calculating ter-

ms and doing repetitions only; expressing and discussing the validity of a demonstration, looking for possible errors or alternatives to suggest creative solutions to problems that seem to have no clear answer.

Collaborate with other students to solve an everyday problem, cooperating with their own ideas and listening to those of others; in this way in the classroom soft skills are strengthened by proposing problems and exercises that have multiple solutions and require analysis for decision making, creating an environment where students feel comfortable expressing their ideas and other doubts. Through peer--to-peer work, activities can be organized to develop knowledge together and the didactic strategy of Proyecto Aula mobilizes knowledge to investigate and present findings, allowing students to reflect on their thought processes and ways to improve.

The activities proposed to develop the skills efficiently are as follows:

-Understand the problem: Identify data.

-Plan a strategy: Break the problem into simpler parts and look for the different solutions.

-Execute the strategy: Use the corresponding formulas to calculate the results.

-Evaluate the solution: Check if the result is correct and if the value obtained is reasonable in the context of the problem.

-Communicate the solution: Explain the procedure followed and present the result clearly and concisely.

Soft skills and mathematics form a synergy that benefits both the individual and society. By fostering the development of both, we are preparing students to face the challenges of today's and tomorrow's world successfully.

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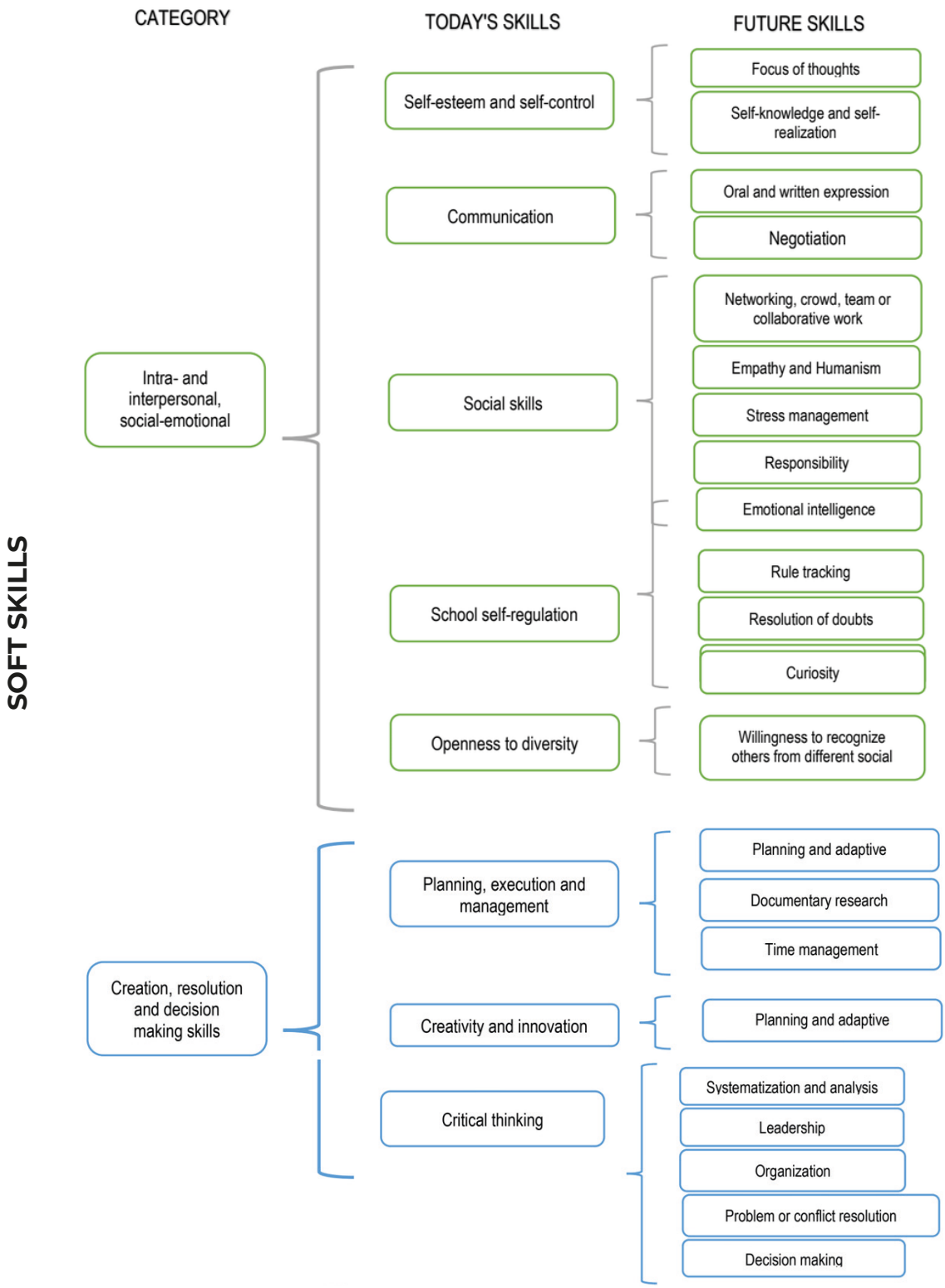
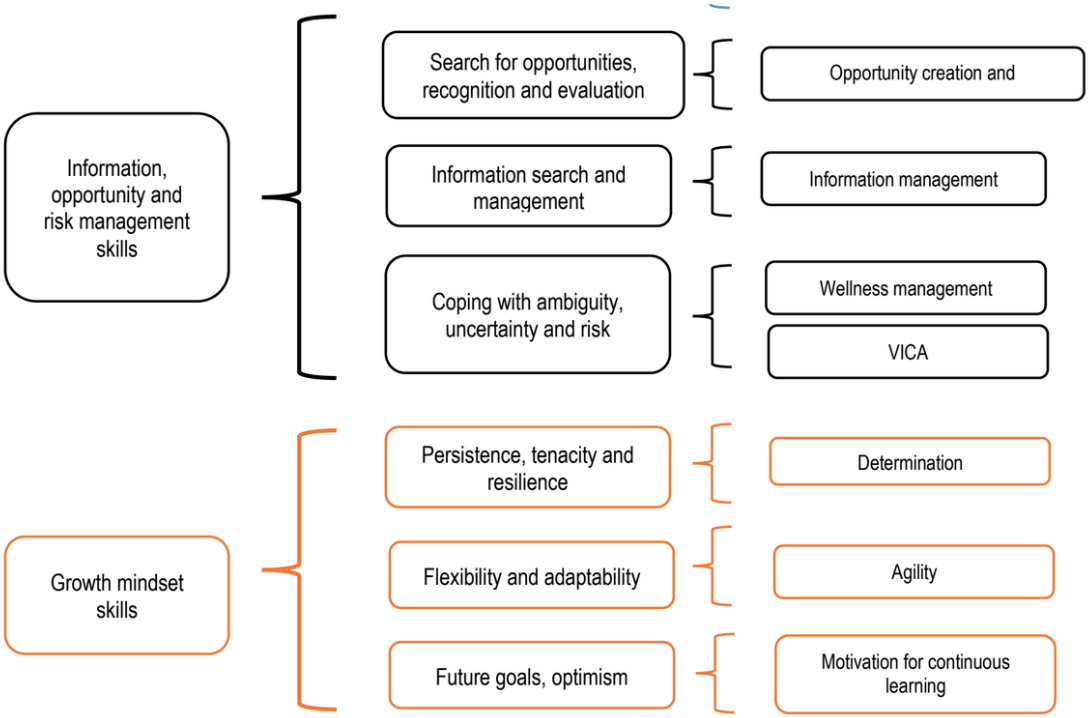
ANEXO 1


SOFT SKILLS
CATEGORY
TODAY'S SKILLS
FUTURE SKILLS
Intra- and interpersonal, social-emotional
Self-esteem and self-control
Focus of thoughts
Self-knowledge and self-realization
Communication
Oral and written expression
Negotiation
Social skills
Networking, crowd, team or collaborative work
Empathy and Humanism
Stress management
Responsibility
Emotional intelligence
School self-regulation
Rule tracking
Resolution of doubts
Curiosity
Openness to diversity
Willingness to recognize others from different social
Creation, resolution and decision making skills
Planning, execution and management
Planning and adaptive
Documentary research
Time management
Creativity and innovation
Planning and adaptive
Critical thinking
Systematization and analysis
Leadership
Organization
Problem or conflict resolution
Decision making


Information, opportunity and risk management skills
Search for opportunities, recognition and evaluation
Opportunity creation and
Information search and management
Information management
Coping with ambiguity, uncertainty and risk
Wellness management
VICA
Growth mindset skills
Persistence, tenacity and resilience
Determination
Flexibility and adaptability
Agility
Future goals, optimism
Motivation for continuous learning