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MATHEMATICAL ERRORS IDENTIFIED IN THE DIAGNOSTIC EXAM IN FIRST SEMESTER STUDENTS OF CECYT 16 "HIDALGO"

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Abstract: The research is a qualitative study conducted at ``Centro de Estudios Científicos y Tecnológicos``, Number 16 "Hidalgo", a high school belonging to the Instituto Politécnico Nacional. 16 "Hidalgo", a higher secondary school belonging to the National Polytechnic Institute; two years after having the face-to-face modality, there has been an increase in several mathematical errors implying a higher rate of failure or dropout; in the present return, the written evaluations (exams) were forced, with the analysis of the results of the new entrance groups of the school cycle 23-1 (August - December 2022) of the Algebra Learning Unit, showing a repetition of factors that affect the lack of previous knowledge of basic education (secondary level), besides that they come accustomed to bad study habits, copy and paste of concepts without the minimum interest in reading to know what they are talking about, plagiarism of activities and/or exercises, abuse of apps or web pages that solve tasks, disinterest, non-attendance, conformism, apathy, among others. These errors have become common among more students, a phenomenon that before the pandemic was not so visible and has aroused the concern of the teachers of the academy of Mathematics, since, of the ten and eight groups of new entrants, approximately forty students in each group, i.e. a population of 649 students was the sample of the analysis, with common results in errors such as: lack of mathematical spelling, correct application of properties, laws and mathematical axioms. These errors have become common among more students, a phenomenon that was not so visible before the pandemic and that has aroused the concern of the teachers of the Mathematics Academy, since, of the eighteen newly admitted groups, approximately Forty students from each group, that is, a population of 649 students, was the sample of the analysis, with common results in errors such as: the lack of mathematical spelling, correct application of mathematical properties, laws and axioms.

Keywords: Mathematical errors, diagnostic test, concepts, procedure, mathematical notation.

INTRODUCTION

Mathematical errors have been common in the teaching-learning process at any educational level, new students (August 2022) and are enrolled in the bivalent baccalaureate in CECyT 16, are considered a problem with the increase in these when performing face-to-face activities or exams; Some aspects to consider are: the absence of the teacher in the class or the decrease in learning. These generations come from online or hybrid classes, where both parties argue for various causes that make the transmission of knowledge difficult; The errors found in the review of the exams mainly range from erroneous notation, absence of concepts, incomplete or wrong procedures.

Mathematical knowledge is built, through a process of reflective abstraction, where errors are a possibility and a reality in scientific knowledge, which requires the inclusion of a diagnosis, detection, correction and overcoming of these through activities (Abrate, R, et al, 2006). The error can occur for various reasons, one of the common ones is because the prior knowledge acquired is not conceptualized, that is, from basic education the association of concepts is taken for granted empirically, without explaining the mathematical definition; We must also take into account the context, the tasks, the discourse and the trainer of this knowledge. What mathematical errors did the new students of the 23-1 school year show?

Mathematics is considered a fundamental area within the IPN school curriculum, its importance in the development of analysis and communication of ideas allows the

development of aspects such as: creativity, the capacity for analysis and synthesis, and critical reasoning. The National Polytechnic Institute is an institution that trains students from high school level to professionals in different branches of knowledge, within the competency-based model, academic programs are designed, redesigned, and updated, considering their relevance and the national and international environment, for the development of competencies that respond to the requirements of the advancement of science and technology, social responsibility, sustainability, human progress and learning based on social challenges.

The mathematics learning units provided in the 6 semesters are from the area of basic scientific, humanistic and technological training, and are located at different levels of complexity and are compulsory in the three branches of knowledge: physical-mathematical sciences, social sciences -administrative and medical-biological sciences.

The focus of the study programs allows addressing everyday problems by establishing approaches to express deductive and inductive procedures for problem solving, in the skills different knowledge is mobilized: perceptual (observation and spatial relationship), communication (oral, written and graphic), the elaboration of conjectures, abstraction and generalization that have been affected during the pandemic in meaningful and integral learning.

Therefore, problem solving allows to form and complete knowledge with the identification of the problem, procedure and obtaining results, in order to develop their ability to communicate and the student to get used to various means of mathematical expression: natural language, symbolic and graphics, the use of tables, diagrams and, above all, the correct use of mathematical notation or spelling.

The word "error" is used when the student performs a practice (action, argument, mistake, concept or judgment based on incorrect or false traits, among others) that is not valid from the point of view of the school mathematical institution, researchers in mathematics education they suggest diagnosing and seriously treating students' errors, and discussing their misconceptions with them, and then presenting them with mathematical situations that allow them to readjust their ideas. (Del Puerto, Minnaard and Seminara, 2006, p. 2).

In the analysis of the activities and evaluations that were reviewed of each student, it can be verified that, those of new admission show deficiencies from the basic level and the young people of the following levels or semesters, their deficit manifests itself significantly, from not knowing or know what is required, without reading comprehension or dyslexia and from there they start to know these mistakes and be an area of opportunity for future generations.

Every educational process and construction of knowledge has errors (Gamboa, 2019); Engler (2004) mentions: In the process of learning mathematics, errors are constantly present; what worries, on some occasions, is the persistence and massiveness of some of them, which directly influence the construction of other content.

According to Carrion (2007), errors can be sporadic, that is, they occur occasionally, by chance and caused by carelessness in the productions of the student body, or systematic, based on previously acquired knowledge and that favor a distorted understanding of the concepts.

DEVELOPMENT

This research was applied in the period August 2022 - December 2022, qualitative, explanatory and descriptive work, since the

aspects related to the frequency of errors in the diagnostic examination are exposed and described and can be seen as an attempt to obtain a deep understanding of the meanings and definitions of the situation as presented by the students, taking into consideration the data obtained from the nine teachers of the Academy of Mathematics of the Hidalgo campus of the IPN. The research approach is non-experimental, understanding reality by identifying the deep nature of the meanings of the actors, being a social type of research that deals with the context, setting or cultural groups (Avalos, 2017) but with a methodological organization.

The data was collected with a phenomenological design, which focuses on the subjective individual experiences of the participating teachers of the mathematics academy and from the perceptions under a checklist for the review of each one of the exams and the photos collected from the ten and eight first semester groups showing repetitive errors. The context of the Center for Scientific and Technological Studies Number 16, Hidalgo, of upper secondary level, has been a foreigner for ten years with the characteristic of being multidisciplinary with careers in the three areas of knowledge and seven terminal career options, that is, technicians in : Nursing, Clinical Laboratory Technician, Industrial Maintenance, Industrial Processes, Machines with Automated Systems, International Trade and Administration.

With the bank of evidence, the errors were mainly reported in two large groups: 1) Conceptual, it is when the knowledge, the concept, the application of the properties, wrong mathematical notation, without distinguishing it are missing; 2) Procedural, without structure, omission of steps, that when carrying out the procedure it is done by memorization. These failures were taken from the following population (Table 1), with the

groups and students served during the period, with a total of 649 students.

RESULTS

From the results, the first classification (table 1) were the errors where they do not understand, do not know what to apply or do not identify the difference between the concepts, and as is known, mathematics is an abstract and essential tool for different contexts, applied to different real situations from counting objects, money, steps, photos among others. Mathematics is a refined way of interpreting a surprising and powerful game, what they have to be exactly and precisely, the dialect that describes our world and a way of reasoning logically and elegantly on a day-to-day basis, where, at any Anytime and anywhere when you look, it's already math!

> Eventual errors due to deficiencies in the construction of prior knowledge. These errors are caused by erroneous or inadequate learning of facts, skills, abilities and previous concepts that prevent a proper understanding of the information. Included in this category are those errors that have occurred due to a discrepancy between the data that appears in a question and the treatment given to it by the student. (Gamboa, 2019).

Mathematics is the science of the structure, the algorithms, the models, the order with repetitive patterns that is based on counting, measuring, interpreting and describing the forms. The essence of his study is: the magnitudes, the quantities and the changes of these in time and space, but above all the logical mathematical thinking to understand, interpret and implement mathematical models.

As a second classification, the errors due to incomplete procedures (Table 2) were determined, which can be jumps, omissions, not having the requested structure in the performance of exercises (data, formula,

DESCRIPTION	Teachers								
Lack of concept of:	P1	P2	P3	P4	P5	Q6	Q7	Q8	Q9
Rational numbers	x	x	x	x	x	x	x	x	x
Irrational numbers		x	x	x	x	x	x	x	x
Absolute value	x	x	x	x	x	x	x	x	x
relative value	x	x	x	x	x		x	x	x
Power	x	x	x	x	x	x	x	x	x
Division	x	x	x		x	x		x	x
Difference	x	x	x	x	x	x	x	x	x
Addition	x	x	x		x			x	x
Multiplication	x	x	x		x		x	x	x
Algebraic expressions	x	x	x	x	x	x	x	x	x
equations	x	x	x	x	x	x	x	x	x
Properties of real numbers	x	x	x	x	x	x	x	x	x
like terms	x	x	x	x	x	x		x	x
grouping signs	x	x	x	x	x	x	x	x	x
property application	x	x		x	x	x	x	x	x
percentages	x	x			x		x	x	x
Decimals	x	x			x	x		x	x
Proportion	x	x	x	x	x		x	x	x

Table 1: *Classification of errors due to the lack of correct identification of the concept*

DESCRIPTION	P1	P2	P3	P4	P5	Q6	Q7	Q8	Q9
Incomplete procedures of:	Teachers								
Basic operations of rationals	x	x	x	x	x	x	x	x	x
Basic operations of integers	x	x	x	x	x			x	x
Basic operations of polynomials	x	x	x	x	x	x	x	x	x
Removal of grouping signs	x	x	x	x	x	x	x	x	x
Operations hierarchy	x	x	x	x	x	x	x	x	x
Making diagrams, drawings and/or schemes.	x	x	x	x	x	x	x	x	x
Operations with decimal numbers	x	x	x		x			x	x
Direct and inverse proportions.	x	x	x	x	x		x	x	X
Application of properties of real numbers	x	x	x	x	x	x	x	x	x

Table 2: *Errors detected in the execution of the procedure*

procedure, substitution and result) and it is considered that it is due to the failure to review the evaluation rubric of the exercises proposed by the academy (Table 3).

Errors due to incorrect inferences or associations (figure 1) are caused by applying mathematical properties incorrectly, with associations of operations without complying with what is established in mathematical logic. "In this situation, the student is aware that the proposed means is different from others addressed, but fantasizes new rules or derives the validity of the ones he knows from other situations for the case he is dealing with." (Gamboa, 2019).

It is known from several authors and each country has a type of nomenclature, however, according to different texts, the mathematical notation or the simplest fact of correctly placing the literals, exponents, sign, or coefficients in a term is something repetitive and observable. Gamboa (2019) exposes: Errors due to mathematical language: they are the product of an incorrect translation of mathematical facts defined in a natural language to a more formal mathematical language, or from a symbolic language to a different symbolic language.

The instrument to detect errors was an exam carried out by the academy, with the objective of clearly and specifically identifying the problem, it was printed and applied in the first week of classes, with different schedules and with three sections to be analyzed (exhibit):

Section 1: Notation; In this section, it is requested to identify the mathematical spelling of a mathematical expression, where the student correctly identifies the names, concepts or requested operation (figure 2).

Section 2: Concepts; Language is universal, and a specific mathematical notation must be taken, so that when placing a statement or definition, the understanding of the concept, the reasoning and its relationships are understood (figure 3).

Section 3: Procedure; A repetitive phenomenon when solving an exercise is the omission or skipping of steps; the repetition of patterns or their memorization without identifying the use of the concepts according to the hierarchy and application of mathematical properties (figure 4).

Case: The twelve newly admitted group, with a population of 34 students, show different errors in the three sections of the diagnostic test and according to the definitions of the authors, their classification is shown in Table 4.

CONCLUSIONS

The knowledge of mathematics, as well as the different competences that are acquired in basic education, whether it is called primary or secondary, demonstrates with these results a deficit or lack in these; coupled with the belief that they are difficult, the teacher does not know how to teach or his saying "I do not understand", with this background various ways are sought to intervene in that area of improvement.

The study of errors must be considered a main topic in the teaching and learning process of mathematics, where the teacher identifies the deficiencies that the student has not been able to understand, since it is not only about giving a score, but also about implementing Some strategy correcting the lack of knowledge.

The use of mathematical notation in an appropriate way allows interpreting and carrying out operations, establishing priorities in carrying out activities; also the correct inferences cause the student to apply properties when appropriate as laws of exponents in operations with polynomials.

There is confidence that by explaining to the student the origin of the concept and
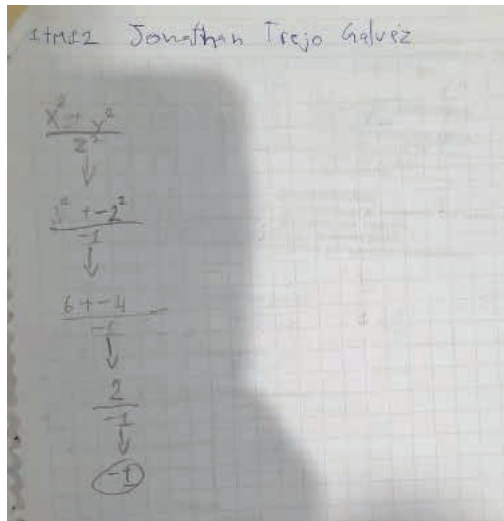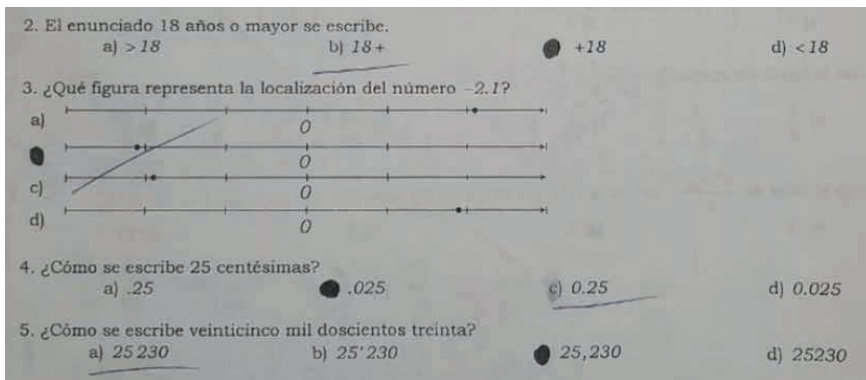
Note: This figure shows the lack of the correct process in the solution of the exercise

Figure 1 - Error identifying the variable to clear

EXERCISE RUBRIC				
DESCRIPTION	**0.25**	**0.50**	**0.75**	**1**
Data	No data corresponding to the exercise	show only the data	Show 50% of the data and unknowns to solve.	There are all the data and unknowns of the problem.
formulas	I identify and apply the 10% of the formulas to be used.	I identify 50% of the formulas to be used.	I identify 75% of the formulas to use	I identify 100% of the formulas to be used.
Formula substitution.	I substitute 25% of the formulas.	Applied 50% of the formulas correctly	Applied 75% of the formulas correctly	Applied 100% of the formulas correctly and consistently
Theoretical justification.	The justification is not clear in the solution.	Justify 25% of the steps in the solution.	Justify 50% of the steps in the solution.	The justification is precise showing the congruence of the solution.
Development and/ or Procedure	I perform 25% of the operations respecting the arithmetic hierarchy and the properties and mathematical axioms.	I perform 50% of the operations respecting the arithmetic hierarchy and the properties and mathematical axioms.	I perform 75% of the operations respecting the arithmetic hierarchy and the properties and mathematical axioms.	He performed 100% of the operations respecting the arithmetic hierarchy, the properties and mathematical axioms.
Graph (if apply)	He only identified the data, numbering and coordinate axes.	He identified 50% of the data, numbering and coordinate axes. sketch only	He identified the data, numbering and coordinate axes, the graph, does not correspond to the exercise.	I identify 100% of the data, numbering and coordinate axes. Graph corresponds to exercise
Result	It only shows the result.			Show the result and the discussion correctly interpreting it according to the exercise.

Table 3: *Academy evaluation rubric, CECyT 16 Hidalgo, 1/23*

Note: This figure shows errors in mathematical notation

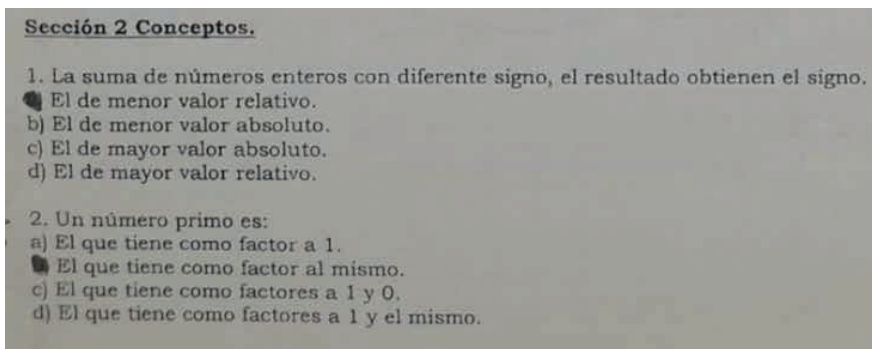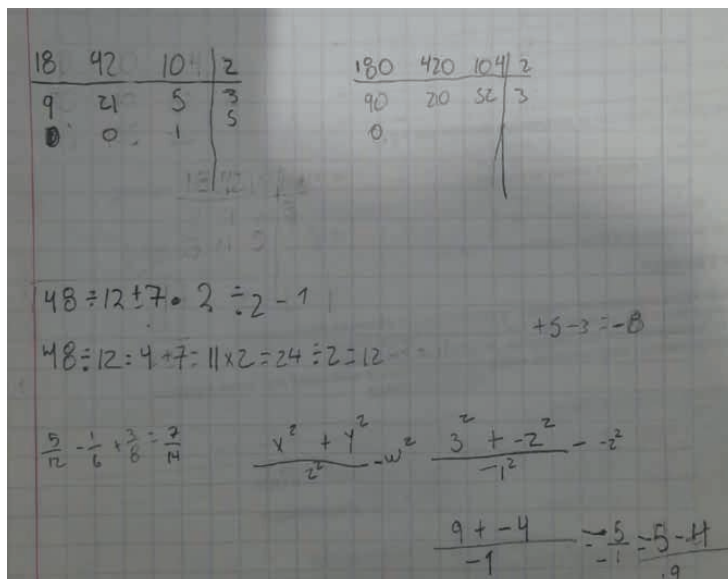**Figure 2** - *Example of answered exam*

Figure 3 - *Section 2 knowledge of concepts*

Note: This figure shows the errors in the identification of the concepts

Note: This figure shows the errors in the procedure, without identifying where to start or how to continue, without order

Figure 4 - *Section 3 execution of the process*

TYPE OF ERRORS AND CLASSIFICATION						
question number	Total errors per question according to their classification	Errors due to mathematical language Abrate et al. (2006)	Errors due to incorrect inferences or associations.	Errors due to the recovery of a previous scheme according to Abrate et al. (2006)	Errors due to incorrect or accidental calculations according to Abrate et al. (2006)	Eventual errors due to deficiencies in the construction of previous knowledge or the absence of it.
1	twenty	0	6	0	4	10
2	24	0	8	0	5	eleven
3	24	5	8	1	10	0
4	twenty-one	0	0	0	14	7
5	22	3	2	2	10	5
total	111	8	24	3	43	33

Table 4: *Analysis and classification of the Type of errors of the diagnostic examination of group 1TM12*

why? A specific procedure must be carried out to help make their learning meaningful and as a problem arises at any level, they can solve it effectively and efficiently, so the activities proposed for the semester 1/23: 1) carrying out activities transversal arithmetic to the algebra course, reinforcing what is still missing in each new student, 2) tutoring between peers in counter-turn of social service providers, 3) regularization tutoring carried out by teachers, 4) individual tutoring for students who took and appealed and have not yet passed, 5) courses in polivirtual (online modality) mainly.

The universal study of mathematics at any level entails a long-term study, however, during the pandemic learning stagnated or deteriorated since an infinity of traps and vices were acquired for the approval of the Learning Units, and at the same time face-to-face return, the need to integrate tutorials has been expressed to avoid falling behind and the increase in the failure rate. Therefore, it is important that this generational gap of the pandemic is addressed with awareness and dedication, since the deficiencies in the study of mathematics are palpable since they are the future professionals who will be in charge of the different work occupations.

REFERENCES

Abrate, R. (2006). Errores y dificultades en matemáticas. Análisis de causas y sugerencias de trabajo. Recuperado de: https://docplayer.es/10747249-Errores-y-dificultades-en-matematica-analisis-de-causas-y-sugerencias-de-trabajo.html

Avalos, A. (2017). De la Etnografía o cómo lograr que la escuela te sorprenda hasta quitarte el aliento. Herramientas metodológicas de la investigación construcciones para la práctica de la gestión escolar en la formación inicial de la educación básica. Cd. de México, México: ENSM.

Carrión, M. (2007). Análisis de errores de estudiantes y profesores en expresiones combinadas con números naturales. Unión Revista Iberoamericana de Educación Matemática, (11), 19-57. Recuperado de http://www.fisem.org/www/union/revistas/2007/11/Union_011_007.pdf

Del Puerto, S.; Minnaard, C., Seminara, S. (2004-2005): "Errores en el aprendizaje de las Matemáticas", Elementos de Matemática, publicación didáctico-científica de la Universidad CAECE, 1ª parte: 19 (74), pp. 5-18, 2ª parte: 19(75).

Engler, A. G., Müller, D., (2004). Los errores en el aprendizaje de matemática. Revista Premisa, 6(23), 23-32.

Gamboa, A. R., Castillo, S. M., Hidalgo, M. R. (2019). Errores matemáticos de estudiantes que entran a la universidad. Redalyc, Scielo, 19(1), DOI 10.15517/aie.v19i1.35278

NATIONAL POLYTECHNIC INSTITUTE
SCIENTIFIC AND TECHNOLOGICAL STUDIES CENTER NUMBER 16 "HIDALGO"
MATH ACADEMY

*LEARNING UNIT:***ALGEBRA**

*SEMESTER:***FIRST**   *ASSESSMENT:***DIAGNOSTIC**

*SCHOOL CYCLE:***2022 – 2023 (1)**   *SHIFT:***ONLY**

EVALUATION DATE: *EVALUATION TYPE:***ONLY**

STUDENT NAME: _____

*BALLOT Number.:*_____   *CLUSTER:* _____

*SPECIALTY:***COMMON TRUNK**   *QUALIFICATION:*_____

INSTRUCTIONS

- **Read each item carefully before selecting the answer you think is correct.**
- **Attach the procedure that justifies the answer you chose.**
- **The procedure that you attach must be clear and without omitting steps.**
- **It is forbidden to take out a calculator, cell phone, forms and/or electronic devices.**

Section 1: Notation

1. How do you write the fraction minus three fourths?

  to) $\frac{3}{4}-$ b) $\frac{-3}{4}$ c) $\frac{3}{-4}$ d) $-\frac{3}{4}$

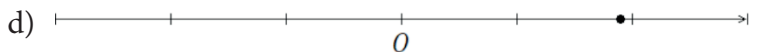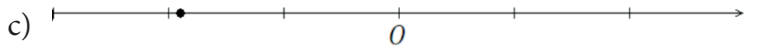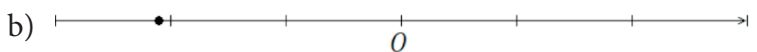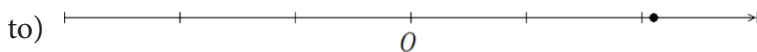2. The statement 18 years or older is written.

  to)>18   b)18+   c)-18   d)<18

3. Which figure represents the location of the number -2.1?

to)

b)

c)

d)

4. How do you write 25 hundredths?

  to).25   b).025   c)0.25   d)0.025

5. How do you write twenty-five thousand two hundred thirty?

  to)25 230   b)25'230   c)25,230   d)25230

Section 2: Concepts.

1. The sum of integers with different signs, the result gets the sign.

a) The one with the lowest relative value.

b) The one with the smallest absolute value.

c) The one with the highest absolute value.

d) The one with the highest relative value.

2. A prime number is:
a) The one whose factor is 1.
b) The one whose factor is the same.
c) The one whose factors are 1 and 0.
d) The one whose factors are 1 and itself.

3. A rational number is:
a) The quotient of two integers.
b) The quotient of two natural numbers.
c) The quotient of a natural number between an integer.
d) The quotient of an integer between a natural number.

4. What number belongs to the set of irrational numbers?

to) $\sqrt{-2}$ b) $\dfrac{2}{3}$ c) $\dfrac{\sqrt{3}}{2}$ d) $3\dfrac{5}{4}$

5. What number belongs to the set of real numbers?

to) e^2 b) π^i c) i d) $4-i$

Section 3: Procedures.

1. Calculate the lcm of 18, 42 and 10.

 a) 630   b) 210   c) 126   d) 315

2. Calculate the gcf of 180 420 and 104.

 a) 2   b) 4   c) 6   d) 5

3. Perform the following operations

 a) 0   b) 6   c) 10   d) 12

4. Perform the following operation $\dfrac{5}{12} - \dfrac{1}{6} + \dfrac{3}{8}$

to) $\dfrac{1}{2}$ b) $\dfrac{3}{13}$ c) $\dfrac{23}{24}$ d) $\dfrac{5}{8}$

5. Calculate the value of $\dfrac{x^2 + y^2}{z^2} - w^2$, Yeah x=3, y=-2, z=-1 and w=-2.

 a) -1   b) 9   c) 1   d) 17