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Evaluative Processes Around The Teaching Of Mathematical Concepts

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Abstract

This research focuses its efforts on characterising the assessment practices used by mathematics teachers and their influence on student learning. The data collection was carried out through a semi-structured interview with a group of participating teachers, complemented with the opinions derived from various discussion groups with students of the subjects they teach. The results found regarding the identification of the Mathematics teachers' evaluation practices allow us to affirm that teachers are autonomous and therefore there is a diversity of practices that reflect their personal style as a result of their experience and preparation, emphasising the acquisition of knowledge.

Keywords: Teaching process, meta-evaluation, evaluative practices, continuous improvement.

Introduction

In recent decades there have been many changes in the field of teaching and learning, as well as various assessment proposals in which what is important is not what teachers teach but what students do (Avendaño et al., 2021; Gamboa et al., 2020; Gómez, 2020; Matthew, 2000). However, for Barberá (1997), these changes and recommendations have had little impact on teachers' assessment practices (Perilla et al., 2022).

This paper is the result of a research project whose objective was to define the assessment methods applied by practising teachers in the Department of Mathematics working in a public higher education institution. Specifically, the aim was to identify the bases that support the

evaluative practices, characterise them from the construction of categories and subcategories, in order to reflect on the pedagogical practice carried out.

Theoretical references in different fields

The concept of assessment has evolved from the traditional model as the final stage of the pedagogical process, it has become a powerful tool for monitoring teaching and learning processes, and accurately, rather than another way of learning students (Jane, 2004). For Cerda (2000), evaluation is a systematic and reflective process that forms an ordered pattern, whose function is not only to collect the information sought but also to analyse and interpret it, giving it unity and coherence.

Álvarez Méndez (2001) argues that evaluation involves activities such as classifying, correcting and verifying, but should not be confused with them, although they share a semantic field. Evaluation is distinguished by the resources it uses and the uses it serves. Assessment is considered by Reynolds and Trehan (2000) as the most political educational process, as it is the point of convergence between institutions, teachers and students. This is why they suggest rethinking power relations, which is why it is important to generate knowledge and critical thinking, without being afraid of the actions of those who exercise them. For Gimeno (1994), evaluative practice is an activity that fulfils multiple functions, is based on a series of ideas and ways of carrying it out, and is the response to certain conditioning factors of institutionalised teaching. Several studies have been carried out in order to determine the type of evaluation that is carried out in university classrooms, including one by Digión et al (2006) in Argentina, which concluded that in that institution the conception of learning evaluation from the technical paradigm predominates over the critical paradigm. Likewise, Contreras (2008) in Chile concluded that teachers' assessment practices have a traditional approach, i.e. assessment is associated with measurement and grading, and not with an informed reflection on the quality of student learning. The research by Villalonga et al.(2011) concludes that there is no coherence between the guiding criteria for the assessment of learning in mathematics and the assessment practices implemented in the subject, since the assessment of learning is equivalent to examination, measurement or accreditation.

Torres (2010) makes a pedagogical reflection on student assessment in higher education by analysing practices in various contexts, followed by emerging theoretical references that can support practical alternatives for change and invites teachers to reflect in order to initiate the process towards a new culture of assessment. In the research carried out by Serpa (2012) in Integral Calculus courses, it is concluded that the assessment carried out by teachers corresponds to the traditional paradigm and for their part, students recognise that they study to be certified and not to learn. In the same context of higher education, the work of Perilla Fernández, Prada Núñez and Marmolejo Avernia (2022) is carried out with Bachelor's

Degree students in Mathematics from all semesters in order to analyse whether their conception of assessment evolves as they progress in their training process in the academic programme. The results validated this change in a percentage of no more than 30% of the students, which makes it possible to verify the effect that the predominant practices in the teaching exercise have on the training process.

A look at the research context

Assessment practices are expected to be coherent with the pedagogical model suggested by the educational institution, since it guides curriculum management and delimits the forms of assessment by answering the questions: what, how and when to assess, which have to do with the partial or total fulfilment of the proposed learning goals. In a general sense, assessment implies a permanent action through which one seeks to appreciate, estimate and make judgements on the academic progress of students' learning. From an evaluation centred on results (summative evaluation), we are moving on to a conception that takes into account the initial conditions (diagnostic evaluation) and the educational processes. We thus speak of continuous and formative assessment. From a rigid, product-oriented evaluation that emphasises grading, we postulate an integral evaluation that takes into account the process and the product, that considers concrete achievements and that diversifies the instruments and techniques of evaluation. In the institution where this research is being developed, three evaluation moments or cuts are contemplated, each one of them corresponds to a written evaluation with a value equivalent to 77%, and the remaining 23% corresponds to the evaluation of independent work or extracurricular activities that are developed within the framework of each course. During the written assessment, students are anxious and worried, which indicates that they perceive that the assessment only takes place at that moment and are not aware that it is a continuous and formative process.

The questions that arose with respect to the evaluative practices of Calculus teachers are: what are the evaluative practices being carried out by the teachers who guide the Calculus courses; does the evaluation in Calculus, as it is currently being carried out, reflect student learning; do the evaluative practices in Calculus, as they are currently being carried out, contribute to the academic training of future professionals; what aspects are evaluated; do the evaluative practices respond to the objective of the course; do the evaluative practices respond to the objective of the course; and if so, which aspects are evaluated?

Methodology

Type of Research

For Taylor and Bogdan (in Herrera, 2008) qualitative research is that which produces descriptive data: people's own words, spoken or written, and observable behaviour. When aiming to identify the evaluative practices of Calculus teachers, it was decided to apply qualitative research, since it is necessary to look at the context and the people from a holistic

perspective, trying to make sense of the phenomena according to the meanings they have for the people involved. Contexts or groups are not reduced to variables, but are considered as a whole.

Participants

Sandoval (1996) suggests that the selection of participants should be guided by the principles of relevance and appropriateness. The first has to do with identifying and securing the participation of participants who can contribute the most and best information to the research. Adequacy refers to having sufficient data available to develop a full and rich description of the phenomenon, preferably when the saturation stage has been reached.

The participants in this research consisted of two groups: a) a group of five teachers who taught the subjects Differential Calculus and Integral Calculus, who joined the project voluntarily; and a second group, b) made up of fifteen students who were drawn from the courses taught by the teachers on a random proportional basis, i.e. three students per teacher.

Method

Given the qualitative nature of the research, the Comparison method is used, since it is intended to find the similarities and differences existing in the groups of informants, and from these divergences, it is hoped that the reality studied will be known in depth and with precision (Panqueva, 2008).

Techniques

The techniques used in the development of this research were the semi-structured interview and the focus group. The former was applied to the group of teachers while the latter was carried out with the students.

The individual interviews with teachers followed the following phases to define their topics: a) the questions were drafted based on the objectives of the project; b) they were subjected to a pilot test in order to make some modifications that were relevant to the work to be carried out; c) once the drafting corrections had been made, the questionnaires were submitted for validation by experts; d) based on the considerations of the experts, the final version of the questions to be addressed with each teacher was generated. Each teacher was invited by means of a letter stating the objective pursued, the scope of the research, the questions to be asked and clarifying that participation was completely anonymous. Afterwards, a meeting was arranged to conduct the interview, which was audio-recorded and used exclusively for the purposes of this study.

Two discussion groups were generated, one for each Calculus course (Differential and Integral) in which the students of all the participating teachers were mixed, leaving eight

students in one and seven in the other, complying with the requirement of this technique, which demands that the number of participants be greater than 6 but less than 10. The activity developed with them begins with a greeting, followed by a contextualisation of the objective of the research to then present the topics to be dealt with around the evaluation process in the development of their Calculus course. As with the teachers, this activity was audio-recorded and the identity of the informants was kept completely anonymous.

For the coding process, teachers were assigned the letter P followed by a number between 1 and 5, while Differential Calculus students were assigned the code CD followed by a number between 1 and 8, and similarly for students in Integral Calculus courses the code CI followed by a number between 1 and 7.

Analysis and interpretation of information

For the processing of the information, the Atlas Ti software was used, where pre-existing categories were used as a starting point for coding the information collected through the instruments used. These were established on the basis of the objectives of the research project, which were reviewed through the questions contained in the interview questionnaires and the focus group scripts.

Next, the inferential procedure was applied, which according to Cisterna (2005), consists of establishing ascending conclusions, grouping the relevant responses by trends, which can be classified in terms of coincidences or divergences in each of the instruments applied. The information obtained from each group (teachers or students) was processed in the following way: the answers given to each of the questions were grouped together, and the information relevant to the project objectives was analysed question by question, incorporating the emerging elements. The coded information was cross-checked by highlighting the relevant ideas, taking into account their recurrence or assertiveness; this allowed us to know the opinion of the participants and to group the answers by trends called subcategories (or first level conclusions). The information from the subcategories was then cross-referenced, giving rise to a new grouping called categories (or second-level conclusions), known as first findings. The results of the first findings (first-level conclusions) provided by both the interviews and the focus groups were cross-checked to establish similarities and differences between them in order to give rise to the second findings (second-level conclusions or categorical conclusions).

Results y discussion

Correlation with Research Findings

Correlating the second findings with the questions posed in the problem description gives the third level conclusions:

- The evaluative practices developed by the teachers are: Investigative evaluation by trial and error, diagnostic evaluation, workshops, quizzes, group evaluation, oral evaluation, evaluation using technological resources, evaluation of the self, board trips or written test.
- Other types of assessment are self-assessment, co-assessment and meta-assessment..
- The evaluative practices that are being carried out in these courses, according to students and teachers, do contribute to learning as they provide them with the necessary training for the courses to come; additionally, students are aware that evaluation is an instrument that helps to improve pedagogical practices.
- The assessment being carried out follows the guidelines for academic development defined by the educational institution, since the teachers take into account the criteria established institutionally to assess the students. These criteria refer to the learning outcomes explicitly expressed for each subject, the percentages assigned to the mid-term exams and the value established for autonomous work.
- Teachers consider that their own evaluation system does promote research training, but in practice this is not the case.
- The assessment being carried out does not promote critical thinking, as students comment on the lack of interpretation and analysis in the assessments. The fact that teachers pose exercises similar to those developed in class leads students to a mechanical process.
- In the training of students, the teachers state that the students are only interested in passing the course, but there is no desire to learn beyond what is being worked on in the classroom. In addition, they are concerned about providing a comprehensive education in which communication processes are improved and they manage to develop a collaborative spirit and tolerance towards others in teamwork.
- The assessment practices in Calculus, as they are being carried out, do contribute to academic training, since the aim is for students to demonstrate what they know, starting from exercises and in some cases advancing to situations in context that demand greater cognitive skills in their solution.
- The aspects that teachers take into account when assessing are the procedures and the accurate and punctual answers that students give to the problem situations or exercises they are given. Others are more interested in the process, and for some teachers, order is also important.
- The objective of training in Calculus is that the student acquires the ability to apply the concepts in the approach and solution of problems in their academic environment. In the present research, this objective is achieved when teachers design the different tests taking into account that, through them, the student can apply the knowledge and they also design them thinking about the characteristics of each group.

When correlating the second findings with the theoretical framework taken for this research it has been found:

Aspects to consider when preparing for a test in Calculus

When drawing up the various tests that the teachers apply to the students, they take into account the criteria established institutionally and socialise them with the students, even presenting them to them in writing. These criteria refer to the learning outcomes explicitly expressed for each subject, the percentages assigned to the mid-term exams and the value established for autonomous work. As for class activities, they take into account their ability to communicate using everyday and mathematical language.

From the above it can be affirmed that, although the institution sets out general parameters or guidelines, teachers have the autonomy to determine their own criteria. On the other hand, although students are informed of them, they have no influence on the process. According to Bordas and Cabrera (2001), these characteristics correspond to the traditional assessment paradigm.

As for the criteria established for grading, these also differ among teachers, since for some, the process is more important; for others, the process and the response are important, and there are even those who value the order. In the case of the former, their practice corresponds more to Cronbach's (1963) approach to evaluation, which favours processes over results, while for the latter, it is in line with Stake's (1976) approach, which gives equal importance to processes and results.

As for the time teachers spend on test preparation, this varies greatly from one teacher to another. Some spent half an hour, others three hours, and one teacher said he spent up to half a day designing and preparing the tests. What the students do agree on is that they are all very complex and take a lot of time to answer, more than the time they are usually given to complete them. In this aspect, it is necessary to bear in mind what Mejía (2012) states when he affirms that it is necessary that the design of instruments conceived by teachers should take into account the specific conditions of each group of students.

The teachers use books or texts in physical or virtual format as the main sources of consultation for drawing up the different tests; they also mention Internet pages, workshops held in class or tests applied previously, but with modifications. These are the only ones that are recognised by the students as evaluations, since they are marked and returned by their teachers, despite the fact that the teachers state that evaluation is permanent. Thus, students see assessment as a punctual and final act, alien to the teaching process, a characteristic of traditional assessment (Chercasky, 2009).

With regard to the type of questions posed to students in the tests, students and teachers agree that they use both open and closed or multiple choice questions. In the former, problem situations are proposed so that, by means of a context analysis procedure, the solution is sought by applying the contents seen. The latter are aimed more at preparing students for the Saber Pro tests, in which they must demonstrate mastery of interpretative, argumentative and propositional skills. In the conception of assessment according to Bordas and Cabrera (2001), the proposed assessment should facilitate the control of the acquisition of knowledge and skills in order to identify the most effective procedures for each learning style and pace.

Types of tests that teachers administer to students.

Teachers use different techniques in the assessment process, which according to Berliner (in Díaz and Hernández, 2002), are classified as formal, semi-formal and informal. To the first belong the written ones (mid-term exams, quizzes, workshops); in the second we find oral tests (presentations, presentations, group work) and group work. The third is observation, which has been called "evaluation of the self". Each of these has a purpose defined by the teacher, who determines what is graded back to the student.

The main and most valuable tests are the mid-term exams (three per semester) which have a value of 73%. These are written and individual. Aschbacher and Winters, (1992) cited by Díaz (2006), proposed that assessment should assess contextualised learning, focusing on the learner's performance and including a diversity of instructional-assessment strategies that are not only holistic, but also rigorous.

On the other hand, Bordas and Cabrera (2001) recognise in this type of practice another characteristic of traditional assessment. The quizzes or workshops can either be taken as a whole as the mark for a partial or be taken into account for 23% of the third mark. This is at the discretion of the teacher, who is autonomous in this respect.

As far as oral tests are concerned, teachers frequently use the use of the board games, through which they not only demonstrate the appropriation of knowledge, but also serve to develop the communicative competence of the students. They also sometimes resort to presentations.

Another type of evaluation applied by teachers is the observation of students' attitudes and behaviour, which is taken into account for the third mark, which students only know about until the end of the course and about which they are not very clear as to the criteria their teachers take into account in assigning it.

In each of the above tests it is the teacher who holds the power, imposes the rules of the game, and exercises control. The students assume a passive role since they are the ones being

assessed. In all these practices, the characteristics of assessment in the traditional paradigm are evident.

However, it should not be overlooked that the implementation that is taking place through the group workshops has a more formative than cognitive purpose, in the sense that through them the teachers intend that the students develop social skills in such a way that they can interact in a tolerant manner and that each person contributes to the achievement of the objective. This practice is part of the qualitative paradigm of evaluation with a formative approach.

On the other hand, new technologies have not been incorporated into the assessment practices of teachers who recognise that the use of the personal calculator is the only resource used.

Actions during assessment

Teachers and students explicitly recognise each other's role during assessment: the teacher monitors and the student answers the test. The teacher knows that he/she has to be vigilant to avoid cheating, as there is very little trust in such situations in the classroom.

On the other hand, at the time of the assessment, the mood of the students depends on their level of preparation and mastery of the subjects to be assessed: they feel stressed and nervous when they have not studied or understood the subject; on the other hand, they are calm when they recognise that they know the subject because they have studied or understood it. These elements also characterise traditional evaluation, in the sense that it generates anxiety, conflict, rupture and misunderstanding between the evaluated and the evaluator (Chercasky, 2009).

Actions after the Evaluation

Teachers develop similar practices when correcting students' assessments. Through these they try to highlight the error and take care not to give the student the opportunity to make unjustified claims. Chercasky (2009), states that in traditional assessment, error is seen as failure and that it does not take into account what the student does not know or did not learn. However, a teacher applies a novel procedure in which he assumes the assessment as a new opportunity to learn from the error and with the collaboration of his classmates.

On the other hand, teachers and students recognise that the handing in of assessments is a personal and discreet process, through which mutual respect is evident. Most teachers hand in corrected written tests, although there are some who correct them in front of the student, pointing out any mistakes made and clarifying any concerns or doubts. This usually takes place in the meeting or class following the evaluation.

At the end of the cut-off, the average grade is three or four, as a result of the mid-term exams and the occasional workshop. Most teachers do not give students the opportunity to raise the low marks obtained in any of them, as they understand that these are final (Chercasky, 2009). Others assign a workshop and, depending on the result, raise the grade. Whether or not the student corrects his or her test does not change the grade obtained in the test.

Other ways to evaluate

Although teachers state that self-assessment is a practice they use and that they attach great importance to it in their students' learning process, it can be affirmed that, if they do it, they do not assume it as such, since they do not have clarity about it.

A similar situation occurs with co-evaluation, where the teachers state that the students are not very objective and that when it comes to evaluating the work of their classmates, the affinity they feel for them takes precedence; while the students do not state anything to suggest that this practice is carried out with them.

The opposite is the case with meta-evaluation, where teachers and students recognise that there is a dialogue on evaluation and propose changes to improve them based on the shortcomings found in them.

Reflections on Evaluation

Teachers and students fundamentally agree in understanding assessment as a measurement of learning, as a means of determining the achievement of objectives or as a means of certification. In this sense, Tyler (1950) initially points to this as the fundamental purpose of assessment.

However, when it comes to choosing a type of test, there is no unity in the selection: some students say they prefer written tests because they have time to complete them, others say they like group tests because of the cooperative work involved, and some opt for board tests because they gain self-confidence. In this respect, it is important to emphasise that individual differences should guide teachers in the choice of the type of instrument to be used according to the student in front of them. In this respect, Cabrera (2000) proposes that different forms of assessment and alternative tasks should be promoted where the student can choose, in such a way that these respond to the different learning styles of students.

However, for students, assessment is seen as something necessary to enable them to improve. Although some teachers give them the opportunity to make suggestions or recommendations to modify assessment practices, few dare to do so. This is logical, since they are used to assuming a passive role in the evaluation process.

The opinion that teachers and students have about group assessment is different for each of them. Most teachers consider that this type of test is not very favourable because it does not contribute to learning, although some say that it is necessary to use it to promote collaborative work. On the other hand, students recognise that it is part of life at work, where they help each other to carry out assigned tasks.

The teachers highlight as strengths of the assessment applied at the institution its rigorousness, relevance and reliability. They agree with the students that their greatest weakness is the limited time available and the deficiencies in interpretation and analysis of the students, who come from secondary education with inadequate study habits that emphasise memoristic processes. In addition, students point to the inflexibility of some teachers as a significant weakness.

The teachers' and students' opinion of the institutional assessment system is favourable because they consider that, despite being quantitative, it does not only assess cognitive aspects, but tries to take into account the whole person of the student. This element is an indicator of the transformation process that is taking place with regard to assessment in the educational sphere. According to Cabrera (2000), the aim is for assessment to be more comprehensive and formative.
Teachers recognise that their assessment practices take into account individual differences, are transparent, fair, formative and useful. Meanwhile, students say that the assessments are difficult, but that the institutional assessment system itself gives them opportunities to pass. The latter speaks to the fact that the idea of certification is still prevalent among students above any other purpose of assessment.

According to the findings, it can be affirmed that the assessment practices applied by Calculus teachers are based on the cognitive model (Guerra, 2007), since it focuses on the subject and seeks to develop their mental structures in order to achieve their effective insertion into the world of work. Therefore, the evaluative practices they carry out are contextualised problem-type situations in which students, individually, must put their knowledge into play to solve them.

Conclusions

The results found regarding the identification of the assessment practices of the Calculus teachers allow us to affirm that the teachers are autonomous and therefore there is a diversity of practices that reflect the personal style resulting from the experience and preparation that they possess. Furthermore, they emphasise the acquisition of knowledge, since a high percentage is assigned to the written tests that are part of the total mark for the semester.

Regarding the conceptualisation of evaluation by the participants in the research, it can be concluded that for the teachers, evaluation is a continuous process that allows them to measure the achievement of objectives, identify progress and difficulties in the process and fulfil an institutional requirement. For students, evaluation is a final act that serves to certify their knowledge, improve their work and rethink the way teachers teach. As can be seen, the concept of evaluation differs in that for the teachers it is a process while the students perceive it as a moment.

The categories and subcategories that made up the assessment practices applied by the teachers made it possible to characterise them within the formative assessment model. In them, it is the teacher who determines the criteria and defines the context of the assessment, and the student should be more interested in what he/she learns than in the assessment process itself. The focus here is not on externalising learning but on reflecting the student's internal knowledge and development.

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