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Teacher Reflection in Teaching Practices - A Methodological Proposal for Its Operationalization

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Abstract

This research studies teacher reflection as a tool to improve teaching practice, focusing on student learning. The objective is to describe the way in which teachers in the area operationalize reflection in the practice of science teaching in various higher education careers. The theoretical framework takes elements from didactics, and the concepts of reflection in action from various theoretical references, especially Donald Schön. This research proposes a qualitative approach with an interpretative-naturalistic, epistemological, ontological and pragmatic paradigm, using the case study as a research method, with a purposive sample. The methodological techniques for data collection proposed are semi-structured interviews, non-participant observations and stimulated recall interviews. The analysis of the data should be carried out by generating a matrix of meanings containing the description of teaching practices, after reflection on their teaching methods and science teaching strategies.

Keywords: teaching reflection, teaching practice, didactics, learning

1. Introduction

The globalized world is characterized by experiencing significant social, economic, political, technological, and cultural changes in short periods of time, which does not leave space for reflection. It is in this dizzying world where current professionals are being subjected to new demands during the exercise of their profession, which has caused training institutions to continuously analyze their work in order to make the necessary adjustments to their professional training programs (Coppelli-Ortiz, 2018). In this reality, the training of professionals and, in particular, the training of professionals in the STEM area, who face new challenges derived from scientific and technological development; on the one hand, and on the other hand, the question of preparing professionals capable of operating with such information, makes it necessary to open a path that allows for the improvement of productive and teaching activities.

Faced with this challenge, it is necessary to reflect on traditional teaching practices that predominate today, in order to respond to the training of STEM professionals in the face of the changes and demands of the current world. In this sense, higher education teaching demands needs and requirements in order to ensure that the training process responds to the demands of the context, which requires an organization of the educational teaching process centered on the student, developed interactively and collaboratively and that allows them to acquire lifelong learning (Capote-León et al, 2016).

University education has the commitment to change and adapt to the new realities of the world. In this regard, Caro and Reyes (2003) establish that STEM training should aim to train professionals who: 1) understand the social responsibility of their actions; 2) behave under high ethical standards; 3) are committed, autonomous, and reliable; 4) have the necessary skills to use, transform, and create technology; 5) can work successfully in teams; 6) have the ability to update and learn in the long term; 7) know how to communicate efficiently; and 8) have negotiation and decision-making skills, among others (Forcael et al, 2013).

In this context, learning in basic sciences is a necessity worldwide, especially when it comes to the training of professionals who base their strength on mathematical competencies and skills, such as in the fields of engineering, natural sciences, and even social sciences, which require a training in mathematics, whether

intermediate level for social sciences or more advanced for natural sciences and engineering (Rodríguez et al, 2018).

Facing the requirements that are presented in all ranges of professional training, the teaching of basic sciences has been and is a research topic that brings together all cultures in which to a greater or lesser extent all orient and guide their students towards the achievement of minimum necessary skills in order to achieve a professional development in line with market requirements (Mendes et al, 2018).

In this sense, reflection is understood as two processes: reflection in action and reflection on action. Reflection in action is understood as what the teacher does in situ at the moment they are teaching, when they decide to do one action or another, when they think about previous situations, from their professional training, as well as their experiences with students, this mainly occurs when a new circumstance or surprising situation arises. On the other hand, reflection on action is the one that is carried out afterwards, which occurs after the class has been given, therefore its context is posterior to the action, that is, "once the event has occurred" (Schön, 1987, p.36).

In this process, analyses and explanations of content, procedures, attitudes, feelings, among other things are carried out; it lacks direct connection with the present and its purpose is to discover how the unexpected or surprising result was produced and why it is proposed to work on a recording of the class to look retrospectively at the actions taken in the class (Schön, 1992). It should be noted that reflection on action is more likely to promote critical reflective learning when it is in the presence of another, as interpersonal interaction through dialogue stimulates critical reflection on the actions of a person and their context, with perspectives of remodeling traditions and embarking on transformative criticism.

2. Objectives

General objective: To carry out a bibliographical review on teacher reflection in teaching and to generate a methodological proposal for its operationalization.

Hypothesis: A reflective teacher delivers better teaching and is more effective in his teaching mission than one who is not.

3. Material Studied and Area Descriptions

3.1 Introduction

Although most of the theorists who have addressed the issue come from the last century, their approaches are more valid than ever, since their theories have now been deepened and disseminated outside the geographical areas where they were created. Thus Lee Shulman, who made several contributions on pedagogical practice in terms of coining the concept of didactic knowledge of content, his contributions were created at a time when a great educational reform was being proposed in the United States, oriented to teacher evaluation and the vindication of teachers as teaching professionals, is still valid today and has been further deepened.

On the other hand, Donald Schön's contributions in the 80's, emerged to solve concrete issues of that time, placing reflection in action as a practical tool that beyond the abstract theories of the concept of reflection, for example, in the sense of the Greeks who proposed reflection as looking in a mirror to see the soul and thus access the truth, reflection was proposed as a practical tool to solve concrete problems of that time, which are still valid today and are deepened in each research.

From then on, the works on Shulman's legacy on the didactic knowledge of content, known by its acronym PCK (Pedagogical Content Knowledge), have followed one another in a large part of the world, throughout America and Europe, even reaching other continents. The same thing has happened with Schön's work on reflection in action, since every research and research reference on reflection in action refers to Schön as one of the forerunners of the subject (Shulman, 1986).

3.1.1 Reflection

The reflective approach nourishes with viable elements to improve the certainty of teachers' work. This approach offers the possibility for educators to examine their attitudes, beliefs and teaching strategies head-on. This gives them the possibility of identifying situations that need to be modified, reformulated and improved, in such a way as to create a connection between people, events and the institutional, social and cultural environment. Reflection seeks to create a bridge between the subject and its context, to help make decisions, self-evaluation helps to solve problems and achieve objectives and respond to the demands of an education committed to society. Professional competence requires a good capacity for reflection, which can occur at any time in relation to a conflictive, unique, uncertain or extraordinary scenario (Iglesias, 2011).

Reflective practice involves the subject's willingness to engage in self-assessment, implies flexibility, rigorous analysis and social awareness. Such reflective practice requires responsibility and enthusiasm on the part of the teacher, an open mind that is "an active desire to listen to more than one side; to pay attention to facts from whatever side they come; to give full attention to all possible alternatives; to recognize the possibility of error even in the beliefs dearest to us" (Dewey, 1933, p. 29, in Iglesias, 2011).

Based on the ideas of Schön, who describes reflection as a way of accessing complex problems. Thus, making an analogy with geography, it can be pointed out that in the topography of professional practice there are high and firm lands in which one sees in the lower part a marshy and distant valley, in which it is not possible to see elements that characterize it. In the highlands, there are problems easy to control, they are solved with the application of the known knowledge and technique. In the lowlands in the swamp, confusing and unclear problems resist a technical solution. The paradox of the situation is that upland problems tend to be of relative importance to individuals or to society, despite how relevant their technical interest may be; while in the swamp reside those other problems of greater human concern (Schön, 1992).

The practical subject must choose: will he stay in the uplands where it is possible to solve problems of relative importance by prevailing standards, or will he descend into the swamp of relevant problems? Such a dilemma has two points of origin: one, the dominant idea of rigorous professional knowledge, based on technical rationality; and the other, the awareness of those poorly defined and swampy areas of practice that remain outside the canons of technical rationality. Technical rationality supports the idea that practitioners solve problems by choosing appropriate technical means for defined purposes. Practitioners solve well-structured instrumental problems through the application of theory and technique derived from systematic and scientific knowledge. Professionals in medicine, law and business are considered, from this point of view, as models of professional practice. But, as we have seen with increasing clarity over the last 50 years, the problems that these professionals face in reality do not always present themselves as well-organized structures. In fact, they often do not even present themselves as problems but as ill-defined and disordered situations (Schön, 1992).

In 1992 Schön made a new contribution to the reflective process, by creating the theory of Reflection in action, which opened a new way to reconstruct and redirect certain behaviors hardened by routine, which prevent breaking with the daily routine and conflict with other visions, both from teaching peers and from my own reflection, whether reflection in action or reflection for transformation. A teacher once commented, "why do we need training if we don't need it...". One way is the practice of Schön's dialogic level of reflection, it is to enter the swamp in which an innovative style of the relationship between subjects emerges; one in its performance as educator and the other is its performance as student, to generate the communicative action between tutor and learner, in a dialogic act of role exchange, which will serve the action of training, not only in the classroom but also in other roles, since training are processes that move from the task as a message to the act of communication (Ochoa et al, 2005).

By way of definition, while reflecting means reflecting, in this study, we will understand reflection as two processes; reflecting in action and reflecting on action. Reflection in action is understood as what the teacher does in situ at the moment he/she teaches the class, when he/she decides to do one action or another, when he/she thinks about previous situations, from his/her professional training, as well as his/her experiences with the students. On the other hand, reflection on the action is done afterwards, which occurs when the class has already taken place, and work is done on a recording of it to look back on the actions carried out in the class previously (Schön, 1992).

3.1.2 Origin of Reflection and Theory

While reflection, in the historical sense, alludes to the soul, where it is conceived as a mirror in which things are reflected, reflexivity would be the gaze of the subject on himself, or it could rather be the external control exercised by another or others on the subject. Thus, reflexivity is the particularity of all human action and is a very singular phenomenon of a type of interactions. Reflexivity is a detachment of oneself from oneself that allows one to look at oneself from the outside; this "seeing oneself seeing" means that the subject distances himself from the action and observes it as if it were another person, so as to observe himself seeing and therefore knows what he sees and what he is observing. At this point, the subject unfolds into an actor who at the same time becomes an observer of himself in such a way that this observation inspects and directs the action. Why does he distance himself from his action and see it from the outside? Naturally, because he can differentiate between what the action provokes and what it should provoke, because he can compare the reality of the scenario with an expected model of the situation. There are four elements in all reflection: the first is the action, it is where the subject who acts. The second is the subject's reflection on his action, which makes him an observer of

himself. Thirdly, there is what the first wants to achieve, the objective of the action. Finally there is, the actual course of action that is reflected by its observer-self (Espinosa, 1990).

Reflection leads to a way of thinking that admits uncertainty and dilemmas, confronts the professional and personal self, unveiling its work, personal and collective actions. Reflective practice seeks to form a connection between the reflective subject and his or her environment, offering a way for teachers to explore their attitudes, beliefs and teaching skills in order to identify situations that need to be modified and improved. In order to create or strengthen a connection between the subject and the institutional, social and cultural context, responding to the demands of an education committed to the society in which it is carried out. The reflective approach tries to investigate and improve the reality when making decisions, planning the curriculum and pedagogical action in the classroom and also outside it. This is immersed in a process in which teachers explore their attitudes, beliefs, values and teaching practices in a critical way, through reflection, allowing them to identify and look at those circumstances that need to be modified, reformulated and innovated. In this sense, a commitment is established with the integration of theory and practice in reflective action that contains an active component, persevering and clean of any belief or way of knowing, in light of the foundations that support it and the horizons to which it is projected (Ramos, 2018).

Reflection on action and on reflection in action, demands the construction of a space and a time destined to reflect on what has been acted, in which professional action becomes a true object of knowledge. By reflecting on the action itself, teachers develop a type of research in the classroom in which they critically analyze the effectiveness of their interventions. By doing so constantly, such exploration will allow teachers to verify whether what they teach corresponds to what students actually learn or whether it should be refocused. For Schön, only through these reflective forms can access to types of knowledge, such as tacit knowledge, product of experience in professional activities, and which the teacher is not fully aware of (Ramos, 2018).

Donald Schön, parallel to Espinosa laid the foundations that allowed the development of the meaning of the concepts associated with reflection through his works The Reflective Professional: How professionals think when they act (1983) and The Formation of Reflective Professionals: Towards a new design of teaching and learning in the professions (1987). According to the above mentioned in relation to the levels of reflection, we can approach the progression of reflection development according to the following classification: 1. Descriptive level of reflection: It refers to how teachers use the information, considers contextual aspects of the observed action, which responds to where, when and how the action is carried out. Dialogic level of reflection: Consists of establishing the relationship between the teachers' intention that motivates the observed action and the dialogue generated with the students. This level of reflection informs about the intention of the action, the reasons for the action and the products generated by the action. 3. Transformative level of reflection: At this level, reflection is oriented to generate new relationships between the teachers' intention and the observed action, with the purpose of changing and improving the observed result. For Schön (1987), professional reflection occurs in action or on action, that is, during the process of doing or at a time after the action of doing or executing an activity.

In terms of teacher education Newman (2018) notes that the notion of 'reflection' has been increasingly used in teacher education; As well as the American teacher, where the notion of the reflective practitioner has been navigating from terms such as 'reflection-inaction' and 'reflective teaching', so too in Britain, 'reflective teaching' tends to be increasingly popular, often used in conjunction with terms such as 'reflective practice', projected to 'teacher education research', 'reflection in action' and 'teacher as researcher'. It is worth noting that the literature on the subject has gradually increased. In one sense, various editors have questioned the growing popularity of the idea of 'reflection', and suggesting that reflective practice is itself far less common than the use of appropriate rhetoric on the subject, that reflection in teaching has become a catchphrase. Undoubtedly, one of the most cited authors in the field of reflection is Donald Schön, although there are other authors in the field, it is Schön's work on the reflective practitioner that is of importance and has the most forcefulness in establishing the notion of reflective practice. On education, which Schön first researched in 1987, the work has been particularly influential (Newman, 2018).

3.1.3 Reflection in Pedagogical Practice

Cornejo (2003) refers to Schön in which reflection is defined in part as "knowledge in action", as that knowledge "of practice", which is generally tacit, developed by the experienced and expert professional, so that such knowledge can be made explicit through observation and reflection; it is built from practice, it is dynamic and situational, hardly reducible to rules and procedures. Reflection in action" is a further step: through observation and reflection such knowledge can be made explicit and used while "in the thick of the situation"; the key here is the ability to recognize the problem, to identify what will be paid attention to, as well as to circumscribe the

"context" from which it will be approached. In his perspective, the "formulation of problems" is a main axis in reflection.

As a formative device for reflection, Schön proposes a "reflective experience": "trainees are involved in experiences that simulate practice, but without the pressures, distractions and risks of real situations; they learn to recognize good practice", to construct images of what it is to "be competent" and to think about the actual doing of the action. In this perspective, 'professional knowledge' in its meaning of 'propositional knowledge' is less important than learning achieved through action under the tutelage of more experienced practitioners. Rational" knowledge is not enough to deal with the complexity of teachers' practice situations; the best possibility would be to rehabilitate "practical reason", the knowledge of action and experience, intuition, the expertise that emerges from dialogue with reality, reflection on action and in action (Cornejo, 2003).

Reflection is a powerful tool in the practice of teaching and in the professional development of teachers, since it requires a systematic analysis of their practice and research on their professional problems from the different perspectives of didactics. The reflective teacher is open and willing to face the conflicts that occur in his or her professional life, through the continuous revision of his or her practice. The teacher is a practical professional, which can be seen in the immediacy to make decisions, to face the dilemmas of his practice, and in the importance of actions in the face of achievements. Thus, it is propitious to face the professional development of the teacher as a process of creating habits of reflection, to learn from the practical work of his teaching work, achieving new ways of acting that allow him to provide solutions to the conflicts that motivated his analysis (Navarro et al, 2017).

The reflective teacher has the ability to analyze his own teaching practice, distinguishing the beliefs that support his performance. He/she obtains from Didactics, in a grounded and genuine way, the characteristics that are more appropriate for him/her when responding to his/her actions. The reflection process considers the difficult task of confronting the teacher with new ways of looking at problems, maintaining his ideas, but at the same time, allowing him to improve his knowledge and professional development. The reflection process pursues the operative conjunction between practical knowledge, necessary for action, and the theoretical knowledge that serves as an argument for the practical one (Navarro et al, 2017).

From the literature reviewed, it is clear that the origin of reflection comes from what Donald Schön proposed in 1983 and deepened in his next publications, especially in the 1992 publication. Schön, with his proposal of the 3 levels of reflection, orients the first steps to operationalize teacher reflection: the descriptive, dialogic and transformative levels of reflection help the teacher and the researcher in the process of reflection. Espinosa (1990) points out four elements in all reflection: the first is the action, the second is the reflection of the subject on his action that turns him into an observer of himself, thirdly, there is what the subject wants to achieve, the objective of the action, and finally there is the actual course of action that is reflected by his observer-self. Finally, there is Shulman (1986) who describes didactic content knowledge, but does not link it to the process of teacher reflection. Thus, we do not find in the origins, an explicit path that orients to carry out case studies with a level of standardization that makes transparent the collection of data, their analysis and conclusions.

Although reflection, in the historical sense, alludes to the soul, where it is conceived as a mirror in which things are reflected, reflexivity is the particularity of all human action and is a very singular phenomenon of a type of interactions. In this sense, after 2 decades, several authors have carried out researches that return to Schön as a theoretical reference, but their research methodologies are diverse and are associated to each author and his interpretation of the theory. Thus we have research conducted by Cornejo (2003) and Ochoa et al (2005) among others, research conducted in the 2000s, Iglesias (2011), Cortés et al (2011), Isoda et al (2012), Navarro et al (2017), Ramos-Rodríguez et al (2017), Ramos (2018) and Newman (2018), among others, research works carried out 3 decades after Schön made his 1983 publication, but that all are somehow without a standard methodology that allows objectifying the process of analysis and conclusions of what was investigated. It is in this sense that this paper proposes a detailed methodology, to carry out the process of teacher reflection, listing step by step, from data collection, standardization of interviews at various levels, as the systematization of the levels of analysis.

In the following, the methodology proposed to conduct this research will be disclosed. This work has a qualitative approach with an Interpretive-Naturalistic paradigm, and the proposal is to conduct a case study with higher education mathematics teachers, but it also operates to do it with elementary and secondary education teachers.

4. Proposed Methodology

4.1 Research Paradigm

This research is based on the interpretative - hermeneutic paradigm, which begins by differentiating social phenomena from natural phenomena, for which it seeks the complexity and incompleteness of social phenomena, which are conditioned to the participation and action of human beings. This paradigm encompasses a set of humanistic-interpretative guidelines, where the interest is directed to the meaning of humanity's actions, its social life. The paradigm understands education as a social process, as a living experience in the evolution of social processes and those who are involved, so it seeks the transformation of teachers' consciousness, who will transform their educational practice (Espinosa et al, 2011).

It should be noted that this paradigm places the teacher and the student at the center of the lines of research. In the student, the process of cognitive metamorphosis is managed taking into account the psychological and sociological view. The teacher is oriented to the cognitive processes and their relationship with alternative conceptions. The teacher's actions are studied in the phases; proactive, interactive and postactive, being the most important investigations those that are consequences of interactive actions and the construction of knowledge. In this case, teaching is analyzed in a way that is dependent on what the student understands, and uses as a method the analysis of discourse and its form through the linguistic and sociolinguistic approach.

4.2 Research Approach

For Serrano (2015), qualitative research consists of detailed descriptions of situations, events, people, interactions and behaviors of people. Also, it incorporates what subjects say; their experiences, attitudes, beliefs, thoughts and reflections, in a genuine way as expressed by themselves. Qualitative research is seen as an active, systematic and rigorous process of directed inquiry, in which decisions are made about what is investigated in the field as the study is conducted. The principles that characterize the qualitative paradigm are: Use of qualitative methods, phenomenological and comprehensive vision, holistic perspective, natural observation, explores and interprets reality inductively, takes into account subjectivity, is close to the data, is process-oriented (real and deep data), non-generalizable and dynamic reality. This paradigm gives rise to a new style of research that is closer to the lives and situations of the subjects. To research qualitatively is to operate with linguistic symbols in order to reduce the distance between theory and data, between context and action.

Qualitative research emphasizes the hermeneutic procedure and the understanding of processes from a naturalistic approach as opposed to a quantitative one. It is interested in the particular case, the group, and the phenomenon in the reality in which they are framed. Qualitative research helps us to situate ourselves in the context in which the event occurs and allows us to record situations, frames of reference, and those events without detaching them from the reality in which they take place. It is interested in personal understanding, motives, values and circumstances that underlie human actions. It is flexible and able to adapt to each concrete reality. It is characterized by the exploration of perceptions and by the understanding of the deep meaning of events, by reliance on data collection techniques such as open and semi-structured interviews, participant and non-participant observation. Qualitative research applied to education is oriented toward solving practical problems. Like any other research it is interested in: inquiring, questioning and problem solving (Serrano, 2015).

4.3 Research Design

The research design is that of a case study, because it is oriented to understanding, understanding being understood as the environment that encloses the social phenomena and within them the educational phenomena that exist in the subjects and interact as a complex system. Thus, the cognitive principle that guided the design of this research is understanding, since it is considered that social and educational phenomena exist in people who interact, so it is of interest to understand the construction presented by the subject in given social situations, which is common when it is considered that knowledge is something that is constructed (Flick, 2007).

It should be noted that Pérez-Serrano (1994) proposes the interpretive case study as one that contains rich and dense descriptions, where the data are used to develop conceptual categories, and thus challenge theoretical assumptions defended before collecting the data. In the collective case study, the focus is on the investigation of a phenomenon, population or general condition. The study does not focus on a specific case, but on a certain set of cases, since it takes collective case studies because it considers teachers from different engineering careers, so it is an intensive study of several cases. In this sense, each individual case of the participating teachers is analyzed in order to establish some relevant comparisons for the research. Therefore, this design is based on the individual work done by each mathematics teacher, in order to characterize the essential knowledge considered

at the time of teaching the class and the reflection made on that knowledge, and from there, a comparison will be made with the other participating teachers.

4.4 Work Methodology

The work methodology and timing of the research will be carried out in different stages, which will allow obtaining partial results, milestones that are shown below: See Table 1.

Table 1. Stages of the research

STAGE	EXPECTED RESULT	TIME PLANNING
1: Bibliographic review	Background, Theoretical Framework of the thesis project and methodology.	Semester 1
2: Access to the field of study	Authorization by signature of consent of participants	Semester 2
3: Selection of participants	Purposive sample of participants	Semester 2
4: Selection of data collection techniques	Semi-structured interview, Stimulated recall interview Videotaping (Non-participant observation)	Semester 2
5: Elaboration and validation of instruments	Semi-structured interview guideline and stimulated recall interview guideline.	
6: Application of instruments	Transcriptions in Word and recordings on magnetic media.	Semester 3
7: Information analysis	*1st order matrix *Case by case analysis *Integration of all cases *Semi-structured interview contrast matrix	Semester 4

Source: Own elaboration

The following is a description of each of the seven stages of the research:

4.4.1 Bibliographic Review

It is proposed to be done in the first semester of the research, however, the present research proposes a robust bibliographic review, which can be summarized and cited.

4.4.2 Access to the Field of Study

At this stage, it is proposed to access the field and obtain the authorization of the participants' informed consent for studies with human subjects of legal age, followed by the authorization of the corresponding ethics committee.

4.4.3 Selection of Participants

This stage should be carried out in the second semester of the research and consists of a group conversation with the teachers and then a personal interview with each of the teachers who will participate in the study. One of the criteria used for the selection of participants should be the criterion of convenience, pointed out by Flick (2007), which allows selecting cases that are more easily accessible according to the existing conditions, since it is anticipated that the research will have limited resources of time and people. In addition, the participating cases should be selected if they meet the criteria posed by Stake (1998) in the sense that:

(i) Are "the maximum return on what we learn" (Stake, 1998, p.17),

(ii) are easy to approach, in terms of time, access, and reception, and

iii) Where participants are willing to give their opinion on certain topics.

4.4.4 Data Collection Techniques

The following three types of data collection techniques are defined as data collection techniques: i) Semi-structured interview, ii) Non-participant observation (through video recordings) and iii) Interview of stimulated recollection, whose characteristics and applications are shown below:

(a) Semi-structured interviews.

In the semi-structured interview, the researcher will ask open-ended questions to the interviewee, who will be free to answer them. Thus, the questions will serve as a guide for the course of the interview and will facilitate the collection of data on teaching practices. In the research, the researcher will act as the interviewer, while the teachers will be the interviewees. One of the advantages of the semi-structured interview is that it allows a certain degree of plasticity in terms of the sequence of questions, as well as restructuring some of them and even allowing the generation of new questions that arise from the interaction between the interviewer and the interviewee, which are relevant to the research (Flick, 2007).

b) Non-participant observation: video recordings

The video recording of a basic science class is expected to have a double use: First, it will allow contrasting the mathematics teachers' characterization of their classes with those teaching practices observed by the researcher in the video recording. Second, it will serve to promote the teachers' reflection on their own teaching practices when a second interview, the stimulated recall interview, is carried out.

c) Stimulated recall interviews

This method was developed by Wagner (1979) as one of the techniques used by cognitive psychology to obtain retrospective data under conditions of explicit recall cues. It is based on the fact that the recorded evidence, either in audio or video, stimulates the person's mind, so that he/she can remember those thoughts he/she had at the time of the recording and report them to the researcher. The participant's memory is triggered by an audio, video or other form of visual recall; while the researcher asks some open questions to collect the relevant data of the study, in which questions such as: What did you think at that moment? Why did you act in that way? What did you want to achieve with that activity? (Ericsson et al, 1993; Gass et al, 2000; Nunan, 2013).

4.4.5 Development of Instruments

The instruments proposed are: (a) semi-structured interview guideline and (b) stimulated recall interview guideline.

(a) Semi-structured interview guideline

The guideline is composed of open-ended questions aimed at collecting data on teaching practice, the role of the teacher and the student in the classroom, social interaction and the didactic resources used. The questions will be applied individually to each of the teachers participating in the study. The elaboration of the set of questions was guided by the theory and the researcher's intention to know the teaching practices of basic science teachers.

Table 2. Semi-structured interview format

Category	Questions
Type of teaching practice	Describe the general format of the class you conduct. What is the beginning, development and end like?
	Do you always use this same class format or does it vary for certain reasons? If so, what are those reasons?
	What teaching methodologies are you familiar with?
	What teaching methodology do you use the most in your classes, and why, in your opinion, what is the strategy that generates the most learning in students?
	Does your institution's educational project state any preference in terms of teaching methodology?
Teacher's role in the classroom	What is your role in the classes?
	Does that role vary or is it always the same?
	If it varies, to what do you attribute it?

Student's role in the classroom	What teaching methodologies are you familiar with?
Social interaction	Do you talk to the students during class, what do you talk to them about, do the students consult you, give their opinions, give examples during class, what do they say?
	Is interaction among students important during class? Why?
	Do students talk to each other in class? What do they talk about?
	In what ways do you promote interaction among your students during class?
	In what ways do you promote reflection among your students during class?
Didactic resources	What are the didactic materials you use in the classroom?
	Of all the materials you have used, with which do students learn best? Why?
	Do you use reflection as a didactic resource?
Evaluation	What type of evaluations are you familiar with?
	What type of evaluations do you use?
	How many evaluations do you perform in a semester?
	When do you perform the evaluations?
	Are you concerned about the results obtained by your students on the assessments?
	What do you do with the results obtained in the evaluations?
	Do you use reflection as an instance of evaluation?
Contents	How do you select the content to teach? Then, what are the criteria for content selection?
	Do students have preferences for certain contents more than others? To what do you attribute this preference?
	How do you organize the selected contents temporally? Then, what are the criteria for content organization?

Source: Own elaboration.

b) Classroom observation

Classroom observation will be carried out using as observation guidelines the 7 categories described in Table 9 above, which are the following: (1) Type of teaching practice, (2) Teacher's role in the classroom, (3) Student's role in the classroom, (4) Social interaction, (5) Didactic resources, (6) Evaluation and (7) Contents.

c) Stimulated recall interview guideline

The guideline contains a series of open-ended questions to obtain information from the mathematics teacher regarding the general evaluation of the class, the type of knowledge base that concerns him/her when he/she observes his/her own videotaped class, and the reflection he/she makes regarding such knowledge. Questions aimed at inducing a first general reflection of the class were elaborated, to then move on to a deeper reflection oriented to the knowledge base for teaching and to the levels of reflection (descriptive, dialogic and transformative).

Table 3. Semi-structured interview format - stimulated recollection

Category	Questions
1. General reflection of the class.	In general terms, what did you think of your class and why? Justify your answers What did you think of yourself in the recorded class?
2. Reflection on the 7 categories in table	Ask the questions in Table 9, which is the semi-structured interview guideline.

9.	
3. Reflection on an episode of the class.	Select an episode from your class that shows an aspect of teaching that is disturbing to you. Why is it disturbing? Describe what happens in the selected episode. What did you want to accomplish in that selected episode? What is the purpose of the teaching? What aspects of the teaching would you change to improve the results you want to achieve?

Source: Own elaboration.

4.4.6 Application of Instruments

This stage is of an operational nature and its purpose is to collect data from the mathematics teachers. For this purpose, the data collection instruments will be applied at different times, sequentially, to each of the teachers.

The sequence of application of the data collection instruments will be done in three moments, as follows:

Moment 1: Semi-structured interviews.

Step 2: Video recordings

Moment 3: Stimulated recall interview.

First, in the semi-structured interview, a series of open-ended questions will be applied to each teacher, as previously described, which are related to their own teaching practices. The interviews with mathematics teachers will be conducted in an office attached to the teachers' lounge or equivalent. All semi-structured interviews will be audio-recorded and transcribed for a subsequent analysis process.

Second, the recordings of the mathematics classes will last around 80 minutes (1 hour 20 minutes). The recordings will be made by the researcher, focusing the camera especially on the teacher, and only in moments of student participation, it will be directed towards him or her for the duration of his or her participation. They will then be edited, copied to DVD and backed up in the cloud, to be watched by the researcher and used with the teachers in the stimulated recall interview.

Third, the stimulated recall interview will consider a series of open-ended questions, applied individually to each of the participating teachers, based on the observation of the class videotaped on DVD. These questions will address the general analysis of the class, and then a specific situation of the class will be addressed, which will be selected by the teacher him/herself, in order to deepen the knowledge base for teaching and the different levels of reflection. The stimulated recall interviews of all teachers will be conducted in the Inacap office set up at the headquarters for researchers. All the stimulated recall interviews will be audio-recorded and transcribed in a Word format file for later analysis of the information.

4.5 Methodology for Data Analysis

The study in this section seeks to describe how the process of data analysis, the construction of categories and subcategories, will be carried out on the basis of all the information collected in the semi-structured interviews and the interviews of stimulated recollection. In this sense, it is significant to keep in mind that the process of data collection and data analysis are not stages that occur sequentially, since the analysis will always be present in the different instances of data collection, that is, both processes are rather conceived as interconnected and mutually influencing each other.

For the present study, the analysis is related to the 7 categories defined in the semi-structured interview, which are: (1) Type of teaching practice, (2) Teacher's role in the classroom, (3) Student's role in the classroom, (4) Social interaction, (5) Didactic resources, (6) Evaluation and (7) Contents, and will be carried out in three levels of analysis:

FIRST LEVEL OF ANALYSIS: Construction of a first-order matrix, case-by-case data analysis and integration of all cases by category.

It should be noted that the semi-structured interview will be conducted prior to the recording of the class and the objective of the interview is to obtain relevant information to describe the teaching practices from the

perspective of the teachers themselves, within the framework of the 7 categories defined for the interview. For this purpose, the following sequential stages will be carried out:

Table 4. Semi-structured interview analysis stages

Step 1	Step 2	Step 3
Construction of a first order matrix	Analysis of the data, case by case, according to categories	Integration of the information of all the cases by categories.

Source: Own elaboration.

Stage 1: Construction of a first-order matrix

In this first stage, a first-order matrix will be constructed to organize the responses from the semi-structured interviews for each of the cases studied, according to the different categories and subcategories of analysis, which will be shown below. For them, three levels of analysis will be carried out:

First STEP: initial reading of the transcripts with all the information collected through the semi-structured interviews conducted for each of the cases studied.

STEP TWO: Reduction and coding of the data of each case, by fragmenting the totality of the information into context units, and then discovering and coding the units of meaning (concepts, phrases or paragraphs) that were pertinent and relevant to the specific objective of the research.

STEP 3: Classification of the relevant categories into the different meaning units.

Finally, in all the cases studied, the units of meaning, once grouped within the same category, will be regrouped into subcategories with respect to recurrent topics, which will allow writing descriptions of the subcategories that would be useful to justify those units of meaning grouped under the same category and subcategory as well as to provide a basis for future replicability tests. In sum, the matrix will be made through this constant comparative method of data analysis, which will combine the process of inductive coding with the simultaneous comparison of all relevant units of meaning obtained up to that moment, giving a degree of flexibility to make some necessary adjustments at the level of coding, categories and subcategories. This will be done as shown below:

Stage 2: Analysis of the information case by case, according to the 7 categories.

Now, the elaboration of the first order matrix will allow organizing the information collected from each mathematics teacher in the semi-structured interviews, which will facilitate the subsequent analysis of the data for each of the cases studied, independently, according to the established categories of analysis. This case-by-case analysis will consider the responses of each teacher and the interpretation according to the corresponding category and subcategory.

Stage 3: Integration of the information of all the cases by categories

Then, based on the analysis and contrast of the data case by case, the integration and articulation of the information will be made through a final triangulation, considering all the cases studied for each of the defined categories.

SECOND LEVEL OF ANALYSIS: Construction of a contrast matrix between what was declared and what was observed.

The integration of the information of all the cases studied will allow the construction of a second matrix called contrast matrix, where, as the name indicates, what was observed by the researcher in the videotaped classes is contrasted with what was declared by the mathematics teacher in the semi-structured interview, establishing a degree of coherence between both aspects. It should be noted that this contrast will be made in relation to those aspects that can be contrasted with the observation of a class. The degree of coherence between the discourse of each mathematics teacher and the practice observed by the researcher for each category will be carried out according to the following criteria:

Description of categories to define the degree of coherence between what was observed by the researcher and what was stated by the teacher:

Table 5. Contrast matrix - Contrast between what was observed by the researcher and what was stated by the teachers

CATEGORY Degree of consistency	DESCRIPTION
HIGH	When it is observed that what is observed by the researcher in the recorded video always coincides with what is stated by the teacher in the interview.
MEDIUM	When it is observed that sometimes what is observed by the researcher in the video recording coincides with what is stated by the teacher in the interview.
NONE	When it is observed that what is observed by the researcher in the videotape never coincides with what is stated by the teacher in the interview.

Source: Own elaboration.

THIRD LEVEL OF ANALYSIS

This level of analysis is oriented to compare what the teacher declares and what he/she observes once the class has been carried out, which will allow the construction of a comparison matrix between what the teacher declares and what the teacher observes of the activity carried out. This matrix is similar in some ways to the contrast matrix, but with the singularity that the one who compares (contrasts) is the teacher being investigated. Here the aim is to carry out Schön's levels of reflection:

Descriptive Level; what is described in the class planning, and stated in the semi-structured interview.

Dialogic level; where the teacher makes the class, reflects on the action and dialogues with the students.

Transformative level; where the teacher reflects on the action previously performed and analyzes it in the videotaped class, and proposes changes to his/her teaching practice after the reflective process.

As a result of the analysis, a second contrast matrix will be constructed, this time contrasting what was described by the teacher and his subsequent reflection, framed in the 7 categories of analysis, and the classification and ordering of the data will be based on the levels of reflection in the action.

5. Results and Discussion

Rogers (2001), in his article "Reflection in higher education: A concept analysis", points out that since the publication of Donald Schön's work in 1983, several articles have appeared with works that seek to emulate the approaches to reflection in action, and to take the reflective experience to all imaginable horizons, and studies have followed one another over time, reaching as far as the Japanese Classroom Study, which in one of its stages proposes reflection as a necessary step prior to improvement approaches. In order to analyze the concept of reflection, various theoretical approaches were identified and examined according to their components. The search was oriented to identify those that contributed to a broad and integrated understanding of the concept.

In this context, it should be noted that reflection is conducive to a permanent learning spiral in which problems emerge, initiating a new cycle of observation, planning, action, reflection, and adaptation, and then continuing the cycle. This ability to reflect begins after recognizing the problem and the acceptance of uncertainty. The surprise caused by recognizing that there is a problem commits the reflective thinker to become an active inquirer. Another characteristic of the reflective subject is the continuous evaluation of assumptions, beliefs and educational Hypotheses in the light of new existing information and other reasonable interpretations related to it (Villalobos et al, 2009).

The educational activity of teachers is a dynamic and reflective practice, which involves the events occurring in the interaction between teacher and students. In the article, three categories are proposed to evaluate the educational activity of teachers: 1) the didactic thinking of the teacher; 2) the educational interaction within the classroom; and 3) the reflection on the results achieved. Thus, the author's purpose is to propose a model that promotes reflection in tertiary education teachers about their teaching activity, which promotes changes aimed at improving the teaching and learning processes of students. Teachers' reflection should take place in three moments, corresponding to before, during (teacher-student interaction) and after the didactic intervention in the classroom, which together are called educational practice (García et al, 2008).

In Cortés et al (2011), international literature on teacher improvement and its benefits in learning is investigated, finding that effective professional development includes five characteristics: recognizing that it is a learning

process, attending to the reality of teachers, taking care to learn contents and strategies, favoring learning among peers and experts, and seeking the most appropriate moment for learning. In this sense, when referring to favoring peer learning, it is stated that effective professional development should include the idea of teachers learning from each other, for example, sharing the planning of a class, observing each other's class, reflecting together and providing feedback as part of peer work (Ramos-Rodr ́guez et al, 2017).

Classroom study is an effective means of empowering teachers to develop and improve their own pedagogical practices through reflection, born as an educational practice with the idea of guiding teachers to study their own ways of teaching, which is nurtured by the collaborative work done by teachers in order to improve their content knowledge and teaching methodologies, as well as to deepen their understanding of student learning (Isoda et al, 2012).

In more recent research, Fujii (2019) describes among other things, that the background of the classroom study process is a teacher development approach, which differs markedly from common professional development practice. In a comparison made, it is shown that classroom study begins with a question. Identifying this question, which becomes the research topic for the Classroom Study. The research topic is developed taking into consideration the reality of the students' current educational situation and long-term goals for their learning and development. The second step is to develop a plan to address the research topic through the classroom. This means making a lesson plan for a given unit and a detailed proposal for one of the classes in that unit, in which the planning team presents its ideas on how to address the research topic while teaching specific academic content. That class is called the research class (Fujii, 2019).

It is usually held in half a day; one class of students is left for the research class while the other classes are for each teacher to come and observe the research class. At the end of the post-class discussion, there are always concluding remarks lasting around 30 minutes, which are made by a knowledgeable expert on the topic from outside the school who has been invited for this purpose. The fifth step is to reflect on the process and to consolidate and carry forward the learning achieved. Teachers usually usually write down their reflections and publish their observations of the study class in the school newsletter (Fujii, 2019).

6. Conclusions

We live in a fast-paced world, where the immediacy of the new generations is confronted with a more relaxed action on the part of the older generations, which generates a gap in the development of the formative processes. On the one hand, students want to get an evaluation by watching a 10 or 15 minute video on youtube, teachers are in the front sidewalk walking slower, inviting them to meditate on the things they do, because learning is achieved by repetition, by training our brain and not instantly. If a student who obtained poor grades in mathematics throughout his secondary education, he will hardly be able to achieve such learning in two semesters in technical-professional education in tertiary or higher education, since there is no time to repeat processes as in school, which forces institutions to prioritize content for training in specific areas, for example, those who study construction should study plane geometry, analytical geometry and trigonometry, but those who study electricity should study complex numbers and polynomials.

On the other hand, part-time teachers are acquiring more and more teaching hours in different institutions, which means that they do not have enough time to allocate to the attention of students, which allows them to motivate and deepen in the subjects that are of interest to them. If teachers are in a hurry to fulfill hours in various subjects in more than one institution, and students want to learn quickly without devoting the necessary time to acquire and mature knowledge, parents are in a hurry to provide food and shelter for their children, then at what point do we slow down and start the path of reflection. As Sch ̈on says, we live on high ground, without problematizing, where problems are easy to solve, where there is an algorithm that tells me the steps I must follow to move from the problematic situation to the solution of the situation that arises.

This study contains a proposal for qualitative studies, with case studies, where teachers can operationalize the process of reflection, where they look at the lesson plans, where they look at the actual class, and where they see what was really achieved, how what was done talks with what was planned, and how what was done talks with what was reflected upon. What changes does a teacher consider that he/she should make to improve his/her teaching practice, and what will be his/her view of the practices of other teachers, in the manner of the Japanese class study, where after the group observation of the class, comes the group reflective process and finally the teacher reflection, as a way to redirect the teaching action with the objective of improving the learning of the students. We must go to swampy lands as Sch ̈on says, where there are difficult problems to solve, where there is no algorithm to follow to solve, where many times we have to create that algorithm, that is where reflection takes us and that is where we must go, to solve difficult problems, because the easy problems, where there are steps to

follow, can be solved by machines, and teachers are called to solve problems where we have to create the path, that step by step that leads us to the solution of the problem we face.

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