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Teacher Discussions as Inputs for the Improvement of the Didactic Suitability of a Massive Study Process in the Period of Admission to the University

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ABSTRACT

Background: For those who coordinate massive study processes –with large teaching teams and student populations–, the question of the quality of said processes (regarding the onto-semiotic approach to mathematical knowledge and instruction, that is, its didactic suitability) entails not only the problem of the specificity of the assessment but also that of its translation into decisions for improvement. **Objective**: To show how the discussions between those responsible for a massive study process allow the assessment of the suitability of the process to be translated into decisions for improvement. **Design**: This is a qualitative research, of an exploratory nature, consisting of the thematic analysis of the discussions developed in 2021 within two focus groups (one of teachers, and the other of coordinators). **Setting and Participants**: Mathematics subject in the area of admission to an Argentine public university, whose teaching team is made up of 29 professors and three coordinators, in 27 classrooms, managed a four-month study process for 1,212 students. **Data collection and analysis**: The discussions, based on the results of a quantitative assessment of didactic suitability, took place in virtual settings, and were video-recorded, transcribed, and coded with the QCAmap application. **Results**: The discussions made it possible to delve into the reasons for the results of the assessment, and to define priority lines of intervention for improvement. **Conclusions**: Discussing the results of the didactic suitability assessment of a massive study process among teachers and coordinators is a pertinent strategy for those who coordinate it to make decisions aimed at improving on a rigorous basis.

Keywords: teacher discussions; didactic suitability; massiveness; reflection on coordination practice; entrance to the university.

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Las discusiones docentes como insumos para la mejora de la idoneidad didáctica de un proceso de estudio masivo en el período de ingreso a la universidad

RESUMEN

Contexto: Para quienes coordinan procesos de estudio masivos –con equipos docentes y poblaciones estudiantiles numerosos–, la pregunta por la calidad de dichos procesos (en términos del Enfoque Ontosemiótico del Conocimiento y la Instrucción Matemáticos, por su idoneidad didáctica) conlleva no solo el problema de la especificidad de la valoración sino también el de su traducción en decisiones de mejora. **Objetivo**: Mostrar de qué modo las discusiones entre los responsables de un proceso de estudio masivo permiten traducir la valoración de idoneidad del proceso en decisiones de mejora. **Diseño**: Se trata de una investigación cualitativa, de carácter exploratorio, consistente en el análisis temático de las discusiones desarrolladas en 2021 en el seno de dos grupos focales (uno, de docentes, y el otro, de coordinadores). **Entorno y participantes**: Asignatura de contenido matemático del área de ingreso a una universidad pública argentina, cuyo equipo docente está conformado por 29 profesores y 3 coordinadores, quienes en 27 aulas gestionaron un proceso de estudio cuatrimestral destinado a 1.212 estudiantes. **Recopilación y análisis de datos**: Las discusiones, basadas en los resultados de una valoración cuantitativa de idoneidad didáctica, se desarrollaron en escenarios virtuales, fueron videograbadas y desgrabadas, y codificadas con la aplicación QCAmap. **Resultados**: Las discusiones permitieron profundizar en los porqués de los resultados de la valoración, y definir líneas prioritarias de intervención para la mejora. **Conclusiones**: Discutir entre docentes y entre coordinadores los resultados de la valoración de idoneidad didáctica de un proceso de estudio masivo es una estrategia pertinente para que quienes lo coordinan tomen decisiones orientadas a la mejora sobre bases rigurosas.

Palabras clave: discusiones docentes; idoneidad didáctica; masividad; reflexión sobre la práctica de coordinación; ingreso a la universidad.

Discussões docentes como insumos para a melhoria da adequação didática de um processo de estudo massivo no período de ingresso na universidade

RESUMO

Contexto: Para quem coordena processos de estudo massivo –com grandes equipes docentes e populações de estudantes–, a questão da qualidade de ditos processos (em termos do enfoque ontossemiótico do conhecimento e a instrução matemáticos, da sua adequação didática) implica não só a problema da especificidade da avaliação, mas também da sua tradução em decisões de melhoria. **Objetivo**: Mostrar como as discussões entre os responsáveis por um processo de estudo massivo permitem que a avaliação da adequação do processo seja traduzida em decisões de melhoria. **Desenho**: Trata-se de uma pesquisa qualitativa, de caráter exploratório, que consiste na análise temática das discussões desenvolvidas em 2021 em dois grupos

focais (um de professores e outro de coordenadores). **Ambiente e participantes**: Disciplina de conteúdo matemático na área de ingresso em uma universidade pública argentina, cuja equipe docente é composta por 29 professores e 3 coordenadores, que em 27 salas de aula administraram um processo de estudo de quatro meses para 1.212 alunos. **Coleta e análise de dados**: As discussões, com base nos resultados de uma avaliação quantitativa da adequação didática, ocorreram em ambientes virtuais, foram filmadas e transcritas e codificadas com a aplicação QCAmap. **Resultados**: As discussões permitiram aprofundar a fundamentação dos resultados da avaliação e definir linhas prioritárias de intervenção para melhoria. **Conclusões**: Discutir entre professores e coordenadores os resultados da avaliação da adequação didática de um processo de estudo massivo é uma estratégia pertinente para quem o coordena tomar decisões que visem a melhoria em bases rigorosas.

Palavras-chave: discussões de professores; adequação didática; massividade; reflexão sobre a prática da coordenação; entrada na universidade**.**

INTRODUCTION

Those who coordinate study processes carried out by a large teaching team and aimed at a large population of students, that is, massive study processes, usually ask themselves about the quality of said processes that, in a preliminary way, it will be agreed to designate as *quality*.

The question entails two problems that in massive contexts require answers according to this condition: What tool can be used to assess quality? How can this assessment be translated into decisions aimed at improvement?

One of the authors of this work is responsible for coordinating a subject that is part of the entry course to nine different undergraduate programs at a national public university in the Argentine Republic (Matemática y Metodología para su Estudio, Universidad Nacional de Tres de Febrero –UNTREF).

In 2021, the year in which the research was carried out, the teaching team for the subject comprised 29 teachers and three coordinators, who in 27 classrooms (remote: a condition imposed by the SARS-CoV2 pandemic) managed a process of a four-month study initially intended for 1,212 students. Due to these figures, the study process organised and implemented through the subject can be classified as massive.

It is necessary to clarify that this massiveness does not refer to a property of the classroom or class, as is usual in the reference literature (Jerez Yañez et al., 2016), but to a property of the study process itself, and derived from the number of teachers, classrooms, and students engaged in it.

Now, said massiveness, which is factual, poses an ethical challenge: offering quality education in such conditions.

Taking on this challenge requires resigning the reading of mass-quality relationships in terms of an irresolvable tension (Villanueva, 2015), and admitting the polysemic nature of the notion of quality:

> In the educational field, its use is as frequent as it is difficult – if not impossible – to define. We all talk about quality, assuming that we know what we are talking about, even if we do not know how to define the object or quality to which we are referring. It is part of those terms that are the result of the triumph of ambiguity or whose texture is so open and malleable that they end up becoming labels, mantras, or metaphysical entelechies (taken from any political or historical content), at the service of broad and easy consensus. (Montané et al., 2017, p. 285)

Aguilar (2006) warns about the effects of the socialisation of the notion, whose existence is accepted by the common citizen-consumer, thus becoming a universal criterion in the perception and choice of goods and services. In ontological terms, it is essentialised.

To escape the dangers of essentialism (Breda, Font & Pino-Fan, 2018), from the onto-semiotic approach to mathematical knowledge and instruction (OSA) (Godino et al., 2007, 2019, 2020), instead of the notion of quality, didactic suitability has been proposed (Godino, 2013; Godino et al., 2006; Godino et al., 2005), conceived as a global criterion of relevance of an instructional process, whose main empirical indicator may be the degree of adaptation between the personal meanings achieved by students and the intended institutional meanings, which is relative to local circumstances (adequacy and relevance of educational agents' actions, the knowledge put into play, and the resources used).

Based on the preceding considerations, the initial problems can be reformulated in these terms: What tool can someone who coordinates a study process that takes place in massive conditions use to assess the didactic suitability of said process? How do we translate this assessment into decisions aimed at improving the suitability of the process in those aspects that the assessment reveals as less suitable?

This article briefly describes a possible solution for the first problem (addressed in Malet et al., 2022; 2023) and focuses on the second, showing

the potential of teaching discussions as a strategy to construct explanations about the degree of suitability of the different aspects of the study process, and to collectively identify paths for improvement.

THEORETICAL FRAMEWORK

As Godino et al. (2020) state, the ultimate goal of didactic research is to optimise learning. For this, there must be a series of criteria that allow us to get closer to that purpose. This expresses the question: What type of actions and resources should be implemented in the instructional processes to optimise mathematical learning?

Now, didactic knowledge can take different forms; they can be presented as elucidations on the nature of mathematical practice and the conceptual systems through which it is organised, or as principles of an action of preference, or as already proven educational resources. Concerning this aspect, the OSA postulates three principles:

1. The principles and instructional resources are not considered as general rules or laws inferred in a positivist manner but rather as criteria of suitability or preferential action on which a certain consensus has been generated in the mathematics education community.
2. Such criteria must be applied locally, so the teacher must adapt and interpret them, and they refer to each of the six facets involved in the mathematics teaching and learning processes: epistemic, cognitive, affective, interactional, mediational, and ecological.
3. The meanings of the institutional objects intended in each educational context must be a representative sample of the global reference meaning of the object and take into account the restrictions of the contexts and subjects involved.

For the OSA, the systemic criterion for optimising a mathematical instruction process is the notion of didactic suitability, which is defined as:

> The degree to which said process (or a part of it) meets specific characteristics that allow it to be classified as optimal or adequate to achieve the adaptation between the personal meanings achieved by the students (learning) and the

> institutional meanings intended or implemented (teaching), considering the circumstances and resources available (environment). (Godino et al., 2020, p. 11)

The didactic suitability of an instructional process supposes the coherent and systemic articulation of six dimensions or facets in which, taking into account the assumptions and tools of the OSA, the general criterion has been particularised:

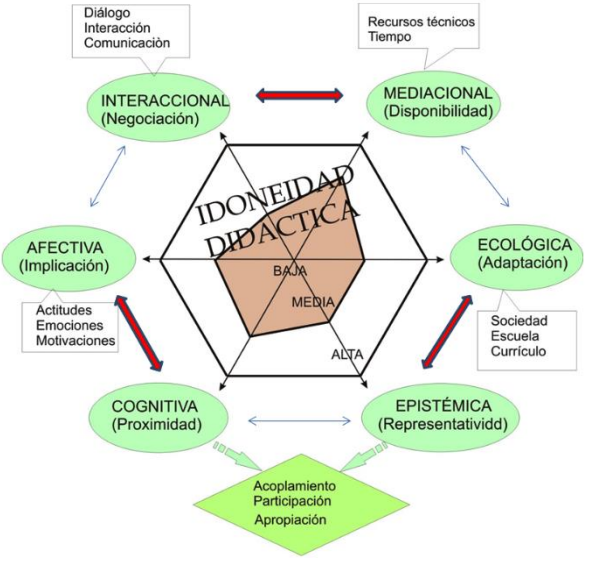
> *Epistemic suitability* refers to the degree of representativeness of the implemented (or intended) institutional meanings concerning a reference meaning.
>
> *Cognitive suitability* expresses the degree to which the intended/implemented meanings are in students' zone of proximal development, as well as the closeness of the personal meanings achieved to the intended/implemented meanings.
>
> *Interactional suitability* is a teaching-learning process that will have greater suitability from an interactional point of view if the didactic configurations and trajectories allow us, on the one hand, to identify potential semiotic conflicts and, on the other hand, resolve conflicts occurring during the instruction process.
>
> *Mediational suitability* is the degree of availability and adequacy of the material and temporal resources necessary for the development of the teaching and learning process.
>
> *Affective suitability* is the degree of students' involvement (interest, motivation,…) in the study process. Affective suitability is related both to factors that depend on the institution and to factors that basically depend on the student and their previous school history.
>
> *Ecological suitability* is the degree to which the study process adjusts to the educational project of the centre, school, society, and environmental conditions. (Godino, 2013, p. 116)

Figure 1 outlines the main characteristics of the didactic suitability construct: its six dimensions or facets, the components of these facets and the basic criteria that allow a study process to be classified as more or less suitable; the regular hexagon represents the maximum degree of partial

aptitudes; the irregular hexagon, the degree actually achieved in each of them in a given study process.

Figure 1

Didactic suitability. (Godino, 2013)



Now, neither the dimensions nor their components are directly observable, which is why, to infer them, it has been necessary to develop systems of empirical indicators such as those proposed in Godino (2013) and in other publications (for example Alsina & Domingo, 2010; Beltrán-Pellicer & Godino, 2017; Breda, Font, Lima et al., 2018; Breda, Font & Pino-Fan, 2018; Breda et al., 2017).

The notion of didactic suitability and its facets, components and indicators compose a powerful tool to guide the optimisation of the mathematics teaching and learning processes; its proper use warrants the following considerations:

- The notion can be applied to the analysis of a specific study process implemented in a class session, to the planning or development of a teaching unit, or more globally, to the

development of a course or a curricular proposal. It can also assist in the analysis of partial aspects of a study process: a teaching resource, a textbook or handbook, students' answers to specific tasks, a teaching incident, etc.

- Achieving a high degree of didactic suitability requires balancing the degrees of the six partial suitabilities. Thus, the criteria that establish it as desirable to teach students relevant mathematics (epistemic criterion), that they learn it (cognitive criterion) and that they be motivated to achieve their involvement (affective criterion) are usually in tension with each other: it is quite easy to implement them separately, but it is extremely difficult, and valuable, to achieve a balance between the three.
- Suitability is relative to changing temporal and contextual circumstances. Therefore, answering the question: What aspects should or can be influenced to improve the teaching and learning processes of mathematics progressively? demands an attitude of reflection and research on the part of the teacher and the other actors with whom they share responsibility for the educational project; in Godino et al.'s (2020, p. 12) words, "it implies the assumption of an axiological rationality in mathematical education that allows analysis, criticism, justification of the choice of means and ends, the justification of change."

METHODOLOGY

This research is qualitative and exploratory and pivots on two investigative strategies: the focus group and thematic analysis.

In fact, both for teachers and coordinators, these are group discussions organised around a specific topic that the researcher monitors, guides, and records, in which the group interaction is explicitly used to produce data; that is, it is what Stewart and Williams (2005) define as a focus group. Furthermore, according to the authors, having developed in an online environment synchronously, they are described as synchronous online focus groups.

Both data were organised, described, and interpreted based on the research problem using thematic analysis, a research strategy to identify, code, analyse, and report patterns of meaning or trends (themes) in the data (Braun & Clarke, 2006).

According to the authors above, to carry out a thematic analysis, we must answer three questions:

- What type of analysis do you want to do: a detailed data set analysis or focused on a particular aspect?
- Will themes or patterns within the data be identified inductively (bottom-up), deductively (top-down), or blended?
- At what level will the themes be identified: at a semantic level (explicit) or a latent level (interpretive)?

As this is an exploratory study, we considered it prudent to analyse in detail the data set of each of the discussions (so that the emerging themes reflect the set accurately) with an inductive approach (so that the themes are strongly linked to the data) and at a semantic level (so that the themes adhere faithfully to participants' expressions).

The QCAmap 2020 web application (Association for the Support of Qualitative Research ASQ, 2020) was used for coding.

RESULTS AND ANALYSIS

The discussions were based on the results obtained through a quantitative model of analysis and assessment of didactic suitability, which is succinctly described in the following paragraphs (Malet et al., 2022; 2023).

The model is based on a device consisting of two surveys through questionnaires, one for teachers and the other for students.

In both cases, they are online, self-administered, and census surveys (i.e., addressed to all teachers and all students of the subject at the time of administration), referring to different aspects of the study process. The respondents, anonymously, had to evaluate the process from the point of view of each aspect, assigning a score from 1 to 9 (1 denoting the lowest rating and 9, the highest).

The teacher's questionnaire consists of 68 statements and the student's questionnaire consists of ten questions. Such statements and questions were conceived as indicators of the didactic suitability variable.

Some of the statements from the teacher's questionnaire are:

- *Statement 13*. (In the subject) the various meanings of the function are identified and articulated: tabular, algebraic, set, and graphic (epistemic facet).
- *Statement 15*. Incoming students have the necessary previous knowledge to study the topic functions (cognitive facet).
- *Statement 25*. The tasks proposed are of interest to students (affective aspect).
- *Statement 48*. The permanent regrouping of students based on their achievements favours mutual horizontal exchanges (interactional facet).
- *Affirmation 60*. The course duration is sufficient for the intended teaching, considering the classes and the non-face-to-face work on the mandatory home resolution exercises (mediational facet).
- *Statement 66*. The contents contribute to the socio-professional education of students (ecological aspect).

Some examples of questions from the student questionnaire are transcribed below:

- *Question 1*. When you began taking the subject, was your knowledge of mathematics sufficient to take it without difficulties?
- *Question 5*. Did working in a group with colleagues with similar knowledge to yours motivate you to learn?
- *Question 6*. Was the study material (booklet) for the subject clear to you?

Both questionnaires were validated by a committee of expert reviewers specialists in the OSA and tested in a pilot study before application.

The responses collected in the application of the questionnaires enabled, among others, the following analysis procedures:

- Calculation of the means of the scores the respondents assigned to each indicator, both for the teacher's and for the student's questionnaires.
- Calculation of the means of these means for each of the facets of didactic suitability for the teacher's questionnaire.

- Identification of relative achievements and deficits in each facet, based on responses to the teacher's questionnaire; relative achievements are those expressed by those indicators whose average is higher than the third quartile of the facet in question; the relative deficits expressed by those indicators whose average is less than the first quartile of that facet.
- Exploratory factor analysis of the student questionnaire, and calculation of the mean scores of the questions that make up each factor.
- Identification of four problems, capitalising on the factor structure obtained through the factor analysis of the student questionnaire, and linking each factor with the statements from the teacher's questionnaire that are related to it:
    - Problem 1: Are students' previous knowledge and the course duration sufficient for them to participate in the study process offered successfully?
    - Problem 2: According to the different evaluation strategies and instances (self-assessment, exams, observations using rubrics, etc.), do students learn when they take the subject? Thanks to what didactic mediations?
    - Problem 3: Does working in groups whose members have similar knowledge benefit the study process?
    - Problem 4: Is the study material clear and interesting for students?

The discussion with the teaching team

The quantitative results chosen to promote this discussion are those that correspond to Statement 15 of the teacher questionnaire and Questions 1 and 6 of the student questionnaire:

- *Statement 15*. Admission students have the necessary previous knowledge to study the topic functions (cognitive facet).
- *Question 1*. When you began taking the subject Mathematics and Methodology for its Study, was your knowledge of mathematics sufficient to take it without difficulties?

- *Question 6*. Was the study material (booklet) for the subject clear to you?

Statement 15 is the item on the teacher's questionnaire that recorded the lowest average score (6.2 points); likewise, Questions 1 and 6 are the items in the student questionnaire that had the lowest average scores (5.4 and 5.7 points, respectively).

The topics for the discussion were:

1. Based on your experiences, how can we interpret this data? What perceptions do you have about them? What do they tell us? What do you think they respond to? Are they related to each other? How?
2. What could we do from our subject to improve the situation that each score suggests?

The topics were shared in a videoconference room to which the 28 present were connected, who were then distributed among seven videoconference rooms for half-an-hour discussion in small groups; the composition of these groups and their respective spokespersons for sharing were determined previously and randomly using the random group generator available at es.rakko.tools.

The sharing and resulting exchanges occurred in the initial videoconference room and were video-recorded and transcribed, including the participants' comments in the chat during other colleagues' speeches.

Using the QCAmap 2020 web application, each fragment of the teachers' interventions was assigned a code. Thus, 36 codes were generated (categories: RQ1-i, $01 \leq i \leq 36$), 20 of which correspond to teachers' interpretations of the data, and 16 to proposals for improvement.

The 36 codes were then brought together into 18 more comprehensive codes (main categories).

Finally, the 18 main codes or categories were combined into five main themes and two secondary themes; the qualification of main or secondary is only related to the intensity of the presence of the topic in the discussion, with its recurrence, with the emphasis that the teachers placed on it: it does not carry other evaluative intentions.

The main threads are:

- The decoupling of the proposal of the Mathematics and Methodology for its Study with students' previous educational experiences.
- The qualities of the study material for Mathematics and Methodology for its Study.
- The tension between the time available and the proposal of Mathematics and Methodology for its Study.
- The need for specific teaching interventions in the classes of Mathematics and Methodology for its Study.
- The incidence of virtuality in the proposal of Mathematics and Methodology for its Study.

The secondary themes are:

- The need for a salary improvement for incoming teachers.
- The possibilities that technology offers for Mathematics and Methodology for its Study.

Table 1 exemplifies this process for one of the identified themes: *The disconnection between the proposal of the Mathematics and Methodology for its Study with students' previous educational experiences*.

Table 1

Identification of main categories and themes in the discussion with the teaching team

Category identifier	Category	Main Category	Theme
RQ1-01	(interpretation) Secondary school: focus (11 fragments)	(interpretation) Secondary school and other sources: focus (2 categories)	The decoupling of the proposal of the Mathematics and Methodology for its Study with students' previous educational experiences (5 main categories).
RQ1-03	(interpretation) Other sources: focus (1 fragment)		
RQ1-04	(interpretation) Secondary school: contents (5 fragments)	(interpretation) Secondary school and other sources: focus (2	

Category identifier	Category	Main Category	Theme
RQ1-19	(interpretation) Other sources: contents (1 fragment)	categories)	
RQ1-07	(improvement) Secondary school: articulation through workshops for teachers (1 fragment)		
RQ1-17	(improvement) Secondary school: articulation through teacher training (2 fragments)	(improvement) Secondary school: articulation (4 categories)	
RQ1-33	(improvement) Secondary school: articulation through anticipation of reading material for students (2 fragments)		
RQ1-35	(improvement) Secondary school: articulation through open classes for students and teachers (1 fragment)		
RQ1-12	(interpretation) Secondary school: heterogeneity of starting points (1 fragment)	(interpretation) Secondary school: heterogeneity of starting points (1 category)	
RQ1-36	(interpretation) Secondary school: purposes (1 fragment)	(interpretation) Secondary school: purposes (1 category)	

In this case, from 26 fragments of the discussion, ten categories were obtained, which were then synthesised into five main categories, which, in turn, converged on the theme above.

About this example, in the interpretation of the data under discussion, the arguments referring to the formal educational experiences that the students went through before entry and some gaps between them and the subject proposal are strongly revealed.

Those experiences are referred to by teachers based on two coordinates. One of the coordinates refers to the level of the educational system that hosted them: secondary school, university. The other coordinate

refers to the time elapsed since such experiences occurred and until the students get to Admission. In fact, some of them join the Admission having recently gone through other areas of study while others do so after some time.

The diversity of experiences that these coordinates imply, plus the diversity of the universe of secondary schools from which the students come, is expressed in the Admission classrooms in terms of the heterogeneity of the starting points:

> *Room 3, Professor 1, Fragment 15. We see that there are many differences, the groups with the knowledge they come with are very heterogeneous and often, the differences are abysmal*[1].

Professors highlight the disconnection between students' previous educational experiences and the subject proposal.

From the teachers' point of view, one of the variables that explain this disconnection is the focus given to mathematics in the other spaces and Admission. The teachers maintain that the approach that prevails in secondary school and other spaces (fields in which many of them also work) emphasises algorithmic, operational or graphic aspects and that the approach of Mathematics and Methodology for its Study, on the other hand, is based on modelling and problem solving, and involves more analytical, more formal, more argued work, in which access to knowledge is strongly mediated by reading competence:

> *Room 1, Professor 1, Fragment 01. The kids from the secondary level are very used to the algorithmic, to the operational thing. Then the entire modelling part, which has to do with seeing mathematics as a mediating and problem-solving tool, begins to break down.*
>
> *Room 2, Professor 1, Fragment 09. In secondary school, functions are not taught in the same way that we ask them to here; that is, they do not know how to argue, they do not know how to justify, they do not know how to work analytically.*
>
> *Room 6, Professor 1, Fragment 42. From the start, we grasp the issue of reading, which is that students do not know how*

[1] In the reproduction of this fragment and those that follow, the colloquial language used by the speakers has been preserved.

> *to read in mathematics and reading in mathematics sounds strange.*

This is another variable that, according to the teachers, explains the gap between the Admission proposal and that of other spaces is the content (the contents). Some contents of Mathematics and Methodology for its Study are contemplated in the curricular designs of secondary education or are the prior knowledge necessary for its treatment. However, not all of them are addressed due to lack of time, either because they are not considered fundamental or because one of the purposes of secondary education established by the National Education Law (2006), i.e., enabling young people to continue their studies, is underestimated:

> *Room 5, Professor 4, Fragments 57 and 58. The curricular designs say one thing, they say that most of the contents that we work on in Admission, the students have previous knowledge. But...*
>
> *Room 7, Professor 1, Fragment 59. I work in state secondary schools and the view is that most students who finish high school do not have their sights set on university.*

To intervene in the problem of disengagement, professors propose articulating actions with secondary schools: workshops for teachers of that educational level, teacher education programmes, distribution of reading materials among students registered to take the Admission, open classes for secondary teachers and students.

However, it is necessary not to lose sight of the fact that articulation actions are not universal: even when they involve many secondary schools, they do not reach all the schools from which the Admission students come, nor all their mathematics teachers (in addition that not all students from the schools with which it would be linked would continue studies at UNTREF). Only the effective validity of the curricular designs and the National Education Law mentioned could guarantee this universality.

This objection was raised within the framework of the discussion between coordinators and illustrates how both discussions dialogue and cross-pollinate each other.

The discussion with the coordinators

The discussion with the two professors who, together with one of the researchers, coordinated the subject was based on the following materials:

- A series of tables that summarise the main results of the quantitative study of didactic suitability assessment mentioned above.
- The topic structure used for the discussion with the teaching team.
- The transcription of said discussion.

These materials were made available to the coordinators before the discussion and accompanied by the following topics:

1. What reflections do the quantitative results and/or teachers' interventions during the transcribed meeting trigger you?
2. Based on these materials, do you see possible improvement decisions for our subject? Which ones?
3. Based on those materials, do you have doubts that would need to be dispelled to advance in decision-making? Which ones? How could the necessary information be gathered to resolve those doubts?
4. Does the set of items in the questionnaires (statements, in the case of the teacher questionnaire; questions, in the case of the student questionnaire), adequately reflect the different facets of didactic suitability and its components? Does it account for the different aspects of Mathematics and Methodology for its Study? Would it have been desirable to include other aspects? Which ones?
5. The tool used (the questionnaires) seeks to obtain information to assess the didactic suitability of the subject at a general and global level, and not broken down per classroom, teacher, major, shift, programme unit, classes, etc. In what other ways do you think information could have been obtained to make that global assessment?

The diversity of materials made available to the coordinators –and the breadth of the instructions they received– indicate that in this research, the coordination perspective, far from being just another perspective, has a privileged status.

On the other hand, given that one of the researchers is also the coordinator of the subject, the coordination perspective is also their perspective.

How was this particular status of the coordination perspective translated methodologically? How do we control the biases that the commitment of one of the researchers to the object investigated could introduce?

The first challenge was resolved by taking as raw material for the discussion with the coordinators both the study process and the device made up of the two questionnaires, the results it yielded, and the discussion with the teaching team. That is, it was resolved by making a wealth of information available to the coordinators according to the centrality of their perspective in the research.

The second challenge was resolved through the triangulation of data sources: giving voice to the students and teachers considered as individuals (through the respective questionnaires) and to the teaching team and coordinators (through separate discussions). In this sense, the fact that the subject had collegial coordination operated as an inestimable advantage, so that the perspective of coordination could be reconstructed not only from the perspective of the coordinating researcher, but, fundamentally, from the looks from the other two coordinators.

The two challenges converge in the specificity of the discussion with the coordinators for this research, both because of the centrality of the coordination perspective on the study process and because of the possibility of triangulating the standpoint of the coordinating researcher with those of the other coordinators.

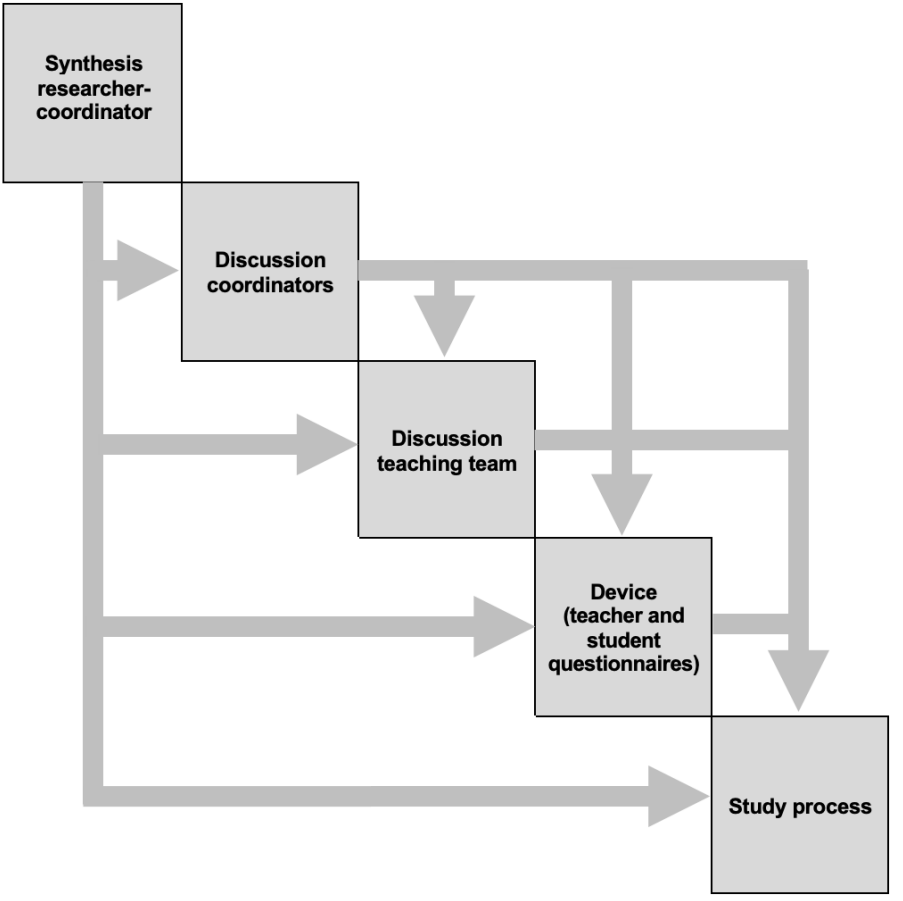
Figure 2 represents how each phase or movement of the research process returns to the preceding phases or movements. Thus, it accounts for the relationships between the different data sources and allows us to visualise the centrality of the coordination perspective.

The discussion between coordinators took place in a videoconference room, being video recorded and transcribed. Using the QCAmap 2020 web application, each fragment of the teachers' interventions was assigned a code. Thus, 28 categories were generated (RQ1-i, $01 \leq i \leq 28$); eight of them refer to limitations of the device or the improvement proposals made by the teaching team; 13 refer to possibilities for improvement perceived by the coordinators; five refer to alternative and complementary sources of

information about the device; one, to the completeness of the device; and one, to the conditions that virtuality imposes on the study process.

Figure 2

Relationships between phases or movements of the investigative process.



The 28 categories were gathered into 12 main categories, and these into three main themes and one secondary theme.

The main threads are:

- The perception of the coordinators about the device and the proposals for improvement of the teaching team.
- Decisions for improvement: reformulation of the study material.
- Decisions for improvement: reformulation of the role of the subject teacher.

And the secondary theme:

- The redesign of the proposal for an occasional blended scenario.

Table 2 exemplifies this process for one of the identified themes: *Improvement decisions: reformulation of the study material*.

Table 2

Identification of main categories and threads in the discussion with the coordinators

Category identifier	Category	Main Category	Theme
RQ1-06	Possibilities for improvement: cushioning the transition from the point of view of work methodology (2 fragments)	Possibilities for improvement: review the first units of the study material (5 categories)	Improvement decisions: reformulation of study material (4 main categories)
RQ1-07	Possibilities for improvement: review the contents of Units 1 and 2 (3 fragments)		
RQ1-08	Possibilities for improvement: epistemic risk when reviewing the contents of Units 1 and 2 (1 fragment)		
RQ1-09	Possibilities for improvement: cushioning the transition from the point of view of work methodology (1 fragment)		

Category identifier	Category	Main Category	Theme
RQ1-11	Possibilities for improvement: make the "startup" more friendly (1 fragment)		
RQ1-10	Possibilities for improvement: review the study material (1 fragment)	Possibilities for improvement: review the study material (1 category)	
RQ1-12	Possibilities for improvement: adapt the study material to the duration of the course (4 fragments)	Possibilities for improvement: adapt the study material to the duration of the course without compromising its cognitive suitability (2 categories)	
RQ1-13	Possibilities for improvement: cognitive risk when adapting the study material to the duration of the course (1 fragment)		
RQ1-22	Possibilities for improvement: review the language of the study material (2 fragments)	Possibilities for improvement: review the study material (1 category)	

In this case, from 16 discussion fragments, we obtained ten categories that we condensed into five main categories, which, in turn, converged on the theme above.

For the coordinators, the main possibility of improving the didactic suitability of the study process lies in reformulating the study material.

In their interventions, they refer to three axes to consider to reformulate the material: review the first units, adapt it to the duration of the course, and review its language.

Reviewing the first units is also part of the improvement proposals from the discussion with the teaching team. It has two aspects: one focuses more on methodological aspects, and the other on the contents.

Regarding the methodological aspects, the discussion revolves around the advantages and disadvantages of making the methodological change proposed by the subject gradual and progressive regarding the preceding educational level, or, on the contrary, proposing this change energetically and quickly from the first days of class:

> *Coordinator 2, Fragment 14. It is a very abrupt change for the student to take charge of what happens within their role as a university student because they have never taken charge of their role as a student, they come from an educational trajectory where the one who takes charge of that is either the institution or the teacher, but the student does not take charge, they just nod as if they have understood, and when we introduce it the first week, it is a complete paradigm shift. We assume part of the responsibility that we understand we have, but we throw a great baggage of responsibility onto the student. I don't know if they are prepared to take it on the first day or do it slightly more gradually.*

> *Coordinator 2, Fragment 20. The person who adapts quickly usually has better results, so one understands that in the face of that shock process that we do in the first classes, over time, they begin to adapt.*

Concerning the contents of the first units, the coordinators reflect on the epistemic and cognitive challenges that their review entails, particularly in the case of Unit 1 of the study material, which addresses numerical sets and the properties of the number operations and which also gave rise to proposals for improvement during the discussion with the teaching team. Considering that the subsequent units are intended for studying relationships and functions between subsets of the set of real numbers, how can we define them if these sets are unknown to the students? How do we operate with functional formulas without appealing to the properties of the operations involved?

> *Coordinator 1, Fragment 18. Unit 1 makes noise to me, although I think that if we started with Unit 2, with some ensemble elements included, we would have similar or perhaps more serious problems because they would enter without some of the things that Unit 1 provides them.*

> *Coordinator 1, Fragment 20. That is where the contradiction comes in for me to generate material that, from a mathematical point of view, is not correct, in short, that the material itself does not have epistemic suitability. It's like an equation that I haven't solved.*

Adapting the study material to the duration of the Admission could be carried out in two different ways: by "losing" or reassigning content or streamlining class work by reassigning some activities to homework.

Neither path is uncomplicated. Reassigning content can affect the ecological suitability of the study process to the extent that it can dismantle it from the requirements of the degree courses that students aspire to enter. Furthermore, reassigning activities to homework can affect cognitive suitability by proposing to students artificially accelerated processes and sequences of knowledge construction (especially if one takes into account that, as some teachers stated in discussion with the teaching team, not always students allocate enough extra class time to study):

> *Coordinator 1, Fragment 25. I think that with this adaptation, we run the risk of losing cognitive suitability; that we abbreviate processes that require more time, or sequences that require more time.*

Finally, and in relation to the proposal to review the language used in the study material, two positions underlie the discussion between the coordinators: the review is necessary based on the quality of the material (the lack of clarity of the language used), or, on the other hand, the revision is necessary based on a quality of the student population (the insufficiency of the reading skills they have):

> *Coordinator 2, Fragment 06. When you survey the students about whether the study material was clear to them, it is the one that obtains the lowest score and I don't know if the study material was not clear to them or because of the deficiencies they bring. It has become more complex in the fact of being able to understand it. I think that sometimes what happens is that the student, on the one hand, is not used to deeper readings and, on the other hand, since they are not used to it, they do not have the training to interpret it.*

Perhaps these are not two positions supported by disjoint hypotheses since, as Bernhardt points out:

> Instead of two fixed entities acting on each other, the reader and the text are two aspects of a total dynamic situation: meaning does not exist beforehand in the text or the reader but is acquired in the transaction between the two. (Bernhardt, 2008, p. 18)

CONCLUSIONS

The coordination of massive study processes, i.e., study processes in which large numbers of students and teachers participate, poses complex and specific challenges, which can be accentuated in the period of entry to the university as a transition stage between one educational level and another.

One of those challenges is assessing the quality of such processes. In this sense, the research referred to in the article showed that the notion of didactic suitability provided by the onto-semiotic approach to mathematical knowledge and instruction (OSA) is an appropriate tool to avoid the ambiguities derived from the polysemy of the term *quality* and that the empirical indicator systems developed from the notion of suitability are effective in guiding that assessment.

In this case, the assessment was carried out using a quantitative model based on two surveys, one intended for teachers and the other for students.

Understanding the reason for the quantitative option, even with the limitations and objections it may merit, requires remembering that it is not about assessing the didactic suitability of a section of the study process nor the study process that takes place in a classroom with a particular group of students, nor the study process carried out by a single teacher or gone through by a single student, but rather to achieve a global or macro assessment that allows decision-making by those who have coordination responsibilities over the entire process.

Now, in massive conditions, how can the assessment results be translated into decisions to improve the study process?

One possible path is the one that this work aims to show: discussions of the quantitative results with the teaching team responsible for the study process and their coordinators.

Indeed, such discussions allow for the development of argumentative games, of arguments and counterarguments that sometimes lead to easily agreed-upon decisions. Other times, however, they generate a tension that is difficult to resolve. As a consequence of these argumentative games, which not only emerge from each discussion but also from the dialogue between one discussion and the other, a typology of possible decisions opens up for coordination. Some of them are listed below, exemplifying decisions actually made in relation to the study process investigated in this work:

- resign and suspend a mode of operation that does not give the expected results (for example, stop requiring, from the first day of class, the autonomous reading of all sections of the study material by all students, regardless of their baseline),
- ratify a mode of operation based on its effectiveness (for example, continue participating in articulation actions with secondary schools),
- expand and generalise a mode of operation or, on the contrary, focus and restrict it (for example, sharing a schedule with students, as was done in some classrooms, but not in all –generalisation–; limiting the study of the rational functions to those whose formula is the quotient of two linear formulas, in the classrooms attended by applicants to careers that do not require intensive use of mathematical tools –focalisation–).
- introduce a new mode of operation (for example, incorporate GeoGebra applets designed to accompany the resolution of those problems that are particularly difficult for students), etc.

In summary, provided they are rigorously analysed, the discussions with and between teachers and with and between the coordinators of a massive study process are revealed as valuable strategies so that the coordination of the process materialises the results produced by the valuation model applied in decisions to improve didactic suitability the results produced by the valuation model applied. Therefore, and according to the literature (Godino et al., 2017; Pino-Fan et al., 2022), having theoretical and methodological tools that allow for generating and guiding such discussions should be a specific didactic competence not only of the teacher or teacher educator but also of the coordinators.

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AUTHORSHIP CONTRIBUTION STATEMENT

The data collection, its preliminary analysis, and the first version of the article were carried out by OM. The three authors, OM, BG, and AMR, actively participated in the analysis discussion and the review and approval of the final version of the work.

DATA AVAILABILITY STATEMENT

The data supporting the results of this research are available upon reasonable request from the corresponding author, OM.

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