CHARACTERIZING MENTORS' PERFORMANCE IN MATHEMATICS TEACHER EDUCATION

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Caracterización de la actuación de tutores en la formación de profesores de matemáticas

Abstract. This study describes the performance of the mentors in a blended graduate-level training program of teachers in the field of secondary school mathematics. We codified and analyzed the mentors' comments on the projects presented by the groups of in-service teachers for whom they (the mentors) were responsible. To do this, we developed a structure of categories and codes based on a combination of a literature review, a model of teacher learning, and a cyclical review of the data. We performed two types of analysis: frequency and cluster. The first analysis permitted us to characterize the common actions shared by most of the mentors. From the second, we established three profiles of the mentors' actions.

Keywords: Didactic analysis, Mentoring, Secondary mathematics, Teacher education.

Resumen. En este estudio se describe la actuación de los tutores en un programa híbrido de formación de postgrado para profesores de matemáticas de secundaria en ejercicio. Codificamos y analizamos los comentarios de los tutores a los trabajos de los grupos de profesores en formación a su cargo. Para ello, construimos una estructura de categorías y códigos conjugando una revisión de literatura, una visión del aprendizaje de los profesores en formación y una revisión cíclica de los datos. Realizamos dos tipos de análisis: de frecuencias y clúster. El primer análisis nos permitió caracterizar las actuaciones comunes a la mayoría de los tutores. Con el segundo análisis establecimos tres perfiles de la actuación de los tutores.

Términos clave: análisis didáctico; formación de profesores; tutores; educación secundaria

Collaborative work in teacher education programs in which trainees work in groups and construct their knowledge collectively with others has been the subject of an increasing amount of research (Borko, 2004; Gómez, 2007; Jaworski, 2008; Llinares, 2008, Vélaz, 2009). The guidance and support that educators and mentors give trainees is one of the characteristics of this type of program (Borko, 2004), which emphasizes the interaction between trainees and mentors (Llinares, 2008; Murphy, Mahoney, Chen, Mendoza & Yang, 2005). Some research has studied the mentoring process, including the role and functions of mentors (Jaworski, 1998; Kram, 1983; Murphy, et al. 2005; Wang, 2008). Existing studies highlight the importance of the interaction between trainees and mentors in the trainees' learning processes. Research in this area in mathematics education includes (among others) studies on the role of mentors in trainees' development of their mathematics pedagogical content knowledge (Han, 2012; Nilssen 2003, 2010) and on the function of tasks in online teacher education programs (Borba & Llinares, 2008, 2012; Geirger & Goos, 2012; Sánchez, 2011).

Researchers also show interest in blended teacher education programs, in which trainees learn through their virtual and actual interaction with peers, educators, and mentors. Mentoring is a focus of attention in this research as, for example, in some studies that analyze how mentors see and understand their job (Hall, Draper, Smith & Bullough, 2008; Hawkey, 1997). However, there are fewer studies on how mentors perform in practice (Hawkey, 1998).

This article focuses on the performance of mentors in a Master's program for in-service teacher education for mathematics teachers. We describe and characterize mentors' performance when they make their written comments on work submitted by their group of trainees. We began with three hypotheses: (a) the categories that we designed—which we present later—are appropriate for characterizing the mentors' performance; (b) based on these categories, we can identify characteristics that describe the mentors' shared performance (its similarities and differences); and (c) it is possible to establish mentors' profiles based on these similarities and

differences. We coded and analyzed the mentors' comments and found that they shared some aspects of behavior. The similarities and differences in their behavior enabled us to characterize their performance. In what follows, we describe the teacher education program in which we carried out the study. We then present the conceptual elements that gave rise to the categories characterizing the mentors' performance, explain the method used, and present and interpret the results.

CONTEXT

The study was performed with the 2010-2011 cohort of a Master's program in teacher education known as MAD ("Máster en Análisis Didáctico"—Master's in Didactic Analysis). This is a short name for the mathematics education section of the Master's program in education at the Universidad de los Andes in Bogotá, Colombia. MAD is an in-service blended learning program for secondary school mathematics teachers. Teachers work in groups of 4 or 5 people. Each group selects a school mathematics topic on which it works throughout the two years of the program, meeting in person twice a week. The group's task is to analyse the topic and design, implement, and assess a set of lesson units for the topic. Each group has a mentor who reviews and comments on the group's work for each of the 32 activities that compose the program. The educators and mentors were lecturers from Colombian and Spanish universities.

Each group of trainees performs a didactic analysis cycle for its topic. The didactic analysis model is organized around four analyses: subject matter, cognitive, instruction, and performance. The content analysis stresses the relationship among concepts, highlights its multiple representations, and distinguishes the connections between the elements of the conceptual structure and between those elements and the phenomena from which they emerge. This information is used in the cognitive analysis, in which the teacher describes his hypothesis about how students construct their knowledge when they face the learning activities that are proposed to them. The cognitive analysis involves the identification of the skills, reasoning, and strategies necessary to solve the tasks, of the mistakes students can make when they are solving them, and of the difficulties and obstacles they might face. The information from the content and cognitive analysis allows the teacher to carry out an instruction analysis: the identification and description of the tasks that can be used in the design of the teaching and learning activities that will compose the instruction in class. These tasks should mobilize students' knowledge in order to generate cognitive conflicts and promote the construction of meaning using the materials and resources available. In the performance analysis the teacher observes, describes, and analyses students' performance in order to produce better descriptions of their current knowledge and review the planning in order to start a new cycle (for a description of the didactic analysis model see Gómez, 2007; Gómez & González, in press). The model allows the teacher to examine and describe the complexity and multiple meanings of the subject matter and to design, implement, and assess teaching/learning activities. Each analysis is performed with the help of pedagogical concepts that we call "curriculum organizers" (Rico, 1997). A curriculum organizer is a pedagogical concept that (a) is part of the mathematics education knowledge base for teaching, and (b) enables the teacher to analyze a school mathematics topic to produce information useful for the design, implementation, and assessment of lesson units (pp. 45-46).

The program lasts two years. It has eight consecutive modules, distributed over four semesters. Figure 1 presents the structure of the modules in the program.

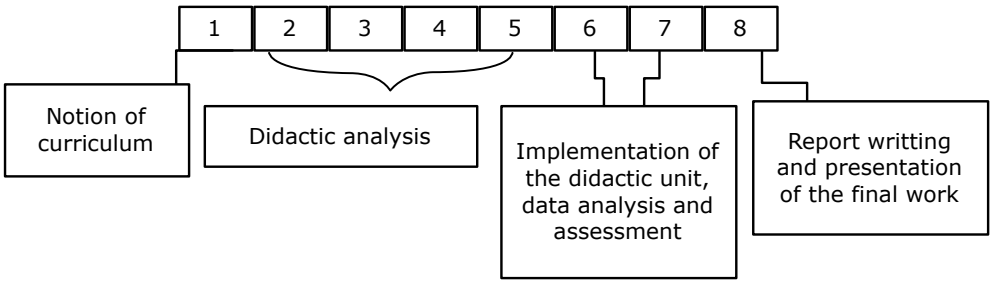

Figure 1. Structure of MAD modules

The groups of trainees perform four activities in each module. Each activity lasts two weeks. During the first week of the module, the educator and the trainees meet every day. In these

sessions, the educator presents the key ideas in the module and sets up the four activities that the groups will perform for the module. At the end of the Saturday session of the week in which an activity starts, the groups organize their work for the next two weeks. From Monday through Thursday of the first week, each group's members work individually and interact virtually. On Saturday, they send a draft of their work to their mentor. Over the next four days, the mentor reviews the draft, makes written comments on it, and sends comments to his group. The group assesses and discusses the comments. At the end of the second week, the group completes the final version of its work.

The mentor plays an important role in the learning processes of his group. His comments encourage the group to discuss their work to improve it. His ongoing interaction with the group also enables him to have an integrated view of the group's progress throughout the two years of the program.

CONCEPTUALIZING MENTORS' PERFORMANCE

To conceptualize mentors' performance, this section establishes the most common roles and functions for mentor identified in the literature. We then propose a view of the trainees' learning in the teacher education program studied here and outline the categories that have been used in the literature to characterize mentors' performance.

Roles and Functions of Mentors in Teacher Education

Research has identified different roles and functions of mentors. Some authors highlight the mentor's role as a guide in the construction of new knowledge and practices (Atjonen 2012; Borko, 2004; Gross, Garcia & Lara, 2009; Jaworski & Watson, 1994; Moore & Kearsley, 1996). Such studies consider the mentor a source of support for people seeking to find their way in the profession (Jaworski & Watson, 1994). Researchers understand that mentors can play different roles—model, trainer, supervisor, helper, guide, support, facilitator, observer, advisor, critical friend, etc.—to promote teachers' professional development (Huang & Chin, 2003, citing Furlong & Maynard, 1995; Jaworski & Watson, 1994).

Trainees' Learning in MAD

Mentors are expected to contribute to their trainees' learning. In this section, we describe how we address trainees' learning in the MAD as a specific context for mathematics teacher education. We attend to two issues:

- What do trainees learn?
- How do they learn it?

Trainee groups perform each analysis in the didactic analysis model in sequence, addressing their topic from the perspective of the curriculum organizers that structure the analysis. The goal of analyzing the topic with a curriculum organizer is to produce information that can be useful in other analyses or in the design, implementation, and assessment of lesson units for the topic. Our focus here is the knowledge that results from the learning of the curriculum organizers. We follow the work of Gómez and González (Gómez & González, 2008a, 2008b, 2009, in review & in press; Gómez, González, Rico & Lupiáñez, 2008) to describe this approach and to implement its concepts in the description and characterization of mentors' performance.

When the trainees analyze their topic with a given curriculum organizer, they produce information about the topic. For instance, when they analyze the topic using the representation systems, they are expected to identify the representations that are the most relevant to the topic, establish the relationships among them, and describe the role of those representation systems in organizing and relating the concepts and procedures involved. The trainees can then use this information to establish the learning goals they expect their students to achieve and to select tasks and justify their choices. The curriculum organizers are the tools that enable trainees to analyze and understand the topic for the purposes of lesson planning. When they analyze their topic with a curriculum organizer—i.e., conceptual structure, representation systems, phenomenology, etc.—the trainees are expected: (a) to understand the curriculum organizer so that they can, for example, distinguish cases pertaining to it; (b) to be able to use the curriculum organizer for analyzing the topic and producing information about it that can be used in the planning process; and (c) to be able to use the information produced with the curriculum organizer for making decisions in the planning process. These three learning expectations involve three types of knowledge that Gómez and González call the meaning, technical use, and practical use of the curriculum organizer. They describe these types of knowledge as follows.

Meaning. The meaning of a curriculum organizer refers to the theoretical option that the educators have chosen from among the multiple meanings present in the pedagogical research knowledge

base. In its intentional definition, it is usually presented in terms of its properties and its relationship to other concepts. Meaning can also be demonstrated in extensional terms by means of examples that describe the collection of instances that compose the concept.

Technical use. Analyzing a topic with a pedagogical concept requires putting its meaning into play in order to produce information that can be used in the planning process. That is, it is necessary to operationalize the key ideas that characterize this concept's meaning to develop techniques that should satisfy two conditions. They should: (a) be grounded in the meaning of the pedagogical concept and (b) make it possible to produce information about the topic that can be used for planning purposes. From among all techniques that satisfy these two conditions, educators propose and make explicit those that they consider most effective for planning purposes.

Practical use. The information that emerges from the technical use of a pedagogical concept can be used for planning purposes. The practical use of a pedagogical concept refers to the set of techniques involved in this process. These techniques should satisfy two conditions. They should: (a) use the information that emerges from the technical use of the pedagogical concept, and (b) involve decisions about the planning process. From among all possible techniques, educators propose and make explicit those that they consider most effective and best suited to each scope and purpose.

Mentors are expected to encourage the development of their trainees' knowledge about the meaning, technical use, and practical use of curriculum organizers. These three types of knowledge will be taken into account in constructing the system of categories with which we will analyze and characterize mentors' performance.

Characterizing Mentors' Performance

The literature review lead us to take into account the following aspects that characterize mentors' performance when they comment the work of their trainees (Barrios, 2008; DeBilli, 2007; Krol, 1996, 1998, Van Looy and Vrijse, 1998): emphasis on the information provided by the trainees, its appropriateness, suggestions and encouragements to reflect, issues of affect and values, and the precision of the comments. Based on these ideas, on the conceptual framework and on a cyclical review of the documents generated by the mentors, we designed a structure of categories and subcategories which were organized in three groups according to its logical structure and relationships: pedagogical content, guidance, and format. Figure 2 shows each group and the categories and subcategories included in it.

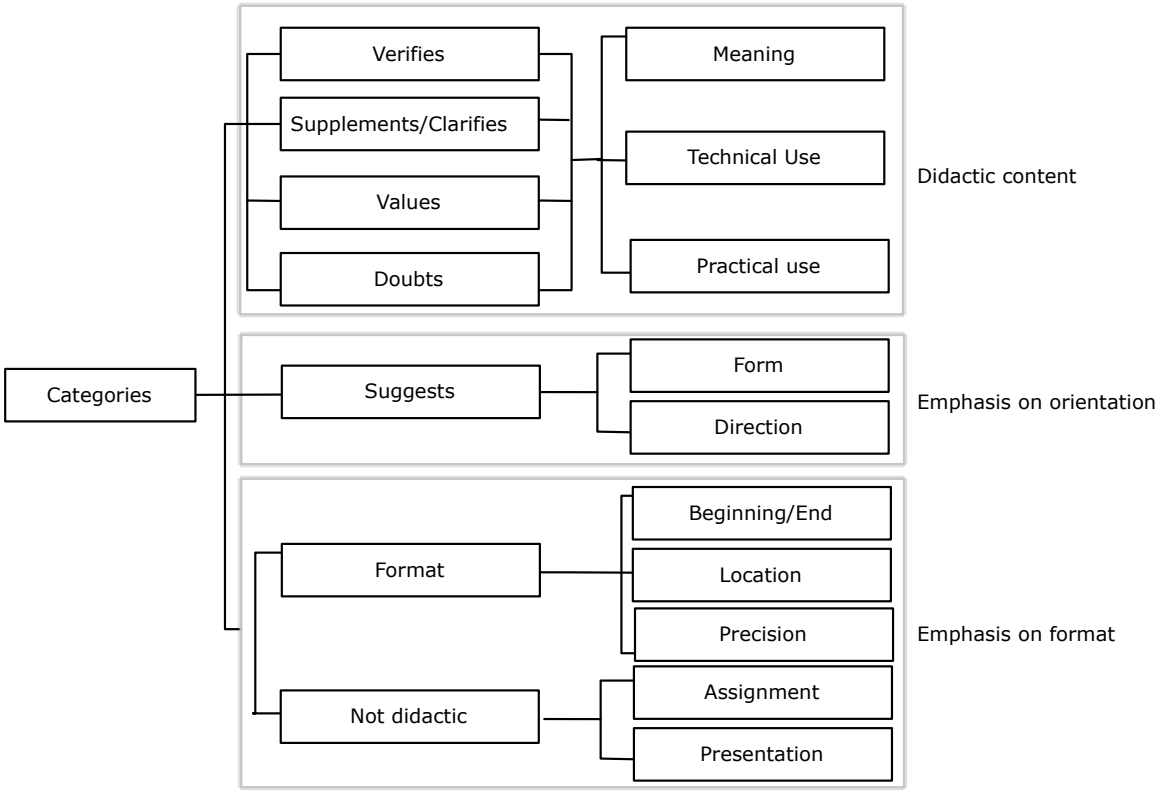

Figure 2. Categories for characterizing mentors' performance

Categories on Pedagogical Content
We have established four categories that organize the mentors' comments that refer to the pedagogical content of their trainees' work. To contribute to his trainees' work, a mentor may (a) notice characteristics of the work; (b) complete or clarify the information proposed by the trainees or the knowledge from which that information was produced; (c) values the trainees' progress or mastery of the three types of knowledge of a curriculum organizer; and (d) convey doubts about the validity of some aspect of the trainees' work. The mentors' comments on this group of categories may be classified as one of the three types of knowledge of a curriculum organizer—meaning, technical use, or practical use.

Categories on Guidance
The two categories in this group identify ways in which mentors can make suggestions to their trainees: the form used to make the suggestion—as a question, directly, raising doubts, or inviting them to reflect; or as a recommendation that arises from the suggestion—e.g., to review the literature, to review other trainees' work, etc.

Categories on Format
The categories on format classify the mentors' comments on the trainees' interpretation of the activity or the format of the work they presented. This group includes categories that refer to the placement and form of the mentor's comments.

RESEARCH GOALS

Our purpose in this study was to describe and characterize MAD mentors' performance through their written comments on their trainees' work. We limited the analysis to the comments made on the trainees' work on the activities corresponding to the subject matter and cognitive analysis. We characterized the mentors' performance in terms of the categories described in the previous section with two concrete research goals in mind:

1. To characterize the common actions shared by most of the mentors.
2. To establish and describe mentors' profiles based on the similarities and differences in their performances.

METHOD

In this section we describe the method we used to achieve our research goals. We specify the subjects and data sources, describe the procedure used to construct the coding instrument, present the coding technique, and outline the instruments and procedure for analysis of the coded data and interpretation of the results—frequency and cluster analysis.

Subjects and Data Sources
We performed an exploratory and descriptive study. The subjects of the study were the 6 mentors of the first cohort of MAD, who were lecturers from three Spanish universities. We analyzed the mentors' written comments on their trainees' written work for the 8 activities related to the subject matter and cognitive analysis modules. A total of 48 documents were coded, 8 per mentor.

Since our data were the mentors' written comments, our unit of analysis was a segment of text in which a comment was expressed. The comment can be a phrase, sentence or short paragraph in which the mentor gives his opinion about a specific aspect of his trainees' work. This portion of text may be associated with one or more codes.

Coding and Code Structure
We followed the guidelines of grounded theory research (Corbin & Strauss, 1990), using an iterative process to produce the structure of categories and codes with which we codified and analyzed the data. Figure 3 shows this process.

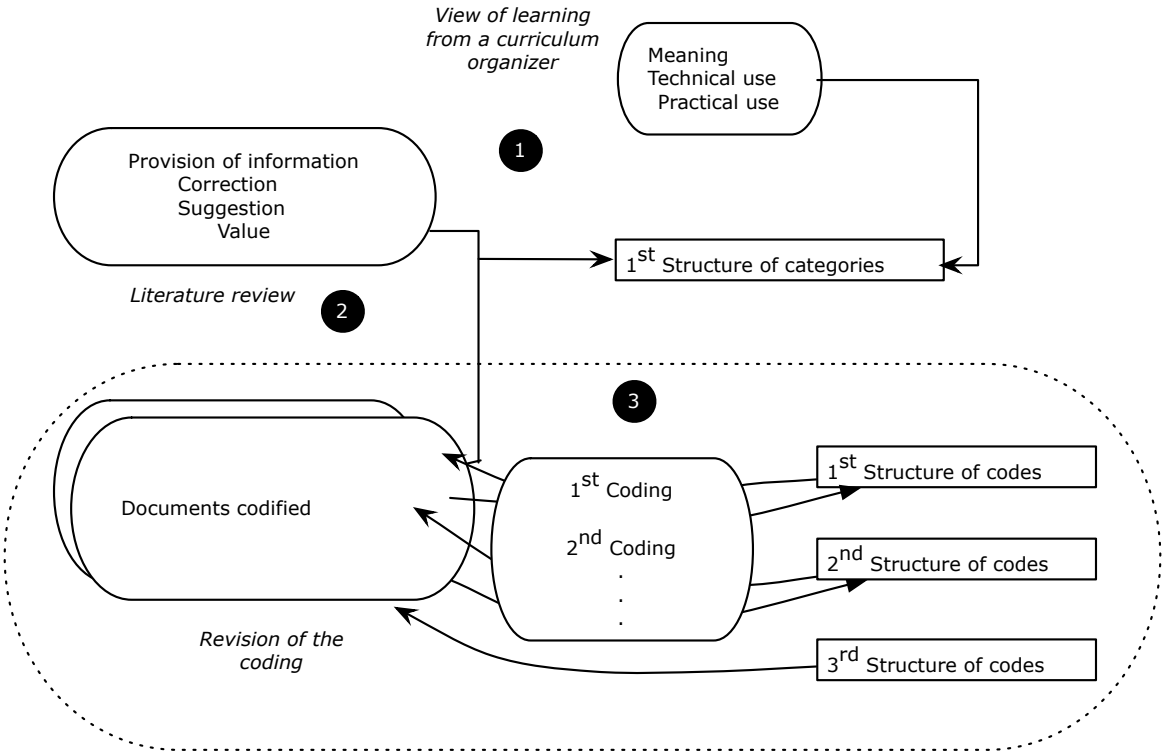

Figure 3. Categories and process of code construction

We developed the first version of the structure for the categories and subcategories based on the literature review (Step 1) and the conceptual framework (Step 2). We defined codes that established the specific categories and performed a preliminary codification of the data with these codes (Step 3). Step 3 was a cyclical and systematic process in which the codes were modified based on the coding of the data. We ended the cycles when we believed we had obtained a list of codes that was clear and exclusive and that allowed proper characterization of the mentors' performance. This step led us, for example, to include a new category. When we analyzed a draft version of the coding, we noted that the subcategory Explanations of Technical Use occurred with greater frequency than the other categories. We therefore decided to set this subcategory apart as a new category and to establish detailed descriptors for it. We obtained 52 codes that gave operational meaning to the categories. We then organized categories, subcategories, and codes into a structure (Figure 4).

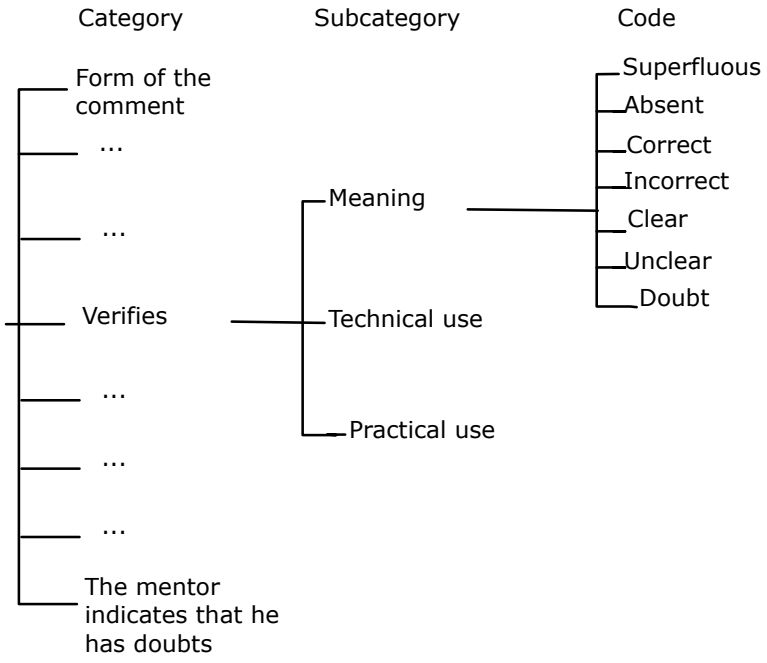

Figure 4. Structure of categories, subcategories, and codes

Figure 4 shows an example of the structure of the system of categories, subcategories, and codes. The category Establish includes the mentor's comments that confirm or verify issues related to his group's knowledge of the curriculum organizers. Its subcategories describe those issues. In this case, the subcategories refer to the meaning, technical use, and practical use of the curriculum organizers. The codes in this subcategory establish whether the mentor's comment refers to lack of knowledge of the meaning of the curriculum organizer, to elements that do not pertain to the key ideas of the meaning of the curriculum organizer, to the validity of that meaning, to whether the meaning is enacted in an appropriate manner, or to whether he has doubts about his group's enactment of the meaning of the curriculum organizer.

In a preliminary phase, the results of the coding performed by two researchers were compared in order to confirm that the code structure was coherent and did not lead to different interpretations of the codes or the comments. Subsequently, the 48 documents containing the 6 mentor's comments were coded.

In what follows, we present some examples of coded comments. We identify the mentor (Ti) and the activity to which the commented draft refers (Aj.k). In the first example, the mentor establishes that the group is enacting the technical use of the curriculum organizer properly—the conceptual structure.

T6-A2.4: I think that the choice of content focus is appropriate.

In the next example, the mentor establishes that the group is not enacting the technical use of the curriculum organizer—phenomenology—properly.

T4-A2.3: *The contexts that you have identified do not correspond to what has been defined in the phenomenological analysis framework.*

We assigned two codes to the comment in the third example. The first code refers to the fact that the mentor establishes lack of information on the group's topic. The second code indicates that the mentor sheds light on the focus of that information. The group is working on the conceptual structure curriculum organizer.

T4-A2.1 *… in the focus on the linear function, I miss the point-slope equation (for any point), as you include only the height-point equation (point (0,b)).*

In the next section, we describe the instruments and procedures used for the data analysis.

Data Analysis Instruments and Procedures

The coding process produced a table of data on which we performed two analyses: frequency and cluster.

Frequency Analysis

In the frequency analysis, we aimed to distinguish common elements in the mentors' performance. We calculated the percent values of each code for each mentor in the activities included in the two modules (see Table 1 below). From this data, we established the common core of the mentors' performance, that we define as follows.

Common Core of Mentors' Performance

The common core contains the characteristics of the mentors' performance—according to the code structure—that are displayed (or not displayed) by at least three mentors. Figure 5 shows the conditions that we established for defining the common core of the mentors' performance. It refers to the actions of the mentors identified by each code.

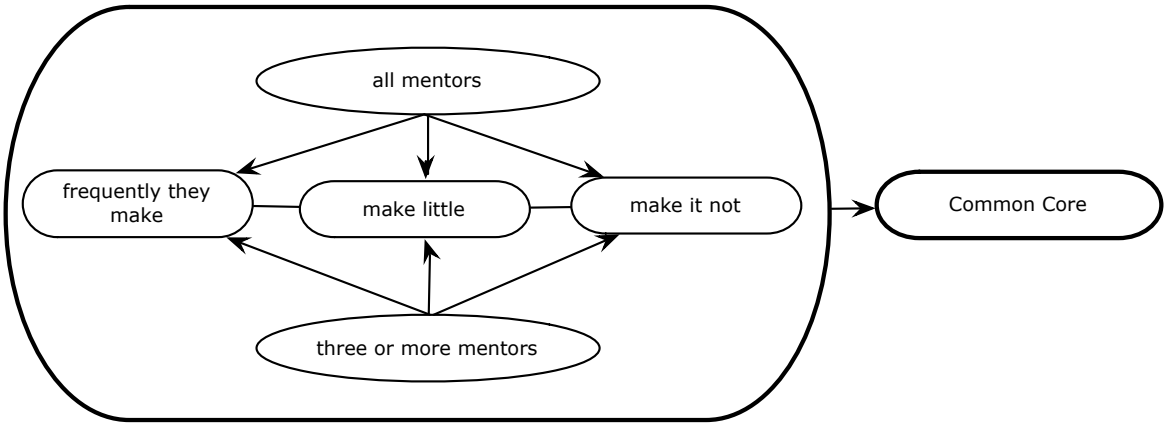

Figure 5. Inclusion in the Common Core

For each action that corresponds to a code, we established three cases: (a) the mentors performed the action frequently; (b) the mentors perform the action infrequently; and (c) the mentors do not perform the action. We fixed reference values—4% and 1%—given by the degree of concentration of the information. If three or more mentors displayed frequencies above 4% for a given code, we considered the mentors to have performed the action corresponding to that code frequently. If the three or more mentors displayed frequencies below 1%, we considered the mentors to have performed the action infrequently or not to have performed it at all. The three cases lead us to consider two dimensions—positive and negative—of the common core. The positive common core contains those actions that the mentors perform frequently. The negative common core contains those actions that the mentors perform infrequently or do not perform at all.

Now that we have established the conditions for determining the common core based on the organization of the structure of categories, subcategories, and codes, we will distinguish the particular situations that allow us to determine that there were differences and similarities in the mentors' actions. In the following, we explain the procedure used to distinguish some particularities from which we can begin to establish a set of mentor profiles.

Cluster Analysis

To identify which mentors have similar actions and to establish differences between groups of mentors, we used cluster analysis as a standard form of classification. The analysis was performed using the codes as descriptive variables. We chose the 43 codes whose variance did not equal zero. Through this analysis, we sought to classify the mentors such that those who belonged to the same cluster were very similar to each other and those who belonged to different clusters had very different behavior relative to some of the variables analyzed. We examined the results at the point at which 3 clusters formed, analyzing the F values of the ANOVA table generated for the analysis. We chose the five variables associated with the highest F values and observed the values of the final centers of the clusters for each of these variables. We will now present the results.

RESULTS

This section presents the most significant results of the study. We have organized it into two sections, one for each of the analyses performed: the frequency analysis and the cluster analysis.

Frequency Analysis

The results of the frequency analysis enable us to describe the common core that the mentors share. Table 1 contains the percentages by mentor (T_1 to T_6) and totals that indicate the codified comments for each of the categories, subcategories, and codes. Following the specifications of our methodology, we indicate the codes that belong to the two dimensions—positive (CC+) and negative (CC-)—of the common core in the last column. If the comment does not belong to the common core, the cell is empty.

Table 1

Percentages of Mentors' Comments by Category, Subcategory, and Code

Categories	Subcategories	Codes	Mentors						Total	CC
			T_1	T_2	T_3	T_4	T_5	T_6		
Form of the mentor's comment									0.0	
	Precision of the comment								0.0	
		1. Not specific	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		2. Vague	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
Comments not related to aspects of the didactic analysis									4	
		3. Presentation	6.2	2.3	4.3	2.2	0.5	3.8	3.6	
		4. Assignment	1.0	0.6	0.6	0.7	0.9	0.7	0.8	CC-
The mentor verifies									221	
	Meaning									
		5. Absent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		6. Superfluous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		7. Correct	0.0	0.0	0.0	0.0	0.0	0.3	0.1	CC-
		8. Incorrect	0.0	0.6	0.0	0.7	0.5	0.0	0.2	CC-
		9. Clear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		10. Unclear	0.0	0.0	0.0	0.0	1.9	2.1	0.8	CC-
		11. Doubt	0.3	0.0	0.6	0.0	0.9	0.0	0.3	CC-
	Technical use								18	
		12. Absent	8.6	5.8	4.9	6.6	7.1	4.5	6.5	CC+
		13. Superfluous	1.0	0.0	0.6	0.0	2.4	1.0	1.0	CC-
		14. Correct	0.3	5.2	3.0	5.8	1.9	0.3	2.3	
		15. Incorrect	2.4	1.7	2.4	0.0	0.0	0.7	1.3	CC-
		16. Clear	0.3	1.2	0.0	1.5	0.9	1.0	0.8	CC-
		17. Unclear	7.5	11.0	6.1	2.2	2.4	6.8	6.4	CC+
		18. Doubt	0.3	0.0	0.0	0.7	0.0	0.0	0.2	CC-
	Practical use								2	
		19. Absent	2.1	1.2	0.0	0.0	1.9	2.1	1.5	
		20. Superfluous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		21. Correct	0.7	0.0	0.0	0.7	0.0	0.0	0.2	CC-
		22. Too much	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		23. Clear	0.0	0.0	0.0	0.0	0.5	0.0	0.1	CC-
		24. Unclear	1.0	0.6	0.0	0.0	0.5	0.0	0.4	CC-
		25. Doubt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
The mentor suggests									2824	
	Form									
		26. Question	7.5	10.5	10.4	4.4	7.5	6.5	7.9	CC+
		27. Suggestion	10.3	9.3	14.6	10.9	6.1	7.2	9.6	CC+
		28. Raises doubts	0.7	0.0	2.4	0.7	1.4	3.4	1.6	CC-
		29. Invites reflection	4.8	1.7	6.1	2.9	3.8	6.8	4.8	CC+
	Direction								4	
		30. Review MAD bibliography	1.0	0.0	1.2	0.0	0.9	0.3	0.6	CC-
		31. Research other bibliography	0.0	0.0	0.0	2.2	0.0	0.0	0.2	CC-
		32. Consult other people	0.0	0.0	0.0	0.0	0.0	0.0	0.0	CC-
		33. Connections with work of other students	0.3	0.6	0.0	1.5	1.4	1.0	0.8	CC-
		34. Work of other groups	2.1	0.0	0.0	0.7	0.5	0.0	0.6	CC-

		of students								
	35.	Offers support	1.4	0.0	0.0	0.0	0.5	0.3	0.5	CC-
	36.	Instruction	1.0	0.0	1.2	0.0	0.9	0.3	0.6	CC-
The mentor supplements or clarifies									10	
Meaning									3	
	37.	Supplements	0.0	0.0	0.0	0.0	0.9	0.0	0.2	CC-
	38.	Clarifies	1.4	1.2	3.7	1.5	3.3	3.8	2.6	
Technical use									4	
	39.	Supplements	6.5	2.3	3.7	7.3	3.3	2.1	4.2	
Practical use									3.4	
	40.	Supplements	0.3	0.6	0.0	2.2	1.9	2.4	1.3	CC-
	41.	Clarifies	3.4	2.9	0.6	0.7	1.9	1.7	2.1	
Mentor clarifies technical use or information									28	
Techniques									5.1	
	42.	Techniques themselves	3.4	9.3	3.0	3.6	7.5	3.8	5.1	
Information									23	
	43.	Focus	3.4	2.9	4.9	3.6	17.5	11.3	7.9	CC+
	44.	Organization	4.8	6.4	1.2	5.8	5.2	7.2	5.4	CC+
	45.	Characteristic	9.2	14.0	15.9	10.9	1.4	6.8	9.3	CC+
The mentor values									4	
	46.	Meaning	0.3	0.0	0.0	1.5	0.9	0.0	0.4	CC-
	47.	Technical use	1.4	3.5	1.2	5.8	1.4	0.0	1.9	
	48.	Practical use	0.0	0.0	0.6	2.9	0.5	0.3	0.6	CC-
	49.	In general	0.3	1.7	1.2	2.9	0.9	1.4	1.3	
The mentor indicates that he has doubts									3.6	
	50.	Meaning	0.0	0.0	0.0	0.0	0.0	0.3	0.1	CC-
	51.	Technical use	1.4	0.6	1.2	5.1	6.1	4.8	3.3	CC+
	52.	Practical use	0.3	0.0	0.0	0.7	0.5	0.0	0.2	CC-

For any given code in Table 1, we can see the percentage of comments associated with each mentor. For example, for code 43, "mentor clarifies information related to the focus," Mentor 5 has a value of 17.5%, higher than the values for the other mentors. The total percentage for this code is 7.9%. The values for the category "mentor clarifies technical use or information" and the subcategory "information" to which this code belongs are 28% and 23%, respectively.

We find that 67.3% of the codes are classified within the negative common core and 17.3% in the common positive core. 15.4% are not classified in either of the two groups. We will now determine the common core.

Common Core

On examining the results in Table 1, we can distinguish the codes associated with the positive and negative dimensions of the common core. We describe these dimensions as follows.

Positive Dimension of the Common Core

This dimension emphasizes the actions that the mentors performed frequently. The codes that describe this situation correspond to the comments in which the mentors:

1. commented if their group had not mastered or was unclear about the technical use of the curriculum organizers;
2. clarified issues related to the information that their group of trainees produced, stressing the focus, organization, and characteristics of the information in relation to their topic;
3. expressed their doubts about how their group made technical use of the organizers; and
4. made direct suggestions, by means of questions or by inviting the group to reflect.

Negative Dimension of the Common Core

The negative dimension of the common core includes the characteristics identifying what the mentors did infrequently or did not do. The mentors made few comments on:

1. the meaning and practical use of the curriculum organizers;
2. the validity or clarity of the technical use;
3. recommendations to find supplementary information; and
4. fulfillment of the requirements explained for the activity.

In addition, the mentors never made comments on:

5. the clarity of the meaning of a curriculum organizer or failure to master one of the theoretical notions that constitute it;
6. errors and doubts in the practical use; and
7. vagueness.

When we defined the conceptual foundations of the research, we distinguished three groups in the structure of the categories: didactic content, emphasis on recommendation, and emphasis on format. Based on this organization, the results show that the mentors' comments focus on the didactic content of the groups' productions and that these comments are related specifically to verifying, supplementing, clarifying, suggesting, and evaluating. Further, it is common for the mentors to express their comments by indicating that they do not understand or that they have doubts about the information generated by their group of trainees.

When the mentors state, verify or confirm characteristics of the work of their group of in-service teachers, they stress the group's technical use of the curriculum organizers. This requires the in-service teachers to make operational the key ideas that characterize the meaning of each curriculum organizer so that they can formulate techniques that enable them to produce information on the topic. The mentors stress aspects of the information that their group produces about the school mathematics topic for which the group is responsible and that will ground the design of the didactic unit.

Just as we distinguished the characteristics common to the mentors, we also determined the characteristics in which we saw differences in the group of mentors. For example, some mentors place greater emphasis on aspects related to the presentation of the projects. Even when all mentors confirm the correct use of the technical aspects and clarify or supplement these, the frequency with which they do this varies.

Cluster Analysis

The goal of the cluster analysis was to establish classifications of the mentors, such that, on the one hand, the actions of the mentors belonging to the same group were very similar to each other and, on the other, the actions of the mentors belonging to different groups showed different behavior with regard to some of the variables analyzed. In this way, we can begin to develop some profiles of mentors according to the way they act when they make written comments on the works of their group of trainees. Table 2 presents the 5 variables with the highest F values, as these provide the greatest separation among the clusters. These variables are derived from the cluster analysis described in the method section. The first column shows the code of the variable, the second its description, and the third the corresponding F value.

Table 2
Highest values of F in ANOVA

Code	Variable Description	F
MV_M_U	Verifies that there is lack of clarity in the meaning of the curriculum organizers	550.4
MV_P	Values aspects related to the practical use of the curriculum organizer	34.1
MD_T	Expresses doubts about how the in-service teachers make technical use of the organizers	33.3
MSC_P_S	Supplements issues related to practical use	25.5
MV_T_I	Verifies that the technical use of the organizers is incorrect	16.3

From the variables that determine the differences between the clusters, Table 3 presents the corresponding values of their final centers. The values of these centers allow us to see what the clusters with more than one mentor have in common. The table identifies the clusters as C1, C2, and C3. The last row indicates the cluster to which each mentor belongs.

Table 3
Final centers of the clusters

Code	C1	C2	C3
MV_M_U	0.00	1.97	0.00
MV_P	2.92	0.41	0.20
MD_T	5.11	5.46	1.06
MSC_P_S	2.19	2.14	0.31
MV_T_I	0.00	0.34	2.19
Mentors	4	5 and 6	1, 2, and 3

Since we know the characteristics shared by all mentors and the characteristics on which they differ most, we can define 3 profiles of mentors based on the results in the previous table. Figure 6 presents an outline in which we summarize the particular qualities of each of the profiles. We use the arrows to indicate the most (↑) or least (↓) emphasis on a specific action.

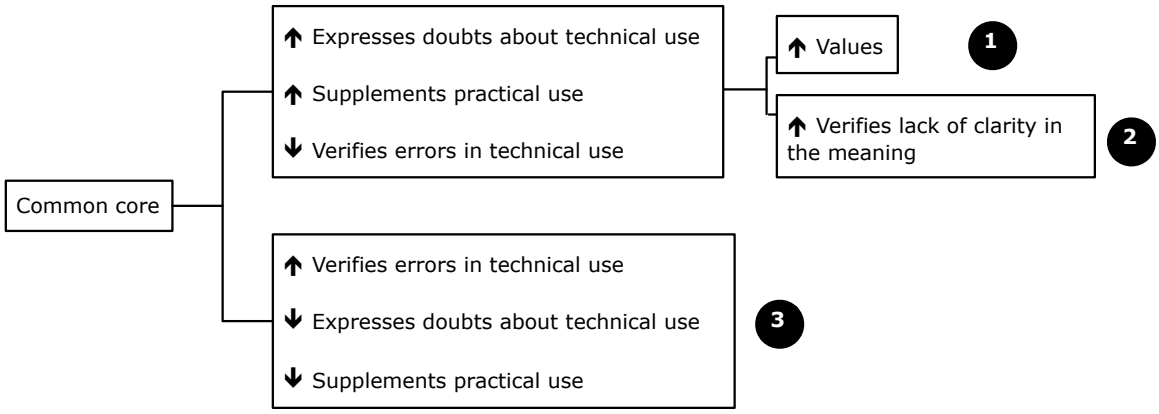

Figure 6. Profiles of the mentors' action

We know that the mentors in each profile have the characteristics that we defined in the positive dimension of the common core. In what follows, we list only the actions that differentiate one profile from the other.

Profile 1. Actions of Mentor 4
This profile is characterized by the mentor

- placing greater emphasis on valuing the work of his group and expressing doubts about the technical use of a curriculum organizer;
- supplementing information related to the practical use of the organizers; and
- not making comments that verify the lack of clarity in the meaning of a curriculum organizer or indicating whether there are errors in the technical use.

Profile 2. Actions of Mentors 5 and 6
This profile is characterized by the mentors

- placing greater emphasis on comments that express doubts about the technical use of the curriculum organizer;
- being the only ones who verify the lack of clarity in the meaning of the curriculum organizer;
- supplementing information related to the practical use of the organizers; and,
- to a lesser degree, evaluating the practical use of an organizer and verifying that the technical use that the in-service teachers make of the curriculum organizer is incorrect.

Profile 3. Actions of Mentors 1, 2, and 3
This profile is characterized by the mentors

- placing greater emphasis on verifying that the technical use of an organizer is incorrect; and,
- to a lesser extent, supplementing information related to the practical use of the organizers, expressing doubts about the technical use of a curriculum organizer, and evaluating the practical use of the curriculum organizers.

DISCUSSION

This section presents a summary of the study performed, proposes some conclusions about the most significant results, and states the study's contributions to the research field. We also explain some lines of future research that emerge from our study.

In this study, we sought to describe and characterize the actions of a group of mentors when they provided written comments for their trainees' work in a training program for mathematics teachers. To achieve this purpose, we formulated 2 specific research goals that have been accomplished. We were able to characterize the performance of the mentors in terms of the categories that we developed. This characterization was focused on the description of a common core of the mentors' performance as a whole and in the establishment of mentors' profiles based on the differences and similarities of their comments. We considered 1269 comments from 48 papers, 8 per mentor. The number and variety of comments allowed us to make a reasoned and deep description of their performance. To do this, we analyzed the comments in two ways. In the first analysis, we found the frequency of types of comments, establishing what mentors do often

or seldom and what they do not do, when they comment on the projects of the groups of in-service teachers. In the second analysis, we performed a cluster analysis that enabled us to define three profiles based on the mentors' actions.

The common core of the mentors' action is characterized by comments that focus on the didactic aspect of the work, emphasizing the technical use of the curriculum organizers rather than their meanings and their practical use. The comments that constitute the common core are specific and make direct suggestions, by means of questions or by inviting the trainees to reflect.

We established three types of profiles for the mentors' actions. The mentors in the first profile typically place greater emphasis on evaluating their group's work; those in the second profile verify the lack of clarity in the meaning of the curriculum organizers; and those in the third profile place greater emphasis on the incorrect technical use of the curriculum organizers.

To produce these results, we developed a structure—organized into categories, subcategories, and codes—that enabled us to describe the mentors' actions. We believe that this structure of categories and codes is one of the contributions of our study, since it proposes an operational system to characterize the mentors' actions in a particular context. In contrast to the systems for characterizing mentors in the literature, this system is specific and enabled us to establish specific aspects that describe the way in which the mentors make written comments on the work submitted by their trainee groups. For example, whereas other systems specify that the mentor identifies errors, the proposed system indicates the type of knowledge in which the error is detected. The mentor's comments are thus associated with suggestions and indicate recommendations that arise from this suggestion. The structure of categories and codes enables detailed characterization of the aspects on which the mentors focus their action. It also allowed us to determine that, for a significant proportion of codes, in the case of the mentors studied, few or no comments are found.

The results show that the mentors act in very similar ways. Their actions focus on the technical use of the curriculum organizers and are intended to motivate the trainees in their work and to stimulate reflection in their group of in-service teachers. We conjecture that this homogeneity in the mentors' actions stems from the characteristics of the requirements for the activities assigned to the groups. Since the purpose of the activities is to analyze a school mathematics topic with various curriculum organizers, the activities focus on the technical use of the curriculum organizers. The mentors therefore focus their attention on this aspect of the groups' work. However, the program also aims to have the in-service teachers develop the meaning and practical use of the curriculum organizers. This is one of the issues in which the mentors' actions become less homogeneous. As can be seen from the characterization of the profiles, the mentors of Groups 1 and 2 make supplementary comments on the practical use, but the mentor of Group 2, unlike the mentors of Groups 1 and 3, establishes deficiencies in the meaning that his group put into practice.

We are aware that this study has limitations, which open directions in which we can continue to investigate this problem. The study we have presented is developed from the data on only two modules of the program, and our source is the comments written on drafts of each group's papers. We could extend the investigation of the mentors' actions to other areas of the program—mentors' comments on other modules, the interaction of the groups with their mentors in discussion forums, and evaluation sheets. We could perform studies that investigate the actions of the mentors in each module and activity in order to establish whether there are changes in the kind of comments from one module (or activity) to another or in the emphasis placed on specific aspects of the group's work. These studies can be supplemented by the information from interviews with the mentors, the groups of in-service teachers, and the educators with regard to each mentor's action.

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