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Characterising lesson planning: a case study with mathematics teachers

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ABSTRACT

The quality of students' learning experience depends on the learning activities that their teachers plan prior to classroom delivery. This article characterises the lesson planning practices of a group of 27 mathematics teachers. The questionnaire and the associated information coding and analysis procedures designed for that purpose may be applicable to lesson planning characterisation involving larger groups of teachers and of other disciplines. Some of the study group's needs and difficulties are established. One of the observations discussed is that planning procedures and criteria tend to be generic rather than specific to the lesson at issue. Another is that these teachers' vision of planning does not necessarily ensure a coordinated approach to all curricular dimensions.

A considerable proportion of what students learn is the fruit of their classroom experience, which is, in turn, the result of the learning opportunities afforded by the teacher (e.g. Kilpatrick, Swafford, & Findell, 2001, p. 9; Little, 2003; Miller, Austin Windle, & Yazdanpanah, 2014).

The quality of teachers' classroom delivery and consequently the opportunities provided students to learn (through the activities they are to perform) depend on the quality of lesson planning (Li, Chen, & Kulm, 2009, p. 719). As teachers plan their classroom delivery in advance, they must be able to draw from lesson planning tools and to implement and review their plans (Akyuz, Dixon, & Stephan, 2013). Moreover, planning is regarded as an essential part of teacher training (Kang, 2017; Mutton, Hagger, & Burn, 2011, p. 400) and a number of experts have posed questions around what it should entail (Zazkis, Liljedahl, & Sinclair, 2009, p. 400).

In order to characterise the planning practices of a group of teachers, a conceptual framework for structuring teachers' lesson planning is necessary. We propose such a curriculum model for lesson planning practices in a section below. This model involves an integrated view of curriculum that takes into account its four dimensions – conceptual, cognitive, formative, and social –, the relationships among them, and the specific features of planning for concrete topics. As discussed in the following section, most researchers exploring this subject have used case study methodologies that involve, among others, reviewing teachers' lesson scripts and

conducting interviews and classroom observations. With that approach, lesson planning can be described and characterised in detail, but it is limited to a small number of teachers. Since the aim here is to characterise the lesson planning practices deployed by a group of 27 teachers, a questionnaire-based approach was adopted, grounded on the aforementioned conceptual framework. Ascertaining the planning practices deployed by a group (as opposed to an individual) furnishes information on the type of teaching conducted in an educational institution, in a given region or by a series of teachers engaging in an education programme.

The article is divided into three parts. The first consists of a brief review of the research on lesson planning and the introduction to a curriculum model (Gómez, 2007) for the conceptualisation of teachers' planning practices. Building on those conceptual foundations, the second part describes the questionnaire and the respective data gathering, coding and analysis procedures. Lastly, the results of applying the questionnaire and procedures are discussed to characterise the lesson planning performed by a group of 27 in-service secondary school mathematics teachers.

Lesson planning practices

Lesson planning is described in a number of ways, although such descriptions revolve around a common issue: 'the interaction of teachers and particular content in order to arrive at decisions regarding what and how particular content should be delivered to suit the unique circumstances of each teaching situation' (Lai & Lam, 2011, p. 221). It refers, then, to the teaching and learning decisions adopted by teachers prior to delivering a lesson (Sardo-Brown, 1996, p. 519).

Experts have proposed a number of schemes, models and conceptual frameworks for addressing lesson planning. This is the case, for instance, of the models proposed by Courey, Tappe, Siker, and LePage (2013), John (2006), and Simon (Simon, 1994, 1995, 2014; Tzur, Simon, Heinz, & Kinzel, 2001), among others.

From another perspective, research has been conducted on how teachers learn to plan lessons when participating in teacher education courses and programmes. This is the case, for instance, of subjects as the information acquisition when planning lessons (Tanni, 2012), how teacher trainees broach planning in terms either of the subject matter or students' cognition (Boudah, Deshler, Schumaker, Lenz, & Cook, 1997), the benefits of specific lesson planning tools in learning planning techniques (Rusznyak & Walton, 2011; Santagata, Zannoni, & Stigler, 2007; Theoharis & Causton-Theoharis, 2011), and rubrics for assessing planning competence, as in the PACT assessment used in California (Darling-Hammond, 2010; Raymond & Ruth, 2006).

These studies and others have used different information collection and analysis procedures. Most are based on case studies that explore the lesson planning performed by a small number of teachers in which interviewing is one of the primary sources of information. They also analyse any available teacher planning documents (lesson scripts). In some cases, classroom performance is observed and what are known as anecdotal records are taken into account.

The findings yielded by these studies cover a wide range, with reports to the effect that teachers plan more from intuition than from academic learning (Miller et al., 2014); experienced teachers' lesson planning focuses on preparation, reflection,

anticipation, evaluation and review (Akyuz et al., 2013), and they form a mental picture of how the lesson will unfold (Kyriacou, 1998); teachers are more concerned about the tasks to be assigned to students than what they aim to achieve (Akyuz et al., 2013; Strangis, Pringle, & Knopf, 2006); pre-service teachers seldom consider their students' learning needs and seldom anticipate how instructional activities facilitate students' thinking (Chizhik & Chizhik, 2018); and certain factors have a beneficial effect on lesson planning, such as the analysis of videos of students' performance (Leikin & Kawass, 2005), specific design methods (Courey et al., 2013) and teachers' creativity and know-how (Panasuk & Todd, 2005). The factors identified as affecting teachers' lesson planning include knowledge, curricular requirements and the materials and resources available (Lai & Lam, 2011); teachers' conceptions and beliefs and their vision of and preferences around the discipline and its teaching (Thompson, 1984) and teachers' knowledge of content and pedagogical know-how (Baumert et al., 2010; Yasemin, 2015).

Other studies have explored the difficulties experienced by teachers when planning lessons. They have been found to be unclear about the learning objective, to evaluate in ways inconsistent with learning objectives and to be uncertain about how to begin a lesson; to find it difficult to view a classroom session globally and align learning objectives, delivery and evaluation (Liyanage & Bartlett, 2010); to be unable to design tasks that are valid and gratifying for students and at the same time help attain learning objectives (Ainley, 2012); to have no notion about how to begin a lesson plan or identify students' needs, to tend to make scantly informed decisions and to report differences between what they plan and what they think about the subject (Schmidt, 2005); and to find it difficult to draw from their knowledge of the discipline when planning lessons (Bigelow & Ranney, 2005).

Our interest in this article focuses on characterising the planning practices of groups of teachers that share two features: they aim to improve their practices and they work in a curriculum autonomy context in which they are fully responsible for the complete design of the syllabus for their classes.

A curriculum model for lesson planning practices

Our idea is to address lesson planning as a whole, involving factors linked to the content to be taught, the way students learn, teaching methodologies and the way teachers plan to evaluate students. Therefore, we start from a view of curriculum aligned with the ideas of Beyer and Liston (1996), Rico (1997), or Stark and Lattuca (1996). According to this view, we assume the curriculum as composed of four dimensions: conceptual, cognitive, formative, and social, each of which deals with four fundamental and interrelated questions: 'what is knowledge, what is learning, what is teaching, and what is

useful knowledge' (Rico, 1997, p. 386). The conceptual dimension refers to content and topics that are specific to a given discipline. The cognitive dimension refers to learning and the learner, and deals with understanding what is learning, how it happens, and how do different people learn. The formative dimension refers to teaching and the teacher and deals with aspects such as what are the practices that are believed to be useful for teaching. The social dimension refers to the value that the society places on the utility and usefulness of knowledge and it deals with the criteria and instruments that are used to judge the capacity of an individual on a given discipline or to assess the usefulness of a curriculum.

Furthermore, curriculum can be conceived as involving levels – from the national educational system through the classroom (Mesa, Gómez, & Cheah, 2013, pp. 867–868). At a given level, each one of the four dimensions of curriculum acquires a specific meaning. The curriculum model we use in this study focuses at the classroom level (Gómez, 2006). At this level, and on the basis of the four curricular dimensions, the model addresses actions and thoughts that teachers could make when planning an hour-long classroom session or series of lessons on a specific topic of school mathematics.

At this level, the conceptual dimension involves teachers' actions and thoughts to identify the concepts and procedures that characterise the lesson (and their interrelationships), the ways it can be represented and the mathematical and non mathematical contexts that afford it meaning.

The information arising from the conceptual dimension serves as a basis for the cognitive dimension. In this dimension and level, we refer to teachers' actions and thoughts to establish and characterise their expectations around student learning (in terms of competences, learning objectives and capacities), identify the errors students may make when performing the tasks proposed and describe the pathways they believe students' learning process will take.

In the formative dimension, taking the characterisation of learning objectives as a reference, the concern refers to teachers' actions and thoughts to choose and describe the tasks comprising their lesson planning (in terms of requirements, instructions, materials and resources, grouping, interaction and timing), foresee students' and their own possible actions, analyse the tasks at issue and make any changes needed to meet learning objectives more efficiently and help students correct errors and surmount difficulties. Teachers also can describe, analyse and improve the task sequences set out in their lesson plans. Some of the ideas around the cognitive and formative dimensions stem from proposals put forward by Simon and others on teaching and learning cycles (Simon, 1994, 1995, 2014; Tzur et al., 2001).

Lastly, in the social dimension, teachers, at this curriculum level, include information gathering and analysis tools and procedures that enable them, in practice, to observe student progress in meeting learning objectives, correcting errors and surmounting difficulties; verify the extent to which their proposal has met all these aims; and evaluate students in keeping with institutional requirements.

In its inclusion of the four curricular dimensions, this curriculum model partially shares processes and ideas with most other models and schemes proposed for lesson planning. Most of those models focus on learning objectives (i.e. John, 2006), highlight instruction and evaluation (i.e. Little, 2003; Milkova, 2012) or include the subject matter analysis (i.e. Causton-Theoharis, Theoharis, & Trezek, 2008; Rusznyak & Walton, 2011). The advantage of this model is that it affords a coordinated approach to all these questions and takes into account the relationship among the four dimensions of curriculum. We will use this conceptual framework to guide the design of the structure of the questionnaire, interpret the coded data and obtain results.

Focus of the study

This study focuses on the content to be taught in school and the curriculum dimensions and elements handled by teachers when planning their lessons. The object of the study is teachers' specific actions and thoughts, not what they think or believe is right or appropriate. The idea is to address lesson planning as a whole, from the selection of the lesson's topics to the way they plan to evaluate students. This descriptive study, then, forms part of the line of research that explores the features, including any difficulties, that characterise teachers' lesson planning.

This study revolved around the characterisation of the lesson planning practices of a group of teachers. Its subjects were teachers just beginning a teacher education programme. As done in other studies on teacher education (e.g. Schwarz, 2015), 'the decision was made to use a questionnaire in order to be able to survey more future mathematics teachers than would have been possible using an interview approach' (p. 384). A questionnaire was consequently designed which, based on the curriculum model proposed, could be used to describe and characterise their lesson planning practices. The section below describes the questionnaire, along with the information gathering, coding and analysis procedures. Lastly, the results of deploying the questionnaire and procedures are discussed to characterise lesson planning in the group of practising secondary school mathematics teachers studied.

Method

The target population, the information collection tool and the coding and analysis procedures are described below.

Context and target population

Law sets curriculum autonomy in Colombia. Schools and teachers are fully responsible for curriculum design and development in all areas. The Colombian State publishes curriculum guidelines that schools can use in their planning practices. Schools are expected to produce syllabi for each course and academic period and teachers are usually autonomous for designing and implementing the lessons they are in charge of. They often do so by producing what is known as 'teaching guides': sets of tasks that they design or copy from different resources, and propose to students. Very different, even opposite, approaches to curriculum and syllabi design are possible under this context.

The population studied comprised 27 practising public and private secondary school mathematics teachers from Bogotá and Cundinamarca, Colombia. The questionnaire was answered by this group of teachers at the beginning of a master teacher education program in which they were participating. Slightly over half (15) of the group were women, most (24) taught in public schools, had a degree (26) in mathematics, mathematics and statistics or mathematics and physics, and 7 to 15 years of experience (23). The master teacher education programme that the subjects were just starting covers mathematics lesson planning, implementation and evaluation. Hence, this was a convenience sample of teachers interested in improving their teaching practices. In this programme, teachers are expected to

develop a deep enough pedagogical content knowledge of a topic so that they can support the choices and decisions they make for their lesson plan (Charalambous, 2008). The master programme is founded in the previously stated curriculum model composed of four dimensions. The first part of the programme, corresponding to the lesson planning period, covers the first 15 months of a two-year term. Participants work in small groups that systematically analyse a mathematical topic from the conceptual, cognitive, formative and social standpoints. Each group write up a report on these matters and formulate a lesson plan for the mathematical topic. In the second part of the programme, teachers implement the curriculum in place in their educational institutions, assess the relevance and effectiveness of the plan implemented, and establish a new and improved design.

We claim that the fact that the subjects were just at the beginning of the master programme did not generate bias on the teachers' responses: the subjects had not yet received any teaching on the topics included in the questionnaire and they were not yet emotionally linked to the programme.

Questionnaire

The questionnaire asked subjects to remember and report on general and specific issues concerning the planning of a recent lesson.1 That is, it explored what teachers specifically did and thought when preparing a mathematics lesson recently taught. It did not explore their opinions on lesson planning in general or how they believed lessons should be planned in an ideal situation. Even though the lesson was on mathematics, the questions use the subject matter as a placeholder for inquiring into general issues related to the teachers' planning practices.

The four sections of the questionnaire are based on the curriculum model described above. Besides, the questionnaire includes two kinds of questions: main questions, which focus on the key points of the corresponding dimension, and subordinated questions, which have the purpose of obtaining details and clarifying different aspects of the main questions. For conciseness reasons, we do not show here the complete questionnaire: only the main questions and the most representative subordinated questions are described. The complete questionnaire can be downloaded at http://bit.ly/1RsdvnK.

The section of the questionnaire associated with the conceptual dimension contains the following question that refers to the mathematical matters borne in mind by the teacher when planning the lesson.

CD1. What aspects of the mathematics involved in the lesson did you have in mind? Our purpose with this single question for this dimension was to establish which aspects of subject matter (as described in the conceptual framework) the teachers took into account for their lesson planning.

The questions in the cognitive dimension section (see Table 1) explored teachers' expectations (in terms of learning objectives), the possible strategies students could use to solve the tasks proposed by the teacher, and the errors in which they might foreseeably commit.

The section on the formative dimension was the longest of the questionnaire due to the variety of perspectives dealt with. Questions were organised from three

perspectives: teaching methodology, task selection and task sequencing (Table 2). The questionnaire included five types of questions on teaching methodology: teacher's performance, moments for students' engagement in activities, students grouping, how students present the results of their work and teacher's interaction. Concerning tasks selection and sequencing, inasmuch as the tasks proposed by teachers constitute a core feature of this dimension, respondents were asked to provide examples, and questions were posed about the elements, sources and criteria involved in choosing and sequencing tasks.

Table 1. Cognitive dimension: main questions and representative subordinated questions.

Main Questions	Representative Subordinated Questions
CgD1. Did you decide what you wanted students to learn from the lesson (in terms, for instance, of learning objectives, competencies, expected achievements or similar) before teaching it?	CgD1.1. What did you intend for them to learn?
CgD2. When working on this lesson, did you take into consideration the errors that your students might make?	CgD2.1. When preparing the lesson, did you include tasks that would address those errors?
CgD3. Before you taught the lesson, did you anticipate the strategies (ways of performing tasks) your students might use to perform the tasks you planned to propose?	CgD3.1. Could you give us a couple of examples of the strategies you anticipated?

Table 2. Formative dimension: main questions and representative subordinated questions.

Main Questions	Representative Subordinated Questions
FD1. Please describe what you planned to do in the classroom, in general, when you were working on this lesson.	FD1.1. Describe the order in which you were going to deliver explanations or present examples. FD1.2. Describe your plans for when students would engage in activities (problem solving, blackboard exercises. . .). FD1.3. Describe how students were going to perform the tasks (individually, two-by-two or in small teams). FD1.4. Describe how students were going to present the results of their work. FD1.5. Describe how you were going to interact with students (individually, with the class as a whole,…).
FD2. Please explain how you chose the tasks you proposed for this lesson.	FD2.1. Where did you look for them (textbooks, earlier guides, internet, self-generated)? FD2.2. What kind of tasks did you propose (problems, routine exercises, etc.)? FD2.3. What proportion of the tasks that you proposed included the use of materials and resources? FD2.4. What proportion of the tasks that you proposed were problems that referred to nonmathematical situations?
FD3. Please explain how you sequenced the tasks you proposed for this lesson.	FD3.1. Please describe the criterion you used to determine the order in which you presented the tasks.

Lastly, in the section on the social dimension, the two following questions were posed about teachers' design for student assessment.

SD1. Before delivering the lesson, did you think about how you would assess students' performance?

SD2. Provide a general description of what assessment approach you planned to adopt.

The questionnaire was compliant with all the minimum design requirements for this type of tool (Travers, 1986, pp. 246 and 273). It did not gather data unrelatedly: it was framed in a theory on the nature of the developments studied (curricular theory and the specific curriculum model proposed). The questions were not ambiguous: pilot tests were conducted prior to implementation to ensure their clarity. The information requested was available to teachers, since it referred to events that had occurred recently. The replies requested were not based on simulated or ideal situations, but on specific events in which the respondents had participated. The questions were short and, where deemed necessary, subdivided to ensure greater clarity. The questions were couched in emotionless terms, so as not to compromise teachers' answers.

Coding and analysis

The principles of qualitative content analysis (Mayring, 2015) were followed to analyse, group and code the replies to the open questions.

The coding procedure used a mixture of deductive and inductive category definition (Mayring (2015), p. 366):

> We combine two fundamental steps of analysis: the first is a qualitative-interpretative step following a hermeneutical logic in assigning categories to text passages; the second is a quantitative analysis of frequencies of those assignments (if the same categories are coded in several text passages).

Categories emerged from teachers' answers. Furthermore, as suggested by Schwarz (2015), 'the theoretical basis of the categories followed from the theoretically-based development of the questionnaire' (p. 388). In what follows, we explain how the categories emerged from the conceptual framework, present anchor samples of their use, and describe the coding rules that we used.

Descriptors were designed in a way that enabled all researchers to classify a given reply under the same code. The list of codes was verified and refined by the three authors. The conceptual framework was used to define the codes, in order to establish whether a reply to a question on a given dimension might refer to aspects pertaining to other dimensions. For instance, when we ask teachers about what they expect their students to learn (cognitive dimension), we defined codes that allow establishing whether a reply refers to conceptual aspects of the subject matter or to issues related to the tasks proposed to the students (formative dimension). For this purpose, we grouped similar questions and decided whether they referred to issues of the question's dimension or other dimensions. We ensured that the number of codes per question was reasonable. 'Reasonable' was deemed to be from five to

nine codes to a given question that could be suitably characterised.2 As the questions were open, any given reply might include information classifiable under more than one code; i.e. a single reply could be labelled with more than one code.

Each author coded the replies separately. The results of the coding operation were subsequently compared. The replies for which the codes did not match were analysed to reach agreement on their interpretation and the coding was refined accordingly. For each question, the number of replies labelled with a given code was counted, the percentage over the total replies was calculated, and summary tables with those percentages were produced. These tables were used to characterise the group of teachers in respect to each question. That entailed identifying the codes with the highest and lowest percentages. After the responses to each question were characterised, the descriptions were arranged in accordance with the conceptual framework (the curriculum model). The outcome was the characterisation of the lesson planning conducted by the group of teachers in terms of the four dimensions of the curriculum model and the relationships among them.

Results

The group of teachers studied were characterised in terms of their replies to the questionnaire as described in the preceding section.3 The following is a short summary of the main results that we describe in more detail below for each section of the questionnaire (corresponding to each dimension of the curriculum model). Teachers gave the same importance in their lesson planning to concepts, procedures and representation systems. They did not refer to the usefulness of mathematics. Almost all teachers claimed to have considered learning expectations when planning their lesson. Most of them took into account the mathematics involved when formulating those expectations, some of them referred to problems and none alluded to higher level learning expectations. The majority of teachers anticipated students' difficulties and errors, but only half of them envisaged specific activities to address them. More than half of the teachers thought about how students would solve the tasks proposed, but they did not so in detail. Most teachers asked students to solve tasks after presenting explanations and examples, which represents the bulk of the interaction between teacher and students. Even though they reported to make students work in pairs, most teachers asked them to present their work individually. The tasks that they selected for their lesson came from textbooks and Internet, are mainly exercises, require paper and pencil with little technology use, and are set up in mathematical contexts. Most teachers did not take into account students' learning when sequencing tasks; some of them use task complexity and the topics themselves as criteria for that purpose. Even though most teachers included assessment in their planning, very few referred to the assessment of learning expectations and the assessment tools used were not specific to the lesson's topic.

Conceptual dimension

When asked about the mathematical matters borne in mind when planning the lesson, the teachers' replies focused on concepts (28.9%), procedures (28.9%) and representation systems (22.2%). For example, a teacher claimed that, 'for the work

with sum of rational numbers I took into account the previous concepts of addition of integers, multiplication of integers [concepts], law of signs of multiplication [procedures]'. No answer was related to the usefulness of mathematics. In Figure 1, we summarise the results corresponding to the main questions in the conceptual dimension.

Cognitive dimension

All except one of the teachers (96.3%) claimed to have considered learning expectations when planning their lesson. When asked what they took into account for formulating learning expectations, most of the answers (65.9%) referred to mathematics (concepts, procedures and representations). Some of them (25%) referred to problems. None of them made any reference to higher level learning expectations when formulating the learning objectives. For example, a teacher claimed: 'the students had to learn to solve contextualized situations formulating a system of linear 2 × 2 equations and solve it using some method: graphic, substitution, elimination or matrix'. This answer refers to procedures, representations and problems. When asked whether they anticipated students' difficulties and errors when planning the lesson, more than two thirds (74.1%) of the teachers took them into account. However, only 55.6% said they envisaged specific activities to address them. For example, a teacher claimed, 'it is common for students to confuse the properties of addition with the properties of multiplication, so I propose activities to differentiate them in each case'. This teacher has anticipated a specific difficulty and, at the same time, he has proposed a way to address it.

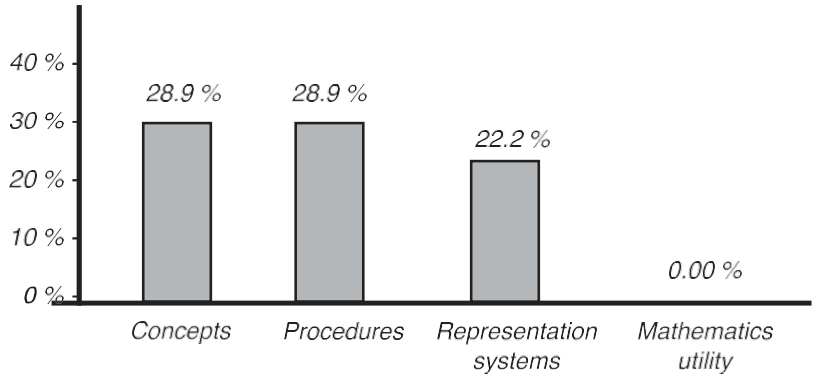

Figure 1. Results in the conceptual dimension.

More than half (59.2%) of the teachers also replied that they envisioned the strategies that students would deploy when trying to perform the tasks proposed, but most (74.1%) provided scant detail, referring to general procedures that students should follow: for example, 'when students work with directly proportional magnitudes, they solve them arithmetically without using the properties and proportions', or 'some students try to solve operations horizontally, which will lead them to make mistakes'. In Figure 2, we summarise the results corresponding to the main questions in the cognitive dimension.

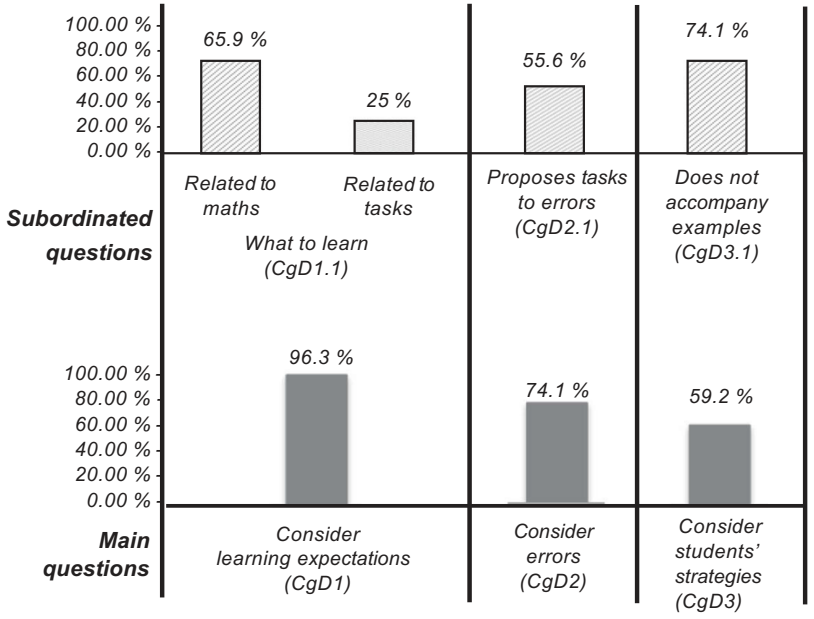

Figure 2. Results in the cognitive dimension.

Formative dimension

The first perspective of the formative dimension refers to teaching methodology. Many teachers (43.6%) start the lesson by presenting information (explanations or examples). Furthermore, most teachers (67.7%) ask students to solve tasks only after having given the explanations or solved their doubts: 'first the explanation and then the exercise'. Concerning the grouping of students when solving tasks, 60.5% of the teachers said that they organise students in pairs or groups. Nevertheless, most teachers (62.5%) asked students to present the results of their work individually. The questionnaire also asked about teachers' performance in class. The question that characterises this group of teachers concerns the teachers' purpose for interacting with his students: 27.7% did so for solving students' doubts or difficulties, whereas 12.8% presented new explanations. This is the case of a teacher who claimed: 'when I recognize that many students have the same doubt, I stop their work and present an example that can help solve that doubt'. Figure 3 summarises the results corresponding to teaching methodology questions.

The second perspective of the formative dimension refers to tasks selection. Teachers answered questions concerning sources where they searched for tasks and type of tasks selected. There are three main sources where teachers reported that they search for tasks: textbooks (35.2%), Internet (37%) and tasks designed by themselves and their colleagues (24.1%). The questionnaire looked into the type of tasks that teachers selected from three points of view: kind of task (problem vs. routine exercise), use of materials and resources, and type of context (mathematical and non-mathematical). For this matter, 40.7% of the teachers reported selecting exercises, whereas 37% selected problems. On the other hand, 53% of teachers selected tasks that just required the use of the textbook and paper and pencil, and only 27.5% of teachers claimed to have selected tasks that involved the use of technology. Every task is set up in a context. This context can be mathematical (e.g. solve the equation 3x + 2 = 6) or non-mathematical ('identify all triangles in the map of a city'). Tasks set up in non-mathematical contexts were not common in teachers' replies: only 7.4% of them used non-mathematical contexts in more than 60% of the tasks. Figure 4 summarises the results corresponding to tasks selection.

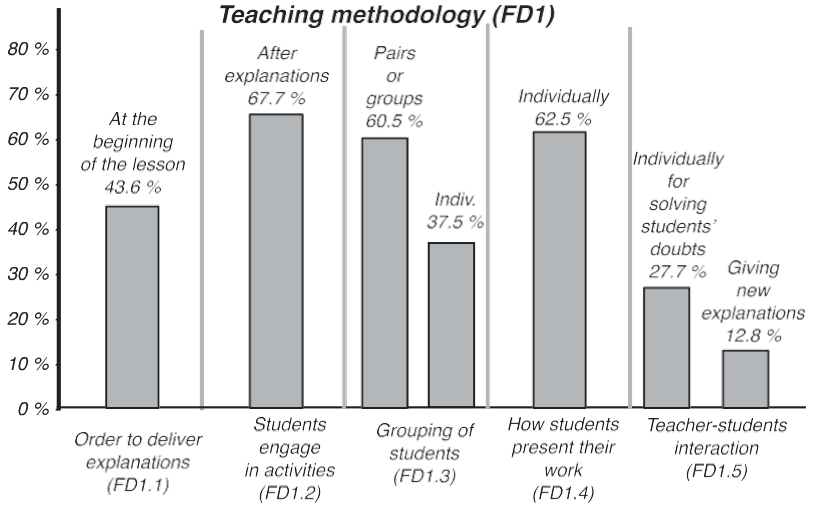

Figure 3. Teaching methodology results in the formative dimension.

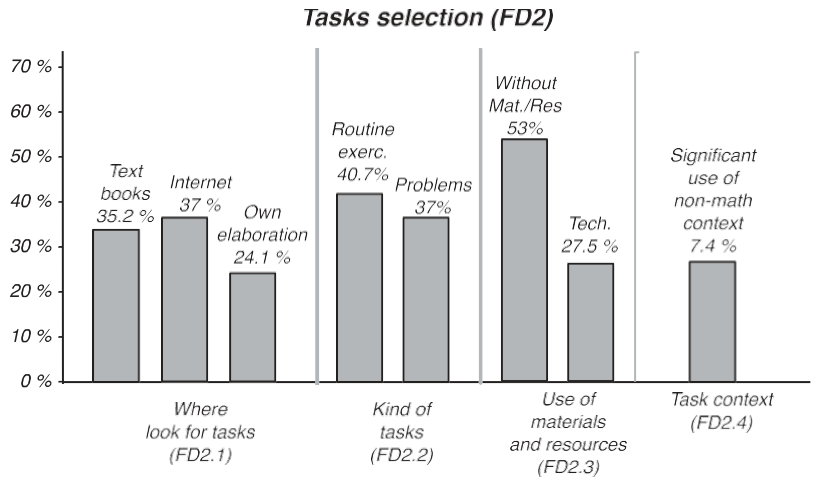

Figure 4. Tasks selection results in the formative dimension.

Finally, the questionnaire inquired about teachers' task sequencing. Only 31.3% informed that they took into account students' learning when sequencing tasks ('For students to carry out a gradual learning process'). They considered two more criteria for organising their task sequence: task complexity (21.9%) ('first, I propose basic exercises that require simple procedures; then I propose exercises that require students to analyze the information; finally, I propose problems in different contexts that require students to put into practice what they have learned') and topics' order (21.9%) ('to establish the relationship between a topic that is familiar to them and a topic that is new'). Figure 5 summarises the results corresponding to tasks sequencing.

Social dimension

The analysis of the social dimension focused on assessment planning (see Figure 6). Most (85%) of the teachers included assessment in their lesson planning. Further inquiry into how that was done showed that, whereas 41.7% of the replies focused on the assessment tools used, only 8.3% referred to assessing students in terms of learning expectations. The assessment tools were not specific to the mathematics lesson being planned.

Discussion

The importance of lesson planning in mathematics teachers' teaching practices and students' learning poses the need for characterising this teaching competence. Most studies conducted on the subject to date have used complex methodologies, including the review of planning documents (lesson scripts), interviews with teachers and classroom observation. Such approaches limit the number of teachers whose planning practices can be characterised. This article proposes a methodology (a questionnaire and information coding and analysis procedures) to surmount that problem with no need for major investments in resources. Lesson planning as implemented by a group of 27 practising mathematics teachers was characterised using this approach. Even though this is a medium-sized group, the information

collection and analysis procedures proposed are apt for systematic application to large groups of teachers. Since the questionnaire asks teachers to recall what they did or thought, the information that is collected does not refer to their opinions on what is correct or appropriate.

Even though the subjects of this study were practicing mathematics teachers, we used a general curriculum model not specific to mathematics as a guide and conceptual background for designing the questionnaire and the coding and analysis procedures. Therefore, the results refer to planning questions that are not related to a specific discipline. Furthermore, the curriculum model used has enabled us to survey a broad spectrum of the issues that characterise teachers' planning practices.

An analysis of the findings showed that the lesson planning implemented by the teachers studied was characterised by the following: learning expectations formulated in mathematical terms; failure to address higher level learning expectations when establishing learning objectives; failure to include activities specifically designed to help students correct errors and overcome difficulties; mathematical tasks to be solved with paper and pencil, not contextualised, obtained in textbooks and Internet; designed for students working individually; introduction of examples or exercises only after the lesson is explained; student-teacher interaction is expected only during student activities; absence of clear criteria for task sequencing; and anticipation of the tools to be used for assessment, but without taking account of learning expectations nor lesson topics.

These findings concur in some respects with the results of earlier studies. The lesson planning conducted by the teachers studied addressed certain prominent criteria and procedures, while others were absent. This revealed difficulties and needs, as mentioned in the preceding paragraph. Specifically, contrary to expert recommendations for planning procedures and practice (Akyuz et al., 2013; Jones, Jones, & Vermette, 2011; Liyanage & Bartlett, 2010; Strangis et al., 2006), the teachers studied showed no systematic global or consistent vision of lesson planning that would afford a coordinated approach to the four curricular dimensions. Learning expectations, for instance, were not defined on the grounds of a characterisation of the topic to be taught. Very few members of the group anticipated students' performance when solving tasks (Chizhik & Chizhik, 2018) and reported that task design and selection were based on learning expectations, while no relationship was observed between assessment tools and procedures and such expectations.

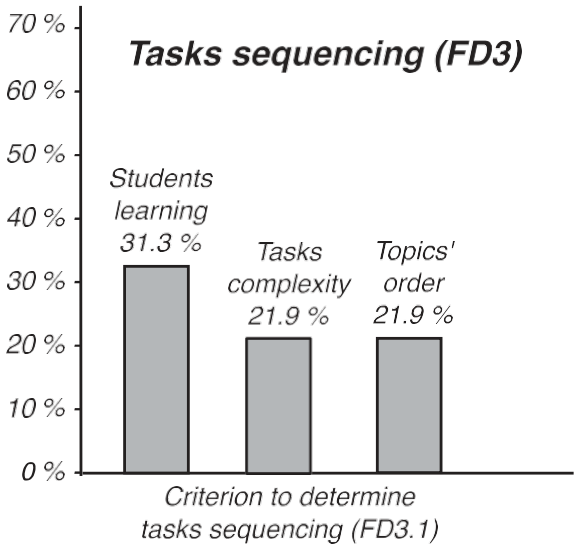

Figure 5. Tasks sequencing results in the formative dimension.

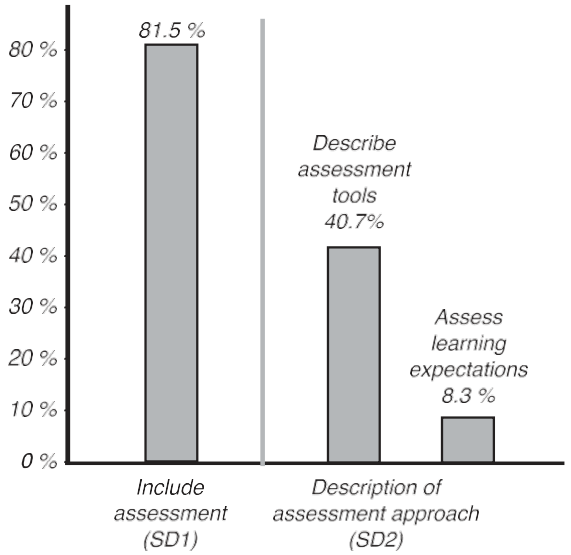

Figure 6. Results in the social dimension.

This lack of a global and interrelated approach to lesson planning might be linked to the teacher education programmes in which these teachers had participated in the past. Some of these programmes present separately and do not link, for instance, subject knowledge, pedagogical knowledge or knowledge of students (Grossman, Hammerness, and McDonald, 2009). Since it has been found that the quality of teachers' lesson planning depends upon their subject content and pedagogical content knowledge (Baumert et al., 2010; Lai & Lam, 2011; Yasemin, 2015) and their beliefs around mathematics and mathematics teaching and learning (Thompson, 1984), many teachers' education programs tend to focus their attention on the development of these types of knowledge in an isolated manner. On the other hand, some studies suggest that the integration of these types of knowledge take place in professional contexts (Abernathy, Forsyth, and Mitchell, 2001, Gafoor and Umer Farooque, 2010) that cannot be achieved in pre-service teacher education. Nevertheless, this study shows that in-service teachers, working in professional contexts, also need help to achieve such integration in order to produce cohesive and coherent lesson plans.

Many variables are involved in teachers' planning practice. Results show that, perhaps as a consequence of their beliefs about teaching and learning, most teachers focus their attention on a few of those variables that they consider dominant. Teacher education programs could take these dominant variables as a starting point for adapting their design and implementation.

Although in some cases teachers' classroom practices differ from what they learned in academic education (Miller et al., 2014) and most continue to learn how to plan lessons throughout their career (Kang, 2017; Mutton et al., 2011), teacher education must address the lesson planning needs and difficulties detected here, which corroborate the results of earlier studies. Tools and procedures for effectively and efficiently evaluating the impact of such needs and difficulties should also be available in teacher education programmes. The tool and procedures proposed here are deemed suitable to meeting that purpose. That is why we claim that the instrument and procedures that we have proposed can be used for evaluating and improving the design and implementation of teachers' education programs. They provide a low-cost, efficient and quick way of establishing the shortcomings and limitations of groups of teachers. With this information, teacher education programmes can adapt their design and implementation to help them overcome those limitations.

The use of a questionnaire can be considered as a limitation of this study. Some authors question the reliability and validity of using questionnaires to investigate teachers' practices. Nevertheless, the literature on teachers' research shows that this issue is not clear-cut. In fact, some researchers consider that this argument bears examination. This is the case of Desimone (2009) who argues that arguments against the use of questionnaires come from early validity studies (i.e. Hook & Rosenshine, 1979; Jorgenson, 1975) which were based on misconceptions about methodology (p. 189). Other studies (i.e. Ross, McDougall, Hogaboam-Gray, & LeSage, 2003), better founded methodologically, have found contrasting results: 'focused teacher self-reports can gather reliable data on instructional practices' (Koziol & Burns, 1986, p. 205). This is the case, in particular, when teachers are asked about their practices on a specific topic for a single lesson (Desimone, 2009, p. 189), as is the case for the questionnaire that we propose.

The questionnaire did not address the second aspect of the definition of the

social dimension (usefulness of the curriculum). Assessing the usefulness of the curriculum would have implied questions related to a topic taught over more than one lesson. As explained in the methodology section, we decided to focus the questionnaire in a specific lesson. Questions for further research, not contemplated in this study, are related to the impact of the planning on students' achievement and learning. In particular, we plan to analyse questions related to how teachers adapt their planning to students' diversity or how students' affective factors are considered in the teachers' planning process.

Notes

1. The text of the questionnaire can be downloaded from http://bit.ly/1RsdvnK.
2. The codes used are listed and described on http://bit.ly/1PHUvMA.
3. A full list of the replies is posted on http://is.gd/Qtskwh.

Funding

This work was supported by the Departamento Administrativo de Ciencia, Tecnología e Innovación [54242], Colombia.

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