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ABSTRACT

The purpose of this study is to describe types and structural properties of instructional activities used by physics and chemistry preservice teachers (N=4) during their teaching of pupils 14 to 16 years old. The study involved the observation and tape recording of 64 classes with all tapes transcribed verbatim. Analysis involved the decomposition of the lesson into segments that have a natural unity of organized action with the objective of finding instructional activities and their structural properties. Activities are categorized by program of action, organizational properties, and structural properties. The dimension of these properties differentiates how the teachers orchestrated the curriculum. Content exposition, laboratory and technical tasks, and problem solving are the activities with the longest duration in these lessons with classroom management being the most frequent instructional activity. Contains 18 references. (Author/DDR)

INSTRUCTIONAL ACTIVITIES IN PHYSICS AND CHEMISTRY CLASSROOM

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The purpose of this study is to describe types and structural proprieties of instructional activities used by four Physics and Chemistry pre-service teachers during their teaching of pupils 14 to 16 years old. The study draws from observations of sixteen classes from each teacher during a school year of practice in school settings. The study involved the observation and tape recording of sixty-four classes of Physics and Chemistry taught by these teachers. All tape-recorded lessons were transcribed verbatim. Analysis was conducted to establish the instructional activities. The first step of analysis involved the decomposition of the lesson into segments that have a natural unity of organized action with the objective to find instructional activities and their structural proprieties. They were classified in thirteen instructional activities depending on their program of action, organizational proprieties and structural proprieties, such as duration and intensity. The dimensions of these proprieties differentiate how the teachers put the curriculum in use. Content exposition, laboratory and technological tasks, and problem solving were the instructional activities with the longest duration in these lessons. Classroom management was the most frequent instructional activity.

INSTRUCTIONAL ACTIVITIES IN PHYSICS AND CHEMISTRY CLASSROOM

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These paper aims at describing the instructional activities used by four Physics and Chemistry pre-service teachers during the teaching of Physics and Chemistry for pupils 14 to 16 years old. This study is part of a broader project that aims at relating science teaching conceptions with science teaching practices. The conceptual framework of the study relates teacher beliefs and knowledge to the curriculum enacted in classroom environment. Acording to the conceptual framework teachers' instructional activities depend on their science teaching conception. More traditional teachers spend more time in content exposition, while teachers with a processual orientation to science teaching do more lab work.

This study bridges two distinct and growing areas of research on teaching: research on teachers' thought processes and actions and their observable effects and research on curriculum in use. Teaching is a practical activity and involves a wide range of instructional actions that relate more or less closely to the essential purpose of helping others understand. Teachers explain, ask questions, respond to students, develop and select tasks and assess what students understand. The instructional action emerges from a bifocal consideration of subject matter and students. It is framed by teachers' own understandings and beliefs about each one and shaped further by their ideas about learning and their role in promoting learning, as well as their understandings and assumptions about the content (McDiarmid, Ball, and Anderson, 1989). Combining these different domains of knowledge is at the heart of teaching. Shulman and his colleagues have labeled the product of this conjugation, pedagogical content knowledge and studied it as a domain of knowledge in its own right (Shulman, 1986, 1987; Wilson, Shulman, & Richert, 1987). According to these scholars, pedagogical content knowledge consists of knowledge of learners, learning, and "the most useful forms of representation of ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations, in a word, the ways of representing and formulating the subject that makes it comprehensible to others" (Shulman, 1986, p. 6). In a recent review of the relationship between teacher thoughts and actions, Clark and Peterson (1986) stated that understanding teachers' thoughts and actions should give us a better understanding of how these two components interact to increase or inhibit students' academic performance. This paper focus on these "forms of representations." Teachers engage constantly in a process of constructing and using instructional representations of subject matter that represent models and means of instruction that we call instructional actions. This may convey something about the subject matter to the learner and has implicitly some educational goals.

In the study of teaching practices, the emphasis is on the practice itself, that is, on larger units that organize and integrate several types of teachers' actions. Recent classroom studies have indicated, however, that choosing the means of instruction also requires consideration of the classroom as a context in which the teacher enacts the curricula (Doyle, 1990, 1992). In these studies, the focus is directly on curriculum events and processes in classroom environments, that is, on the curriculum in motion. This research has called attention to two basic dimensions of classrooms: (1) the social structures in which students carry out work in classroom settings, and (2) the academic tasks that students accomplish with the subject matter. From this perspective, teaching methods or instructional means are classroom activities within which students do academic work (Doyle e Carter, 1987). The task of choosing the means of instruction for this complex setting requires teachers to combine large amounts of information. They create an integrated plan to work with a particular group of students. Teachers organize groups of students for work through their instructional actions (Doyle, 1986). These have two major dimensions. First, an instructional action has organizational proprieties, including (1) a pattern for arranging participants in the room, and (2) props and resources used. Second, has a program for the teacher and the students that guides behavior. The program of action includes (1) roles, responsibilities, and action sequences for carrying out events, and (2) rules of appropriateness that specify the kinds of behaviors allowed or disapproved (Doyle e Carter, 1987, p. 191). To capture the curriculum in use, then, one must describe the instructional activities enacted with respect to that curriculum. From this perspective, I examine issues of content representation, not simply in the explanations teachers provide to the students but also in the instructional activities that teachers enact and the work teachers design for students to accomplish (Doyle, 1990, 1992). Instructional actions involving the same organizational proprieties and program of action define an instructional activity. Instructional activities have structural proprieties, such as (a) duration, the time it takes for the activity to run, and (b) intensity, the number of times, it takes place in the classroom, during the observed lessons.

The paper aims at describing:

- types and proprieties of instructional activities used by four Physics and Chemistry pre-service teachers;
- similarities and differences in instructional activity proprieties among these teachers; and
- changes in their instructional practice during the school year of clinical practice.

METHODOLOGY

The naturalistic research paradigm (Lincoln & Guba, 1985) guided the research methodology. The study reported here is a multiple-case study (Yin, 1988). Data collection, analysis and interpretations have been carried out within an interpretative constructivist approach (Guba & Lincoln, 1994).

Participants

Participants are four Physics and Chemistry pre-service teachers, teaching in different schools: Sérgio, Fernando, Daniel and Rosa, during the school year of clinical practice in school settings. These names are pseudonyms and the teachers are labeled, in this study as T1, T2, T3 and T4. This teacher training program requires that pre-service teachers have two classes during all the school year. In the school they function like the other school teachers. These pre-service teachers had two Physics and Chemistry classes, at grades 8th and 9th, for pupils 14 to 16 years old. They met four and three times a week, respectively with each classroom that has fifty minutes duration. Sérgio, Daniel and Rosa have a Chemistry background while Fernando has at Physics background. For Daniel and Rosa, these were the first experience in teaching.

Sérgio and Fernando are twenty-seven years old, while Daniel and Rosa are twenty-five. Table I summarize this information.

INSERT TABLE I

Data Collection

Data have been collected during the school year of clinical practice. As the teachers' university educational supervisor, I regularly visited their physics and chemistry classes over the course of the school year, from October to May. During this time, I observed, took field notes and audio-taped 64 lessons, 16 from each teacher, using procedures described by Bodgan & Bliklen (1982). All tape-recorded was transcribed by the investigator. Table II summarizes the distribution of the observed lessons by teacher, school level and science teaching.

INSERT TABLE II

Data Analysis

Consistent with a naturalistic research paradigm, data analysis was inductive and ongoing, taking place through asking questions and constant comparison (Strauss and Corbin, 1990). Patterns were sought in the data they were collected and then used to further refine data collection and analysis "so that every new act of investigation takes into account everything that has been learned so far" (Lincoln and Guba, 1985, p. 209). The analysis of the tape-recorded lessons involved reading the verbatim transcripts to develop a system of categories. The analysis first step was to decompose the lessons into their segments, that has a natural unity of organized action and to develop a system of categories. The rules of segmenting brought forth the different types of change, for example in patterns for arranging students, props and recourses and roles and responsibilities for carrying out immediate actions (Doyle, 1986). With this in mind, I constructed a list of instructional actions. Each action is targeted to specific curricular goals (Carter & Doyle, 1989) and represents a way of describing temporally delimited periods (Carlsen, 1991) of Physics and Chemistry lessons characterized by specific subject matters, sets of expectations about teacher' and students' behavior. I used the proprieties recommended by Doyle and Carter (1987). I put together all instructional actions that have similar organizational proprieties and programs of action. Each group of instructional actions is called an instructional activity. Table III summarizes instructional activities by abbreviation and organizational proprieties and program of action. I describe these instructional activities' characteristics later on.

INSERT TABLE III

Carlsen (1991, 1993) defined ActTypes as a class of activities and coded twenty nine ActTypes. In this study I classified instructional actions into thirteen instructional activities. While Carlsen (1991) classified "instructions for an activity" and "laboratory instructions" as ActTypes, I included those instructional activities as classroom management. Below, I describe the characteristics of each instructional activity and use this categorical framework to analyze the lessons. Table IV describes the characteristics of the instructional activities.

INSERT TABLE IV

I used this category framework to write each lesson narrative. The pre-service teachers checked these narratives and validated my research coding. When discrepancies were found between initial coding and other data sources, the coding rules were modified accordingly. During the narrative writing, I found that the teachers structured their lessons in different ways. Sometimes, they used the instructional activity in the lesson, and sometimes they didn´t. Time taken by the instructional activities was variable from teacher to teacher and from lesson to lesson. I considered two dimensional proprieties of each instructional activity: duration, and intensity.

Duration (D) represents the time, expressed in minutes, occupied, by the instructional activity, during the lesson. For one lesson, instructional activity duration varied among zero and fifty minutes. Zero means that the instructional activity didn't occur in this lesson and fifty minutes means that it occupied all the lesson time.

Intensity (I) represents the number of times that the instructional activity was observed in sixteen lessons. Intensity varies between zero and one for one lesson, and among zero and sixteen for the observed lessons. Structural proprieties of instructional activities, like duration and intensity differentiate the enactment of curriculum performed by these pre-service teachers.

RESULTS

Findings were organized along three questions:

- What are the types, duration and intensity of instructional activities used during sixteen lessons of each teacher, over the course of the school year, from October to May?
- What similarities and differences were observed?
- What similarities and differences were observed in the first and second part of the school year, for each teacher? Does these difference mean different science teaching conceptions?

Table V summarizes the information concerning instructional activity types and proprieties used in the observed lessons.

INSERT TABLE V

Each teacher spent different time with the students in these sixteen lessons. Daniel occupied 93% of the total time preview for the observed lessons, while Fernando occupied 88%. Daniel used 65 instructional activities in these sixteen lessons, while Sérgio used only 51, on average, three instructional activities per lesson. Daniel used, on average, four instructional activities per lesson. Fernando, with undergraduate studies in Physics, taught more Chemistry lessons. Daniel, with undergraduate studies in Chemistry, taught more Physics lessons.

Table VI summarizes, for each teacher, instructional activities' proprieties, duration and intensity, that they had used during the observed lessons.

INSERT TABLE VI

The analyses of data summarize in table VI shows the following: Classroom Management (13-A), reached the greatest value for intensity (I=64), but not for duration (D=293 min.), and occupied only 9% from the total time preview. This means that classroom management occurred in all observed lessons, with a duration, on average, of 4.6 minutes per lesson, while films (5-F) occurred just one time, in these same lessons. Laboratory and technological task (7-LTT) occupied 23% of the total time preview and occurred in 34% of these lessons. Problem solving (8-PS) occurred in twenty-six observed lessons, what represents 41% of total time, for these lessons. It corresponds to 16% of total time preview. It means on average of twenty minutes per lesson, while laboratory and technological task had an average of thirty-three minutes, by lesson. Content exposition (1-CE) had sixteen minute's duration, on average, per lesson. It occurred in 67% of these observed lessons. Laboratory and technological task occupied more time in the observed lessons but occurred less. Figure 1 summarizes the differences among instructional activity's duration and intensity, for the total of lessons.

INSERT FIGURE 1

Structural proprieties of instructional activities, like duration and intensity of use, differentiate the enactment of curriculum performed by these pre-service teachers.

Sérgio occupied 36% of total time preview, with laboratory and technological task (7-LTT). This instructional activity had a duration, on average, of 41 minutes per lesson. It occurred in 44% of observed lessons. Content exposition (1-CE) had a duration, on average, of 19 minutes per lesson, and it occupied 22% from total time preview. It occurred in 56% of total observed lessons for this teacher. Problem solving (8-PS) occurred in four observed classes, with 22 minutes average per lesson. It occupied 11% from total time preview for these lessons. There are two instructional activities, films (5-F) and student presentation (10-ST) that hadn't observed in these lessons.

Fernando occupied 24% of total time preview with content exposition (1-CE) and it had happened in 75% of observed lessons. It had, on average, a duration 16 minutes per lesson. Problem solving (8-PS) and task correction (11-TC) occupied, respectively, 13% and 12% of total time preview. It happened in 38% and 44% of total lessons observed. However, the duration, on average, per lesson is, respectively, 17 minutes and 14 minutes. These mean that he used this instructional activity in conjugation with others instructional activities. Questioning and debates (2-QD) occurred in 50% of observed lessons but it occupied only 6% of total time preview. It took, on average, 6 minutes per lesson. The instructional activity, laboratory and technological task (7-LTT) occurred in two observed lessons only with duration, on average, 26 minutes per lesson. Simulation (9-S) was the only instructional activity that Fernando didn't use during the observed lessons.

Daniel occupied more time with problem solving (8-PS), 27% of total time preview for the observed lessons. It happened in 63% of total observed lessons. Content exposition (1-CE) took the same value, but occupied 14 % of total time preview and it had a duration, on average, of 11 minutes per lesson, while problem solving had 21 minutes per lesson. Laboratory and technological task (7-LTT) occupied 22% of total time preview and it happened in 44% of observed lessons. It had a duration, on average, of 25 minutes per lesson. Films (5-F) was the only instructional activity that Daniel didn't use during the observed lessons.

Rosa occupied more time with laboratory and technological task (7-LTT), 28% of total time preview, than with content exposition (1-CE), 26% of total time preview and with problem solving (8-PS), 14% of total time preview. However, content exposition (1-CE) took place in 75% of total observed lessons. Content exposition had, on average, a duration of 17 minutes per lesson and laboratory and technological task (7-LTT) had a duration, on average, of 37 minutes per lesson. Problem solving (8-PS) took place in 38%

of total observed lessons, like task correction (11-TC), but had a duration, on average, of 18 minutes per lesson while task correction had a duration, on average, of 10 minutes per lesson. Figure 2-3 summarizes this information.

INSERT FIGURE 2

INSERT FIGURE 3

These teachers used the instructional activities, content exposition (1-CE), laboratory and technological task (7-LTT) and problem solving (8-PS) in a different way, during the observed lessons. There is a contrast between Sérgio (teacher T1) and Fernando (teacher, T2) concerning these instructional activities. Sérgio used more laboratory and technological task (LTT) than Fernando. Nevertheless, Daniel (teacher, T3) spent more time doing problem solving with algorithm application than the others' teachers. Rosa (teacher T4) spent a similar time with content exposition (CE) and laboratory and technological task (LTT). Figure 4 explores those differences.

INSERT FIGURE 4

There wasn't a uniformity over the course of school year in the way that these teachers performed the instructional activities.

In the first part of the school year (from October to January) some teachers are doing more lab work and technological task (7-LTT) than others. In the second part of the school year (from February to May) some teachers are doing more content exposition (1- CE) than others. However, all teachers are doing more problem solving (8-PS) in the second part of the school year. Figure 5-6 summarizes this information.

INSERT FIGURE 5

INSERT FIGURE 6

Figure 5-6 shows that Sérgio (teacher T1), Daniel (teacher, T3) and Rosa (teacher T4) had very similar changes in laboratory and technological task (LTT) and problem solving (PS). For these teachers and these two instructional activities, there was a decrease in duration and intensity. However, Fernando decreases, in intensity, for problem solving but increased in duration. In this regard, problem solving occupied more time per lesson in the second part of the school year than in the first part. On the other hand, the instructional activity laboratory and technological task (LTT) occupied more time but occurred in the same number of lessons.

Fernando spent less time and fewer classes with content exposition in the second part of the school year. This result is Daniel and Rosa' opposite because content expositions (CE) increase in duration and intensity. For Sérgio content exposition (CE) falls in duration but increased in intensity. However, large differences were found. For example, during problem solving (PS) Sérgio used STS problems and the students could find out many solutions. Daniel and Rosa used exercises. The students had to apply an algorithm to find out a right solution. During laboratory and technological task (LTT) Sérgio' students were doing scientific inquiry while Daniel and Rosa' students used a protocol experience, step by step. For Fernando there were differences in laboratory and technological task' content. In the first lessons the students used a protocol experience, with the procedures' steps. However, in the second lesson, in the second part of the school year, the students were doing scientific inquiry.

DISCUSSION

The analysis of the data of each observed lesson provides a curriculum-level description of the context of instruction. The contrasts suggested, about curriculum in use, in this paper do not demonstrate that some teachers deliver better instruction than others. Nevertheless, the study suggests, that as teachers gain experience in classroom, their strategies for managing instruction change. Does this change correspond to different science teaching conception? The quantitative data presented here are a small part of the interpretative study I'm carrying out as part of a larger research program and with these data I cannot answer the question. However, I interview these pre-service teachers in two moments of school year, in the beginning and the end, to identify their science teaching conceptions. For this, I used a interview about events, from a previous study, (Freire & Sanches, 1992) that appear to confirm these conclusions. The results point us that Sérgio is more processual than other teachers. It is his curricular goal to promote scientific inquiry and problem solving in STS. There are some discrepancies with Fernando'instructional activities. In the first part of school year, he shows a more traditional approach to teaching science in that he is always the dominant speaker. In the second half of the school year the students had more opportunities to speak during the lessons. Does this mean a change in science teaching conception? For Daniel and Rosa, content exposition and exercises were dominant in the second part of school year. Were they becoming more traditional? Were these differences influenced by the teaching context or by the mentor teacher? More time with content exposition means more knowledgeable teachers, as Carlsen (1991) predicted? This study provides us several conclusions. First, the decisions that teachers make about instructional activities to put in use affect the opportunities that students have to communicate in physics and chemistry classroom and to learn science. Schools as institutions may mediate the way's pre-service teachers learn to teach and professional knowledge related differences. Second, the extents to which schools make special materials available affects how often laboratory experience is scheduled and films are shown. The teaching context affects the curriculum in use. Third, in the process of learning to teach, contrasts and similarities in how teachers put the curriculum in use may depend on the teacher training program. Changes in science teaching conceptions may be only small differences in some aspects of their components that are influenced by the program. This is an issue to be further investigated.

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TABLE I

DEMOGRAPHIC INFORMTION ABOUT PRE-SERVICE TEACHERS

PRE-SERVICE TEACHERS	TEACHING EXPERIENCE	BACKGROUND	YEARS OLD
T1 - Sérgio	Yes. Physics and Chemistry Teaching	Chemistry	27
T2 - Fernando	Yes. Physics and Chemistry Teaching	Physics	27
T3 - Daniel	No	Chemistry	25
T4 - Rosa	No	Chemistry	25

TABLE II

DISTRIBUTION IN NUMBER OF OBSERVED LESSONS BY TEACHER, GRADE LEVEL AND SCIENCE TEACHING

PRE-SERVICE TEACHER	GRADE LEVEL 8TH	GRADE LEVEL 9 TH	PHYSICS	CHEMISTRY
T1 - Sérgio	9	7	10	6
T2 - Fernando	8	8	9	7
T3 - Daniel	8	8	13	3
T4 - Rosa	8	8	11	5
TOTAL	33	31	43	21

TABLE III

INSTRUCTIONAL ACTIVITIES RELATED TO ORGANIZATIONAL PROPRIETIES AND PROGRAM OF ACTION

INSTRUCTIONAL ACTIVITY (IA)	ORGANIZATIONAL PROPRIETIES		PROGRAM OF ACTION		CURRICULAR GOALS
	PATTERNS FOR ARRANGING PUPILS	PROPS AND RECOURSES	PRIMARY SPEAKER	ACADEMIC TASK	
1- Content Exposition (CE)	Whole Class	Blackboard. Text book Overhead Projector	Teacher	Listen and hear to teacher. Answer and ask questions.	To deliver the curricular scientific content
2- Questions and Debates (QD)	Whole Class	-	Teacher, students	Listen and hear to teacher. Answer and ask questions, express their ideas	To recall factual of information and memorised material. To offer explanations.
3- Lecture (L)	Whole Class. Group. Individual	Text	Teacher. Students	Read from a text while others listen to and hear.	To interpret the text. To write questions about it
4- Experimental Demonstration (ED)	Whole Class	Experimental material		Listen, hear and watch to teacher	To deliver the curricular scientific content
5- Film (F)	Whole Class	Films, videotape	Recording	Listen, hear and watch to films	To introduce a scientific topic
6 - Home Work (HW)	Whole Class	Text book, Exercise book	Teachers, students	Listen and hear to teacher. Answer and ask questions.	To promote independent learning
7 - Laboratory and Technological Tasks (LTT)	Group	Experimental material	Students, teacher	Exercises to develop practical skills. Students design and experiment to find something out or make some artifacts	To promote understanding of scientific concepts To promote scientific inquiry
8- Problem Solving (PS)	Group	Problems from text book and time-sheet	Students, teacher	Exercises to apply scientific content knowledge. Solve problems	To solve exercises. To solve STS problems
9- Simulation (S)	Group, Individual	Students can use a script. Computer programs	Students, teacher	Role play where students take on roles of individuals in specified situations.	To use computer programs.
10- Student Presentation (SP)	Whole Class	Students recourses	Students, teacher	One student present information to the whole class.	To present information to classmates
11-Task Correction (TC)	Whole Class	Text book, time-sheet	Teacher, students	Listen, hear, and answer to teacher	To give the answer to a printed question
12-Student Assessment (SA)	Whole Class		Teacher, students	Teacher assess students work resulting in the award of a mark or grade	To assess students work
13-Classroom Management (CM)	Whole Class	-	Teacher, students	Listen, hear, answer and ask to teacher	To make announcements about the work

TABLE IV

INSTRUCTIONAL ACTIVITIES CHARACTERISTICS

1 - ***Content Exposition (CE).*** The teacher usually stands before the class, addressing the students. Throughout, the teacher communicates not just by word, but by eye contact and facial expression. The teacher holds attention by skilled delivery and adept use of models, experimental material, charts, blackboard, overhead projector and questioning.
2 - ***Questions and Debates (QD).*** The teacher addresses questions to the whole class and the student signals their readiness to respond. The questions can be closed or open. Closed questions are useful as a quick mean of oral testing and can convey a message that science deals primarily with topics that have right answers. Open questions present students with opportunities to offer explanations, project ideas and express their own opinions and there hasn't a single right answer. During debates, students have the opportunity to express their findings and ideas to their teacher and other students.
3 - ***Lecture (L).*** The students read aloud or silently from a text, to interpret the word meanings, to write questions about it or to write a composition or to answer questions. To promote resource-based learning.
4 - ***Experimental Demonstration (ED).*** At the start of the lesson the teacher has carefully positioned the class so that every student has a clear view of the bench on which is a piece of apparatus unfamiliar to the students. Usually the teachers perform the experiment, explaining the content. Sometimes, the teacher asks questions and one or two students help the teacher to perform the experience.
5 - ***Film (F).*** Science teachers use videotape or movies as valuable teaching resource. During the exhibition, the students listen to the recording giving information and watch to TV. When the program ends the teacher ask questions to elicit from the students those aspects of the movie or videotape that have made a strong impression. A film may be chosen to introduce a topic or alternatively used for consolidation or revision.
6 - ***Home Work (HW).*** The teacher can ask the students to make some tasks at home. This can include to make an exercise, problem or artifact, to answer questions, to read the text book. The teachers take account of the individuality of children and more responsible for their own learning.

TABLE IV

INSTRUCTIONAL ACTIVITIES CHARACTERISTICS (CONT)

*7 - **Laboratory and Technological Task (LTT).*** In this instructional activity are included all actions that involve equipment, tools and measuring instruments with the students performing experiments, that can be make at laboratory or in a classroom. Group is the pattern for arranging students. Some experiences are exercises to develop practical skills and techniques and others are experiences designed to enhance students' understanding of scientific concepts, through observation and illustration. They are often accompanied by step-by-step instructions. In the other hand, scientific inquiry that typically requires students to design and experiments to find something out. This instructional activity included instructional actions that require students to design and make some artifact. Such work is usually open-ended so that students have to make decisions for themselves and learn that there may be several equally valid ways of proceeding.
*8 - **Problem Solving (PS).*** This instructional activity included all instructional actions that require the use of paper and pencil to achieve an outcome. Group is, usually, the pattern for arranging students. The teacher moves around the students' table while they are drilling, assisting and looking at students written work. The teacher's inspection of what is being written is not to award a mark but to offer oral comment. This instructional activity included two opposite kinds of problems. In one side, the students apply an algorithm to find out an outcome. In the other side, the students are confronted with an unsolved situation that cannot be answered immediately and having one or several possible solutions. They are various contexts for problem solving. There is a spectrum of problem types from symbolic, abstract problems to real concrete practical ones, and from everyday, personal and social context to science and technology.
*9 - **Simulations (S).*** Simulations in the broadest sense can be thought of as instructional actions which "mimic" real situations. These actions can take many different forms, like role-play, simulation games and computer simulations. Role-play, where participants take on the roles of individuals in specified situations. The roles can be improvised or students can use a script; role play focuses attention on the interaction of people with one another. Simulation games included simulations that involved elements of competition and games based on real-life situations. Computer simulations, which permitted modeling of real life situations on "micro" scale and reproduce experiments/processes that cannot be undertaken in the school laboratory. The arrival of the wide use of microcomputers in schools in the past decade has crated opportunities to use simulations in new contexts in science. The computer simulation involved interaction between and individual, or small group, and the computer program.

TABLE IV

INSTRUCTIONAL ACTIVITIES CHARACTERISTICS (CONT)

*10 - **Student Presention (SP).*** The student stands before the class, addressing the others' classmates and making public, through communication, their ideas and work.They are reporting on their investigation, scientific inquiry or resource.based inquiry. The young reporters had written a report, but the requirement to give an oral account to their contemporaries sharpened their focus. They were alive to the need to be accurate in describing what they had done, to state what kind of results had been recorded and to ensure that their conclusion was reliable. Teachers participate providing information that thinks is necessary.
*11 - **Task Correction (TC).*** This instructional activity included instructional actions that require to the teacher give some comments about the work that the students made. The teacher comments the students' tasks, sometimes orally and another time writing on the blackboard. The teacher commands the whole class at the same time.
*12 - **Students Assessment (SA).*** This instructional activity included instructional actions where the teachers recognize students' achievements when measured against attainment targets. Assessment that helps teachers and learners is generally known as formative assessment. Its outcomes are used diagnostically. The areas of achievement and weakness of students are determined, so that decisions can be made about the next stages of learning and remedial action can be taken where necessary. Assessment that is used to inform others through some form of reporting may be formative or summative. A summative assessment is made at the end of a learning unit. It provides information on the level of achievement reached by learners. The teacher can assess scientific skills and knowledge.
*13 - **Classroom Management (CM).*** This instructional activity included instructional actions like to dictate the lesson summary, to make a students' call, to give some advice's and to set the rules of appropriateness that specify the kinds of behaviors that are allowed or disapproved. Each lesson started with a clear outline of what the teacher expected to be achieved in the time available.

TABLE V

INSTRUCTIONAL ACTIVITIES USED BY PRE-SERVICE TEACHERS DURING THE OBSERVED LESSONS

LESSONS	T1 D (min)	SERG IO IA	Level SC	T2 D (min)	FERNA NDO IA	Level SC	T3 D (min)	DANI EL IA	Level SC	T4 D (min)	ROSA IA	Level SC
1	46	1,2,13	9F	47	1,2,13	9F	46	1,2,3,4,6,8, 11,13	9F	40	11,12,13	8Q
2	46	1,2,7,13	8Q	45	1,2,4,13	8Q	46	7,13	8Q	45	1,6,8,13	9F
3	47	6,7,13	9F	46	1,8,11,13	9F	46	1,7,11,13	9F	47	7,13	8Q
4	47	7,13	8Q	43	1,2,4,7,13	8Q	47	1,4,6,7,8,13	8Q	46	7,13	9F
5	46	12,13	9F	45	1,4,8,11,13	9F	46	1,6,8,13	9F	44	1,6,13	9F
6	47	1,2,3,9,11 13	8Q	47	1,2,8,11,13	8Q	46	8,9,13	8F	45	1,7,13	8Q
7	47	1,3,9,11,1 3	8Q	41	5,6,13	9F	46	2,6,10,12,13	9F	44	1,2,6,8,13	9F
8	47	7,13	8Q	46	1,8,11,13	8Q	47	1,6,7,13	8F	46	1,7,13	8Q
9	46	1,8,13	8Q	42	1,2,3,11,12, 13	9F	45	7,13	8F	44	1,7, 13	9F
10	48	7,13	9F	41	1,11,12,13	8Q	46	1,3,4,8,13	9F	47	7,13	8F
11	47	1,8,13	9F	44	8,13	8F	47	1,7, 13	9F	46	1,2,8,11,13	8F
12	47	6,7,13	8F	45	7,13	9F	46	8,13	8F	45	1,2,8,11,13	9F
13	39	1,9,13	9F	39	2,3,13	8F	48	1,2,4,7,8,11, 13	9F	45	1,8,11,13	8F
14	45	7,13	8F	42	1,2,8,13	9Q	47	8,13	8Q	46	1,2,13	9F
15	45	1,4,8,13	8F	42	1,2,3,6,11,13	8F	46	1,2,8,13	9F	45	1,8,11,13	9Q
16	45	1,8,11,13	9F	46	1,10,13	9Q	46	1,2,8,13	8F	41	1,6,11,13	8F
T	735	51	16	701	63	16	741	65	16	716	55	16

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TABLE VI

INSTRUCTIONAL ACTIVITIES USED BY PRE- SERVICE TEACHERS AND THEIR PROPRIETIES, DURATION AND INTENSITY

INS. ACT.	DT (MIN) ALL LES	INT T (O) ALL LES	T1 SÉRGIO D (MIN)	T1 SÉRGIO INT (O)	T2 FERNANDO D (MIN)	T2 FERNANDO INT (O)	T3 DANIEL D (MIN)	T3 DANIEL INT (O)	T4 ROSA D (MIN)	T4 ROSA INT (O)
1 - CE	681	43	175	9	190	12	112	10	204	12
2 - QD	94	20	5	3	45	8	26	5	18	4
3 - L	48	7	3	2	42	3	3	2	0	0
4 - ED	95	8	16	1	37	3	42	4	0	0
5 -F	30	1	0	0	30	1	0	0	0	0
6 - HW	55	13	2	2	2	2	23	5	28	4
7 - LTT	734	22	285	7	51	2	176	7	222	6
8 - PS	513	26	87	4	103	6	213	10	110	6
9 - S	70	4	43	3	0	0	27	1	0	0
10 - SP	30	2	0	0	14	1	16	1	0	0
11 - TC	187	19	23	3	95	7	7	3	62	6
12 - SA	63	5	41	1	16	2	2	1	4	1
13 - CM	293	64	55	16	76	16	94	16	68	16
TOTAL	2893	234	735	51	701	63	741	65	716	55

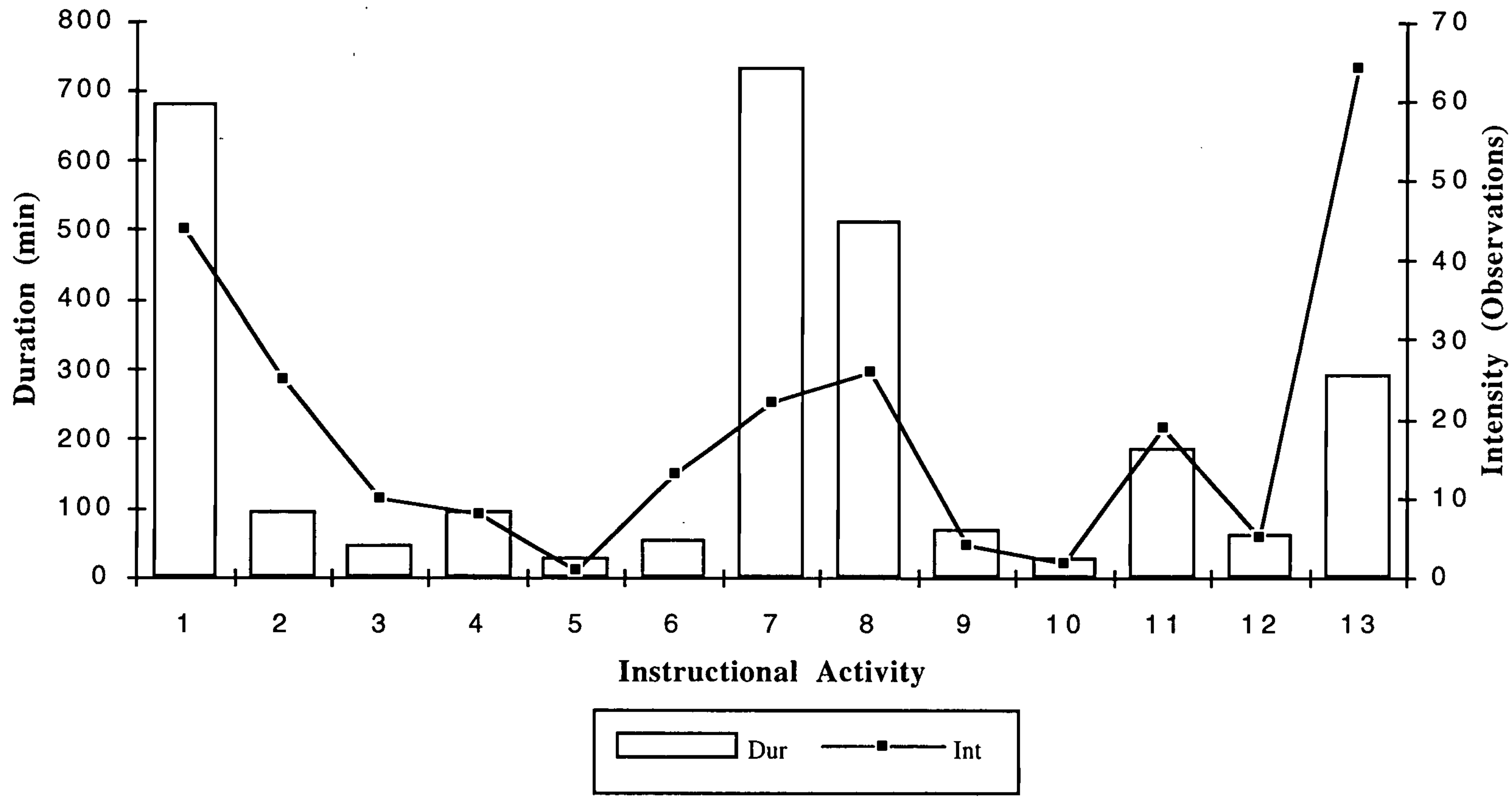

Figure 1. Distribution of instructional activity by duration and intensity to all lessons

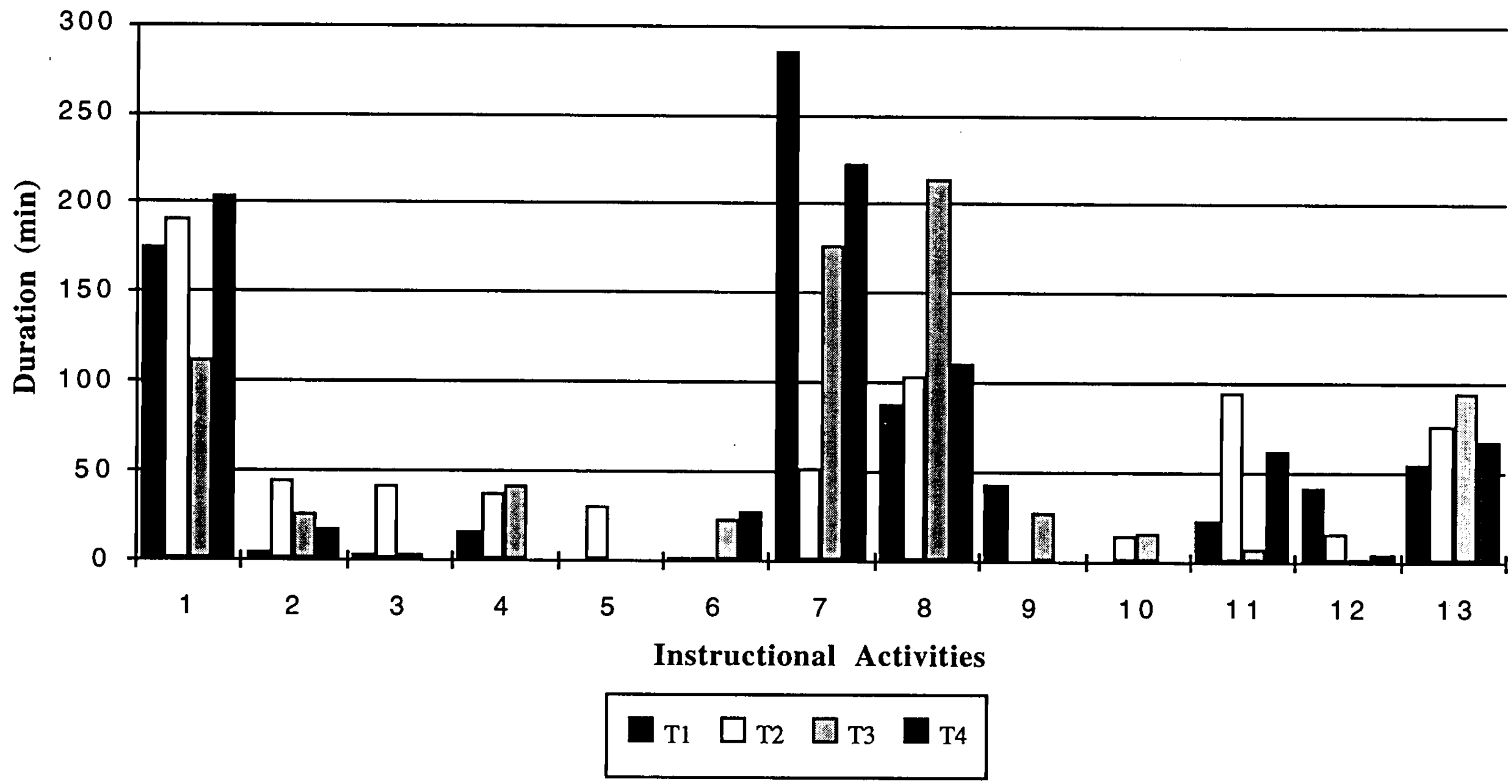

Figure 2. Instructional activities' duration by pre-service teacher

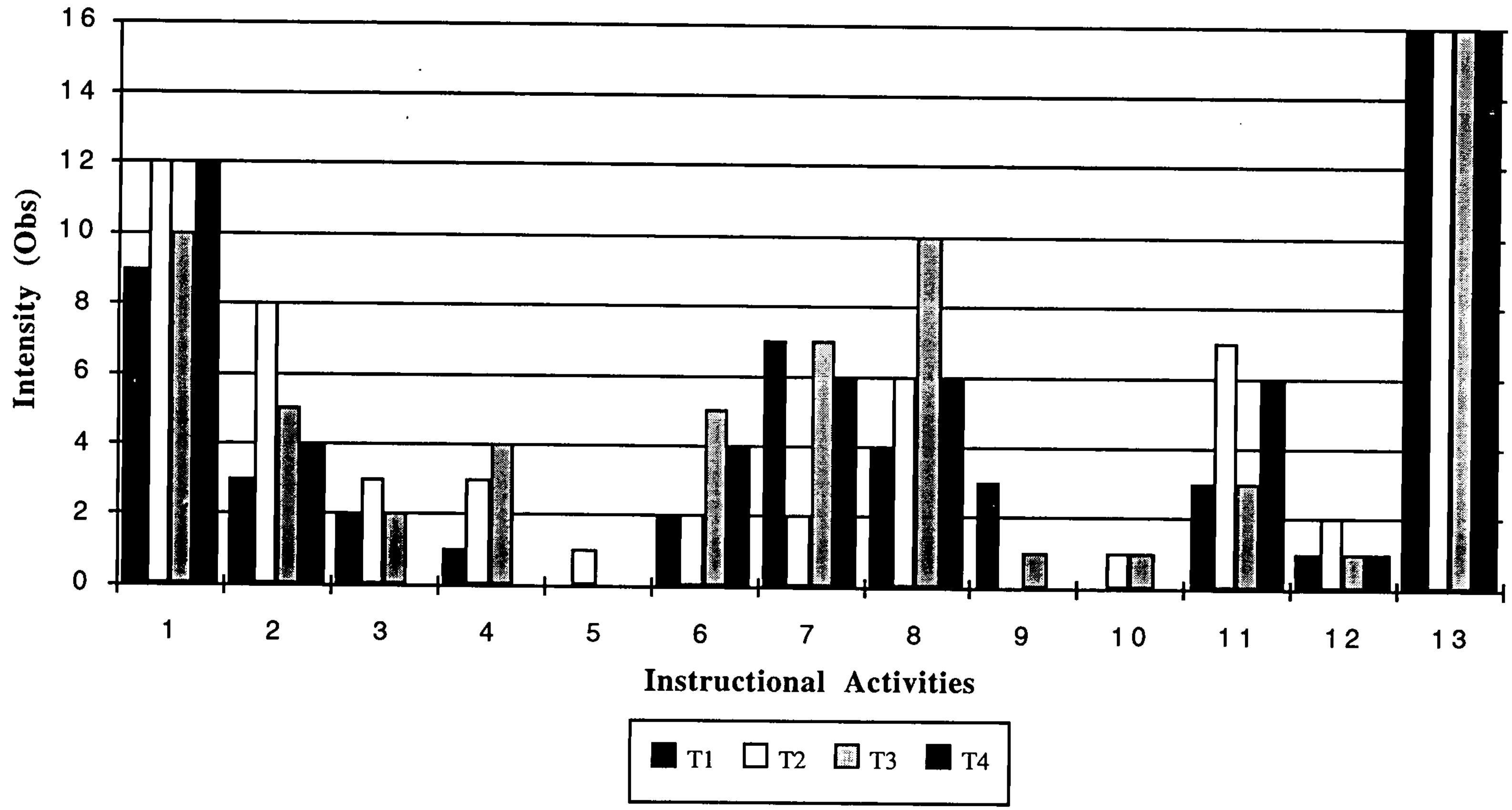

Figure 3. Instructional activities' intensity by pre-service teacher

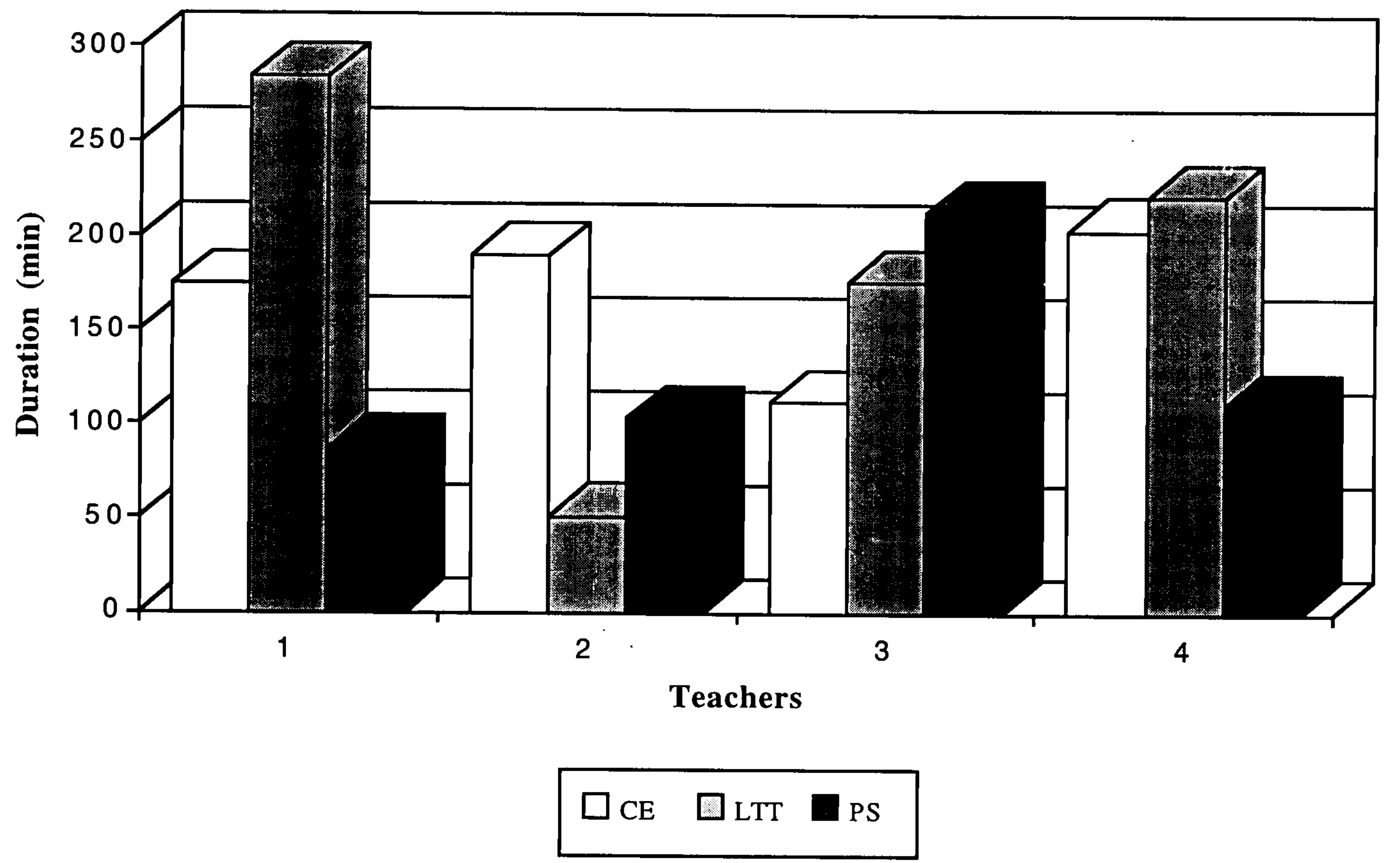

Figure 4. Instructional activities, content exposition (CE), laboratorial and technological task (LTT) and problem solving (PS) duration for each teacher

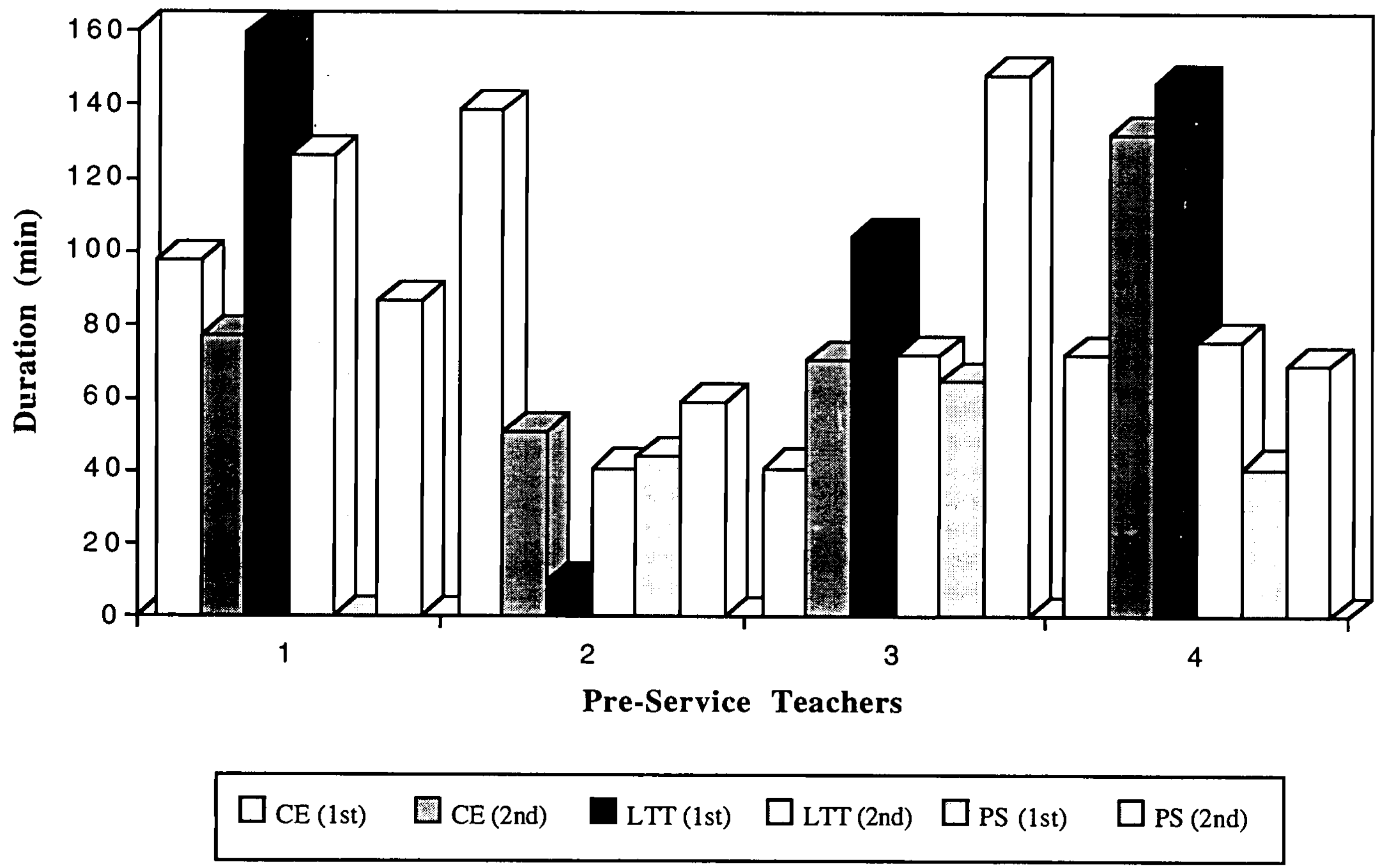

Figure 5. Teachers' comparison about instructional activity' duration in two different parts of the school year

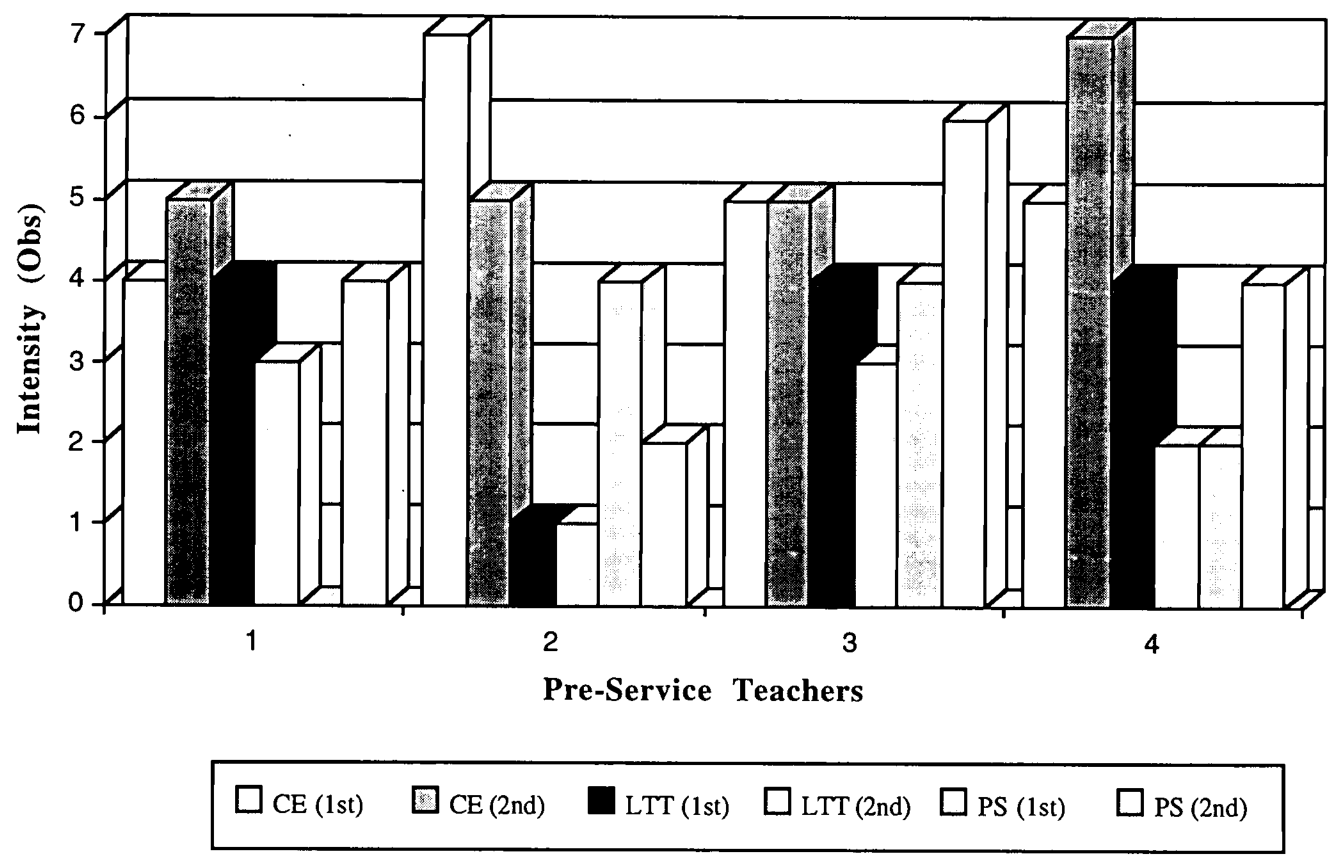

Figure 6. Teachers' comparison about instructional activity' intensity in two different parts of the school year

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