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ABSTRACT

One of the new measures developed as part of the Apple Classrooms of Tomorrow (ACOT) program is described. The ACOT project examines the impact of access to educational technology on the kindergarten through grade 12 classroom environments. The new measure is a technology-based classroom observation instrument for documenting the impact of technology on classroom instruction. The instrument uses a time-sampling procedure and is organized for recording in timed intervals using a machine-scannable form. Observers code a few key indexing variables for the activity period observed as follows: (1) subject area; (2) number of students assigned; (3) classroom observation; (4) adult roles (directing instruction, facilitating instruction, management and discipline, and not present); (5) symbol systems serving key instructional functions; (6) symbol systems that students use; (7) length of responses expected of students; (8) level of processing expected of students; (9) resources in use; and (10) students' responses to the activities. The instrument is currently used in documentation of high technology access classrooms (a database with 12 total hours observed in language arts and 6.1 hours in mathematics) and in documentation of changes in instructional practices associated with technology use over time (observations at elementary school and secondary school sites). The instrument's usefulness will ultimately depend on coordination with other data gathering techniques. Two tables present study findings, and 32 bar graphs provide examples of the "snapshot" graphical displays generated by the instrument. A 35-item list of references is included. (SLD)

A New Mirror for the Classroom: A Technology-Based Tool for Documenting the Impact of Technology on Instruction

CSE Technical Report 336

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A New Mirror for the Classroom: A Technology-Based Tool for Documenting the Impact of Technology on Instruction[1,2]

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Project Background

Since 1987, UCLA's Center for Technology Assessment has been conducting a set of evaluation, research, and development activities at selected Apple Classrooms of Tomorrow^{sm} (ACOT^{sm}) sites, with the goal of documenting the impact of technology access on K-12 environments (Baker, 1988; Baker & Herman, 1988, 1989; Baker, Herman, & Gearhart, 1988; Baker, Gearhart, & Herman, 1990, 1991; Baker & Niemi, 1990, 1991;

1 This paper is based on presentations for the June, 1990 Open House, Apple Classrooms of Tomorrow, Cupertino, CA and the September, 1990 Technology Assessment Conference, UCLA. It will appear in Baker, E. L. & O'Neill, H. (1991), Technology assessment. The work has been supported with funding from the Advanced Development Group, Apple Computer, Inc. The views expressed here, however, are solely those of the authors.

2 Our thanks to the teachers who have permitted us to observe in their classrooms. Thanks as well to our associates who have provided helpful feedback during the research: Laurie Desai, Sharon Dorsey, David Dwyer, Margaret Rogers, Robert Tierney, and Keith Yocam.

Gearhart, Herman, Baker, Novak, & Whittaker, 1990; Gearhart, Herman, & Whittaker, 1991; Gearhart, Herman, Whittaker, & Novak, 1991; Herman, 1988). When Eva Baker and Joan Herman initiated the work with ACOT in 1987, the project had been implemented in selected classrooms at five sites that were dispersed nationally and varied considerably in student characteristics and school context factors. Students and teachers in all classrooms were provided with high access to individual computer support both at home and at school, and ACOT's goal was to document how instructional innovations emerge in high access environments. Since 1987, the ACOT project has evolved to encompass more sites and has assumed a more directive role in the kinds of teacher support provided. It has shifted from a 'bottom-up' exploration of the impact of technology access to a research and development laboratory for the construction of new technology tools for instruction and new tools for the assessment of instruction and instructional impact.

The work of the UCLA Center for Technology Assessment has evolved as well. From the outset, the Center's goal for its work with ACOT has been to develop a model of technology assessment in K-12 environments by exploring the utility and applicability of existing measures and by developing new measures as needed. The shift in our work has been one of emphasis—as a result of continued confrontations with the limitations of existing measures, the development of new assessment tools has become our primary focus.

This paper is a description of one of our new measures, a technology-based classroom observation instrument for documenting the impact of technology on classroom instruction. In the report that follows, we explain the need for a new observation tool sensitive to technology impact, and then illustrate the utility of the tool with samples of two of our current approaches to data analysis.

A Technology-Based Classroom Observation Tool

Our ongoing evaluation of the ACOT project required a method for documenting instructional impact and for providing "process" explanations for student and teacher outcomes. The instrument we had in mind would provide fairly comprehensive "snapshots" of classroom activities that would reveal variations in instructional practices related to uses of diverse resources. Based on data produced from informal observations we needed a tool that could: document subject-specific instructional patterns, determine whether technology limits certain kinds of classroom organizations and supports others, describe how teachers' roles may shift when technology is in use, document how the nature of students' work differs when technology resources are in use (e.g., its challenge, length, the media used), and determine whether technology use has an impact on students' responses to instruction (e.g., their engagement with peers, or investment in their work). No existing observation instrument was available to provide us with data appropriate to our needs.

The Limits of Available Observation Instruments for Our Purposes

Available observation instruments most commonly focus on the teacher's instructional and support roles during teacher-student interactions (see reviews by Cazden, 1986; Dunkin & Biddle, 1974; Evertson & Green, 1986). Some interaction schemes are motivated by process-product analyses of common functions of classroom talk that are believed to influence student outcomes (e.g., Flanders, 1970; Good & Brophy, 1983). These schemes vary in their explication of a model of the cognitive functions of interaction in supporting students' learning and reflection. Other schemes are derived from linguistic or sociolinguistic analyses of discourse (e.g., Green & Wallat, 1981; Sinclair & Coulthard, 1975) and are used in investigations of a range of research questions, including the cultural context of teaching and learning, the functions of language in intellectual activities (e.g, Cazden, John, & Hymes, 1972), and the communicative requirements of classroom participation (e.g., Mehan, 1979). Observation methods derived from both traditions included a considerable range of procedures: on-the-spot coding procedures using either time sampling or event sampling techniques, post-observation coding of video- or audiotape, and ethnographic examinations of selected case excerpts.

While we viewed description of classroom interaction as important to our scheme, it was clear that we needed an instrument which could provide a more comprehensive look at classroom activities. The instruments that were closest in rationale, design, and content were those developed by Stallings (Stallings, 1975; Stallings & Giesen; 1974; Stallings & Kaskowitz, 1974), later adapted by Sirotnik (Giesen & Sirotnik, 1979; Sirotnik, 1979), and used for two highly regarded large-scale evaluations of school programs: A Study of Schooling (Goodlad, Sirotnik, & Overman, 1979) and Follow Through (Stallings, 1975; Stallings & Kaskowitz, 1974). The schemes included the physical environment inventory (PEI), daily summary (DS), classroom snapshot (CS), and five minute interaction (FMI). The schemes varied in method—once per classroom for the PEI and DS vs. time and sampling for the CS and FMI (at four times during the day, all pertinent activities [CS] or events [FMI] are coded). Data were collected for each scheme at different times of the day. The CS captured relations among *activities* (subject area as well as instructional activity, such as demonstration, discussion, work on written assignments), *directors* (teacher, aide, student, group, class, independent), and *group size*. The FMI entailed event recording of classroom interactions: persons involved (Who, Whom), interactions (What—Adult: e.g., direct questions, response, imperative, encouragement, monitor/observe; Student: e.g., directive, response, refusal, question), context (e.g., instruction, behavior, routines), and means (How—e.g., touching, with humor, with materials, negative affect).

These instruments were helpful guides to our own design efforts. We particularly appreciated the potential flexibility of a scheme containing multiple dimensions that can be cross-classified to produce a broad range of analyses. However, the restriction on concurrent use of the four schemes would limit our ability to describe as richly as possible any given classroom activity. We wanted to know what was happening at a *given* time to permit us to examine relations among co-occurring aspects of classroom activities, with particular focus on instruction associated with use of technology resources. For example, if teachers were lecturing, how was the class organized and what resources were in use to support the lecture? When computers were in use, how challenging were the students' tasks, how were they working with the teacher and one another, and what proportion of them were engaged in productive interaction? If students were composing long texts or projects, what resources were they using to support their work, and what symbol systems were in use?

Our Tool

We developed a versatile, technology-based observation tool that could serve our needs for research and evaluation. The tool also gives education professionals an easily learned observation method that permits rapid analysis and display of results. In the observation scheme that resulted, instructional activities are the central organizing blocks. The emphasis of the scheme is on capturing the nature of instructional tasks, the roles of teachers, the nature of social relationships, the variety of resources, and the responses of students. The instrument's breadth of coverage is coordinated with qualitative techniques for collecting fine-grained descriptions of instructional content and process.

The instrument uses a time-sampling procedure to minimize rater bias, which is likely to be greater if raters sample "events" (since events are difficult to define when so many instructional characteristics are coded), or if raters make summary judgments over an entire class period. The observation form is therefore organized for recording in timed intervals. The form is machine scannable, which permits instant updating and rapid analysis of the resulting database.

Observers code[3] (a) a few key *indexing variables* once for the activity period to be observed (subject area, number of students assigned, classroom organization), and (b) a set of *activity descriptors* on a time sampling schedule throughout the period. The following are the indexing variables:

- *Subject Area* (one set for elementary and another set for secondary level)
- *Number of Students Assigned* to the observed activity

The activity descriptors are then coded once during each 5-minute (elementary) or 10-minute (secondary) interval.

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[3] A coding manual is available from the authors.

During an observation period, our coders observe for 1 minute at the start of each 5- or 10-minute interval; they then code just what occurred within that prior minute and use any remaining time to record field notes. The activity descriptors include:

- *Classroom Organization:* teacher-led, independent work, group/cooperative, group/collaborative (jointly produced product), pair/cooperative, pair/collaborative, pair/tutoring, student-led
- *Adult Roles* :
  - *Directing Instruction* (codes that apply only to teacher-led classroom organizations): explain/provide information, question (for comprehension or examination), answer students' questions, direct students' work (step by step), correct/grade, test, read to students
  - *Facilitating instruction* (codes that apply to independent, cooperative, and collaborative work): monitor/rove to help students at work, facilitate discussion, conference, joint problem-solve
  - *Management and Discipline*: manage, discipline
  - *Not Present* (with the group currently observed)
- *Symbol Systems serving key instructional functions* in the material the teachers make available to students: verbal, numeric, math symbols, graphic, chart, diagram, pictorial, model, map, puzzle/pattern, motor/action, music, objects

•*Symbol Systems students use in their products*: verbal, numeric, math symbols, graphic, chart, diagram, pictorial, model, map, puzzle/pattern, motor/action, music, objects

•*Length of the Responses* expected of students: repeat/copy (student replicates provided material exactly—e.g. spelling practice, cursive practice, keyboarding drill), select (multiple choice, true/false), short (no more than a sentence in length), medium (no more than a paragraph in length), long (multi-paragraph)

•*Level of Processing* expected of students: low (emphasis on rote recall), medium (requiring inference or problem solution within a well-structured problem context), high (requiring inference and construction of a response in a less structured task context)

•*Resources in Use*

Textual, including *textbooks* (textbooks, assigned literature, workbooks/worksheets, tests), *print resources* (library books, reference books, periodicals, reference/help sheets), *materials* (paper, file cards, blackboard), *student's own work*

Hands-on materials

Computer, including *instructional software* (electronic worksheet, simulation/strategy), and *applications* (word processing, HyperCard, graphics, database, spreadsheet, programming, telecommunications)

Other technology: laserdisc, scanner, film/video, slide/filmstrip, audio, robotics, class monitor, overhead, MIDI, calculator

•*Students' Responses to the Activities*:

Appropriateness of students' behavior

Students' focus and investment

Productive student-student interaction

Results of the time-sampled observations are scanned, analyzed, and displayed in graphic or tabular formats on a Mac II. Currently the resultant displays are catalogued for flexible retrieval using a menu-driven interface. A goal is to develop a user-friendly interface for real-time, on-line queries.

Illustrative Uses

The instrument provides us with "snapshot" descriptions of classroom instruction which can serve multiple research and development functions. In this paper we illustrate two of our current uses: documentation of commonly reported changes in high access classrooms and model-driven descriptions of change.

Documentation of Reported Changes in High Access Classrooms

There is a clear need for empirical documentation of commonly reported changes in classroom practices in high access environments. Researchers and educators have made informal observations that computer use is associated with:

more challenging projects, less directed teaching and more teacher facilitation, more frequent group projects, more time on task, and more peer assistance (see, for example, Collins, in press; Hawkins & Sheingold, 1986). However, there is little empirical documentation of these changes.

Observations collected in 1989-90 have provided us with enough data to make clear the importance of careful investigation. Our analyses to date indicate certain associations between technology use and classroom activities that are consistent with informal reports. But some of our results are not consistent with what now appear to be overly general and overly romantic sketches of technology's impact. Our data suggest that the teachers make motivated choices about resources and pedagogical methods based on subject area; thus their classroom activities are not technology-driven in any simple way. Our findings serve to underscore the importance of documenting technology impact (a) within specific subject areas, (b) at particular levels of schooling (e.g., elementary vs. secondary), and (c) for specific uses of technology.

We illustrate our analyses of associations between technology use and classroom instruction with 1989-90 observations collected at our elementary site in language arts and in mathematics. The database included 144 5-minute intervals (12 hours) in language arts and 73 5-minute intervals (6.1 hours) in mathematics. These data represent a less than adequate sampling of teachers' instruction, although observations were made of activities that observers and teachers agreed were representative of each teachers' instruction. We must stress the illustrative nature of our results.

The analysis strategy was based on a nested series of queries. We defined a set of resource contexts, beginning with a simple distinction between those where the computer was in use and those where it was not, and compared instructional patterns in those two contexts. We then made further refinements as questions for analysis emerged; for example, how did instruction differ when computers were used for applications (such as word processing) versus instructional software? Most analyses of instructional patterns were based on aggregations of individual codes.[4] For example, when we examined instruction and support roles we created two summary categories: *Directing Instruction* and *Facilitating Instruction*, representing the use of any of the roles in those two categories respectively.

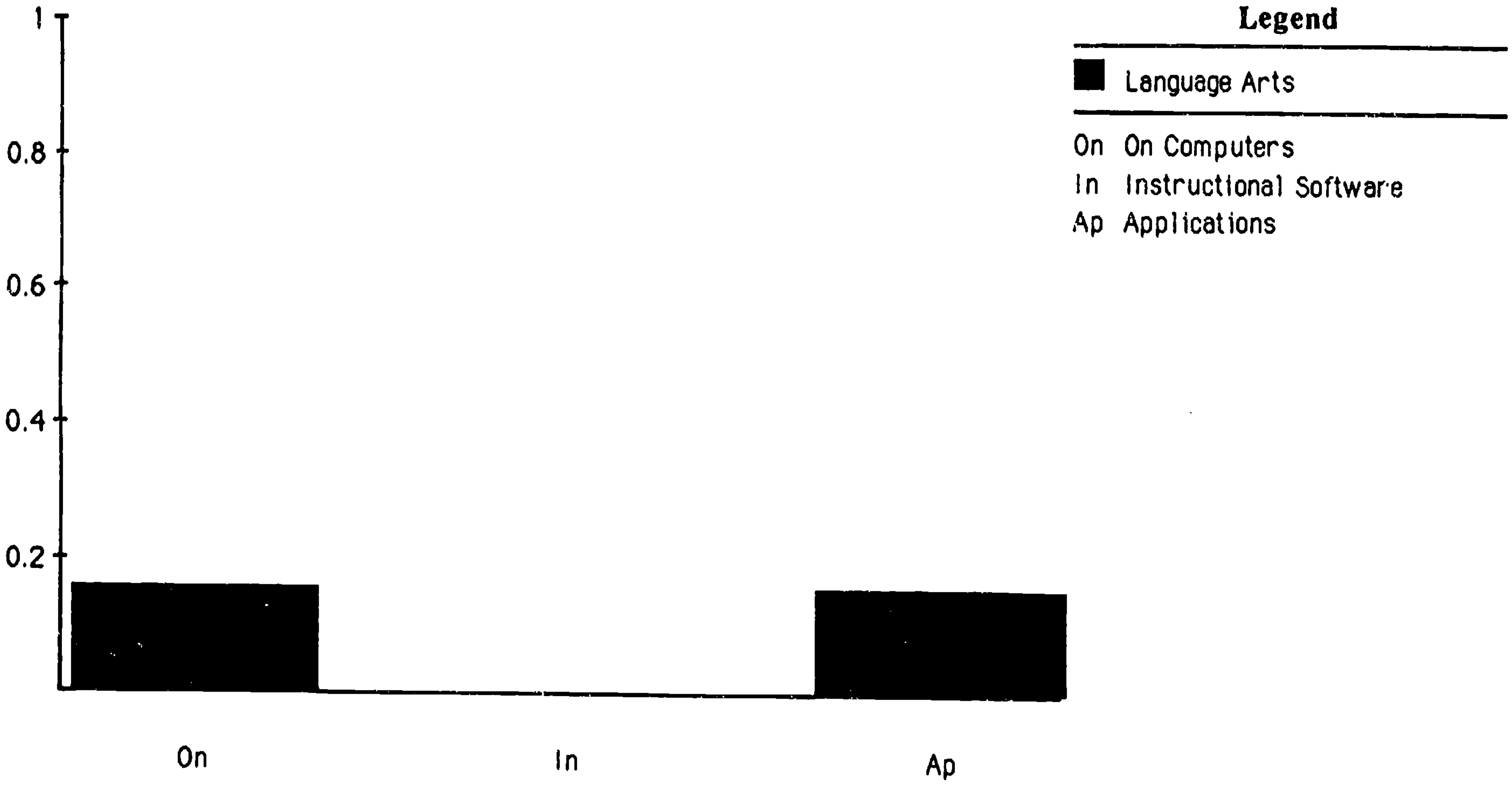
Illustrative results: Language Arts and mathematics at one elementary site.

The results for language arts were most consistent with informal reports of instructional patterns in high access contexts. In language arts, computers were in use a bit less than 20% of the time (Figure 1), and uses were always for applications rather than for delivery of instructional software. Consistent with informal observations of classroom

[4] Descriptions of procedures for aggregation are available from the authors.

Computer Use by Subject - Language Arts

Percentage of intervals in which each variable was observed



Illustrative Findings
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Figure 1

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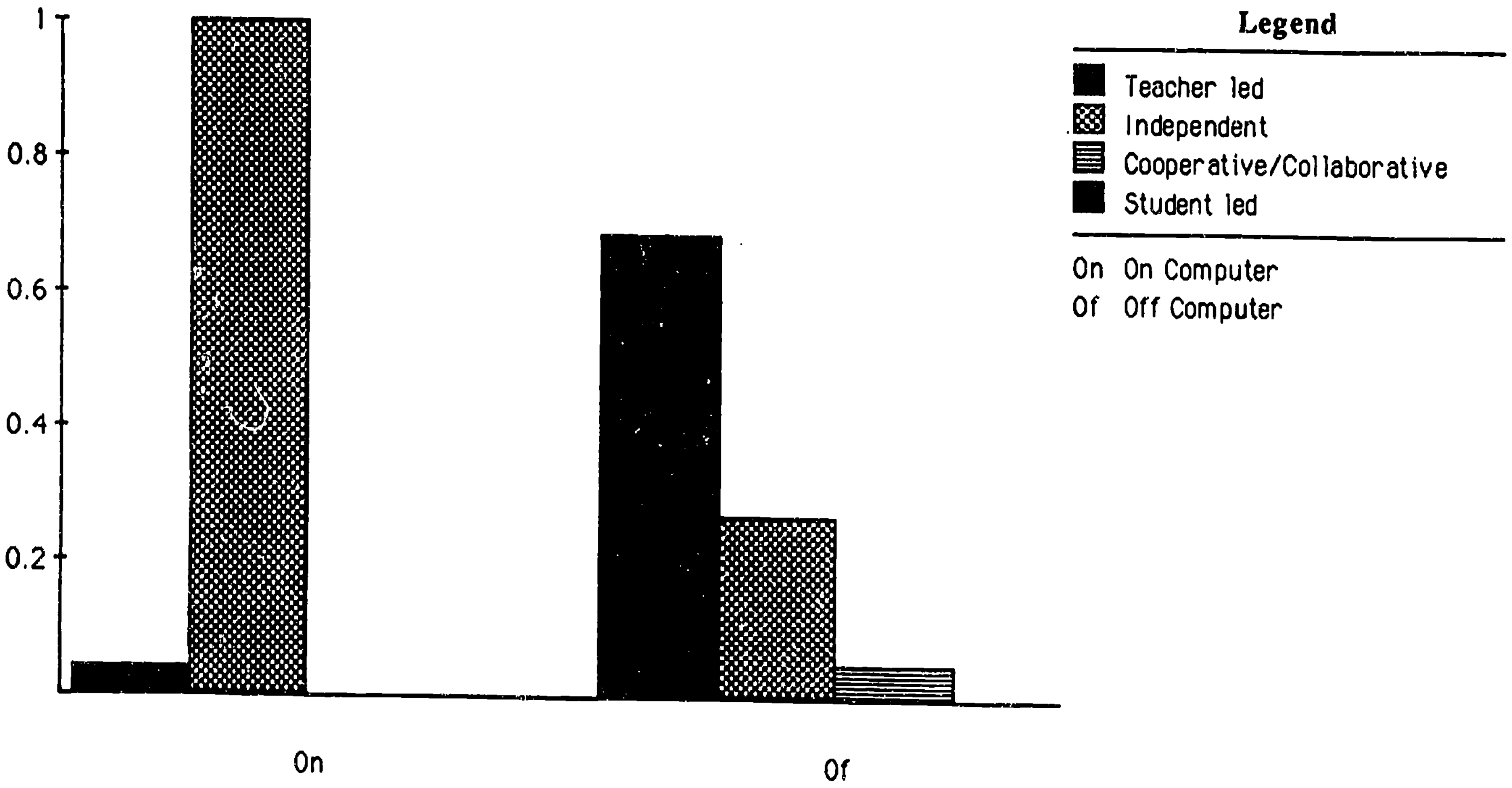
organizations and teacher roles during student computer work, use of applications—primarily word processing—was associated with independent student work rather than teacher-led work (Figure 2), and with a role for teachers as facilitator of students' work rather than as director and deliverer of information (Figure 3).

In mathematics, while computers were observed in use slightly more frequently (32%) than in language arts (Figure 4), the more striking difference was in type of use. Computers were used most often for instructional software rather than for applications. While we found relationships between computer use and classroom organization (Figure 5) and teacher role (Figure 6) that were similar to language arts, the similarity to language arts did not hold when we examined particular computer uses. When we compared use of instructional software to use of applications in mathematics, students were more likely to be working independently or cooperatively (rather than under the direction of the teacher), and teachers were more likely to be facilitating (rather than directing) students' work only when students were using instructional software (Figures 7 and 8). The small number of observations of application use limits inference, but the difference in instructional software versus application use does make clear the importance of examining instructional patterns in terms of the specific functions that technology serves within instruction of particular subject areas.

Classroom Organization Across Resource Contexts - Language Arts

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 2

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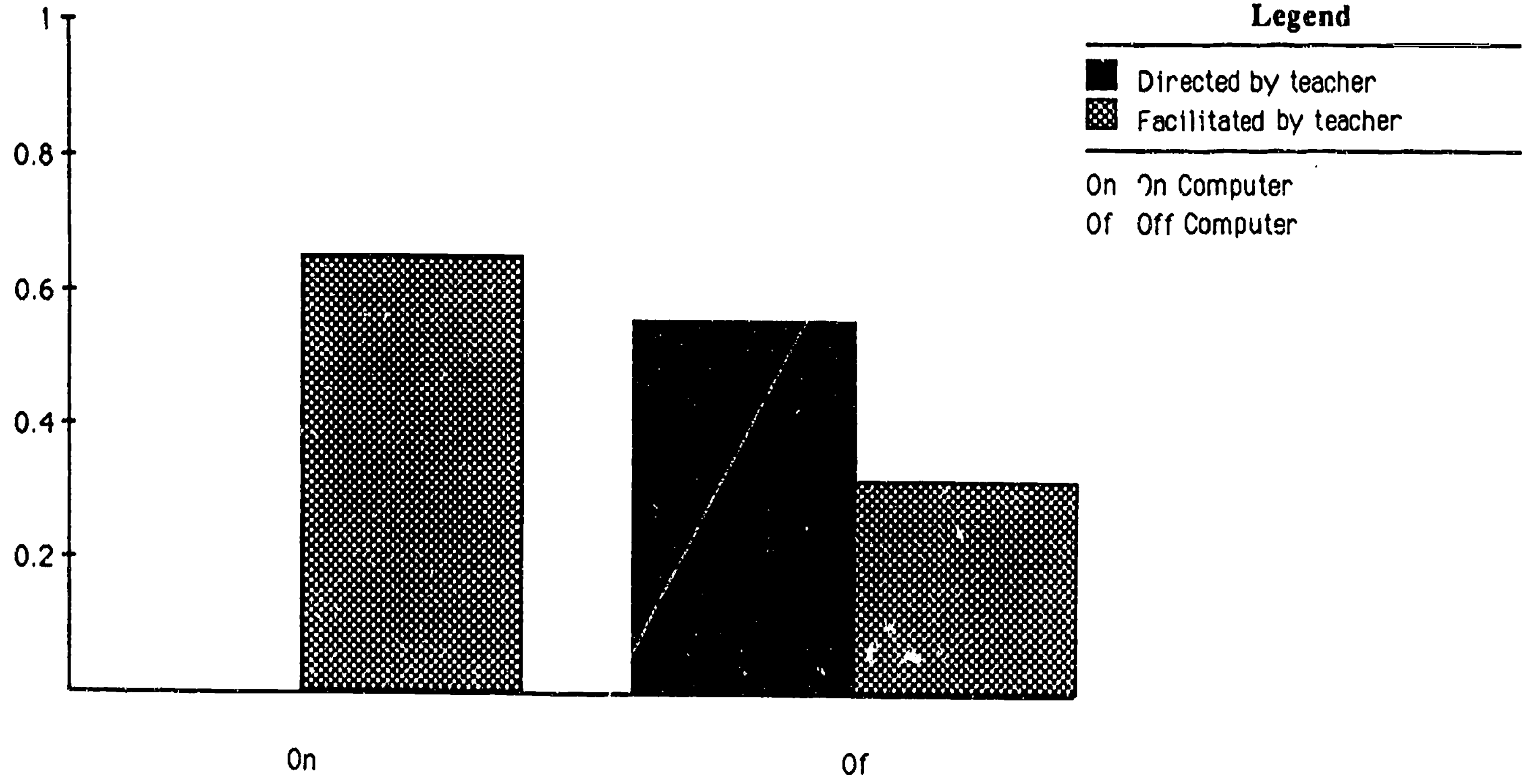
Adult Role Across Resource Contexts -- Language Arts

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 3

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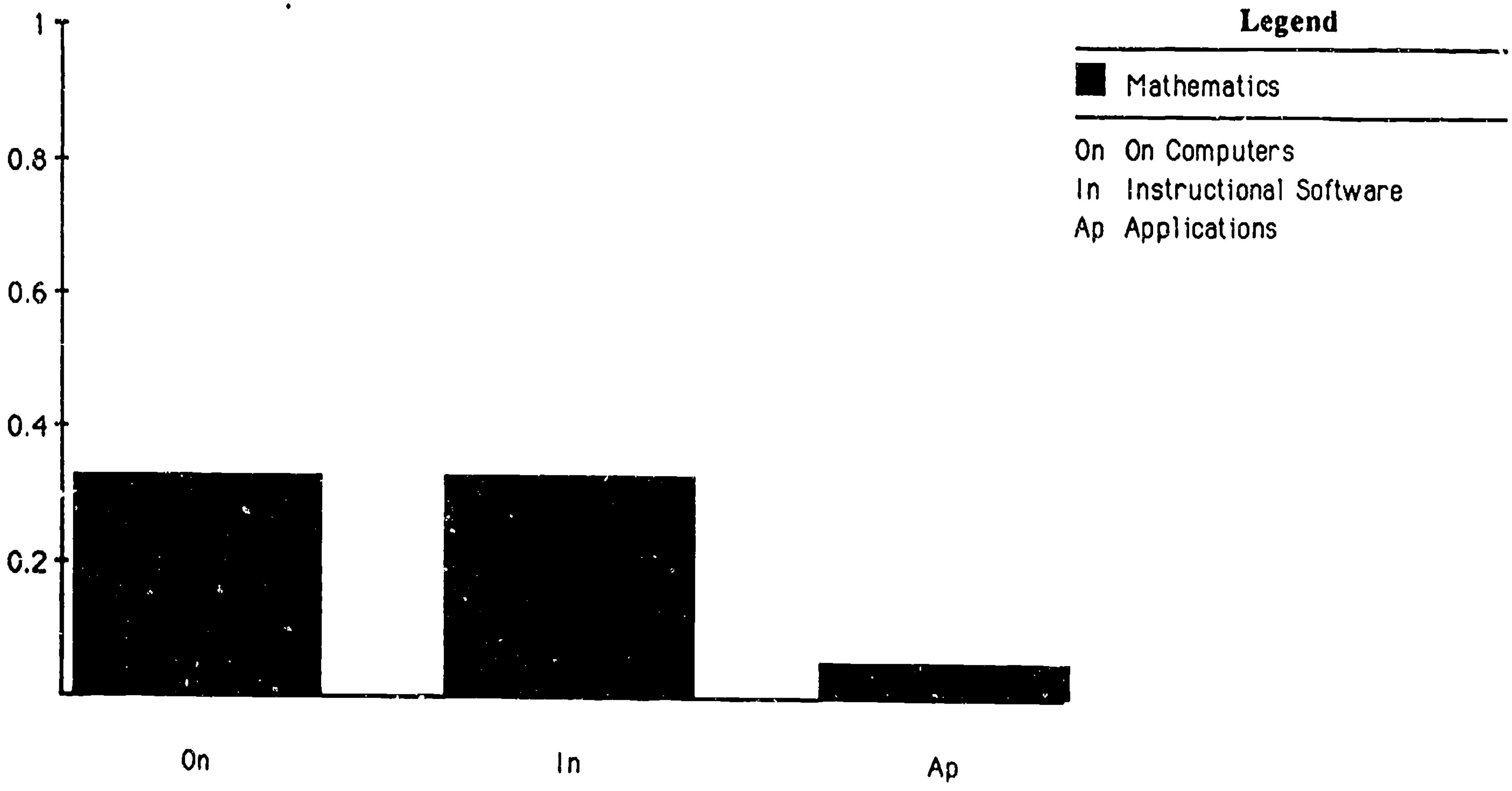
Computer Use by Subject - Mathematics

Percentage of intervals in which each variable was observed



Illustrative Findings

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Figure 4

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Classroom Organization Across Resource Contexts - Mathematics

Percentage of intervals within each resource context that each variable was observed

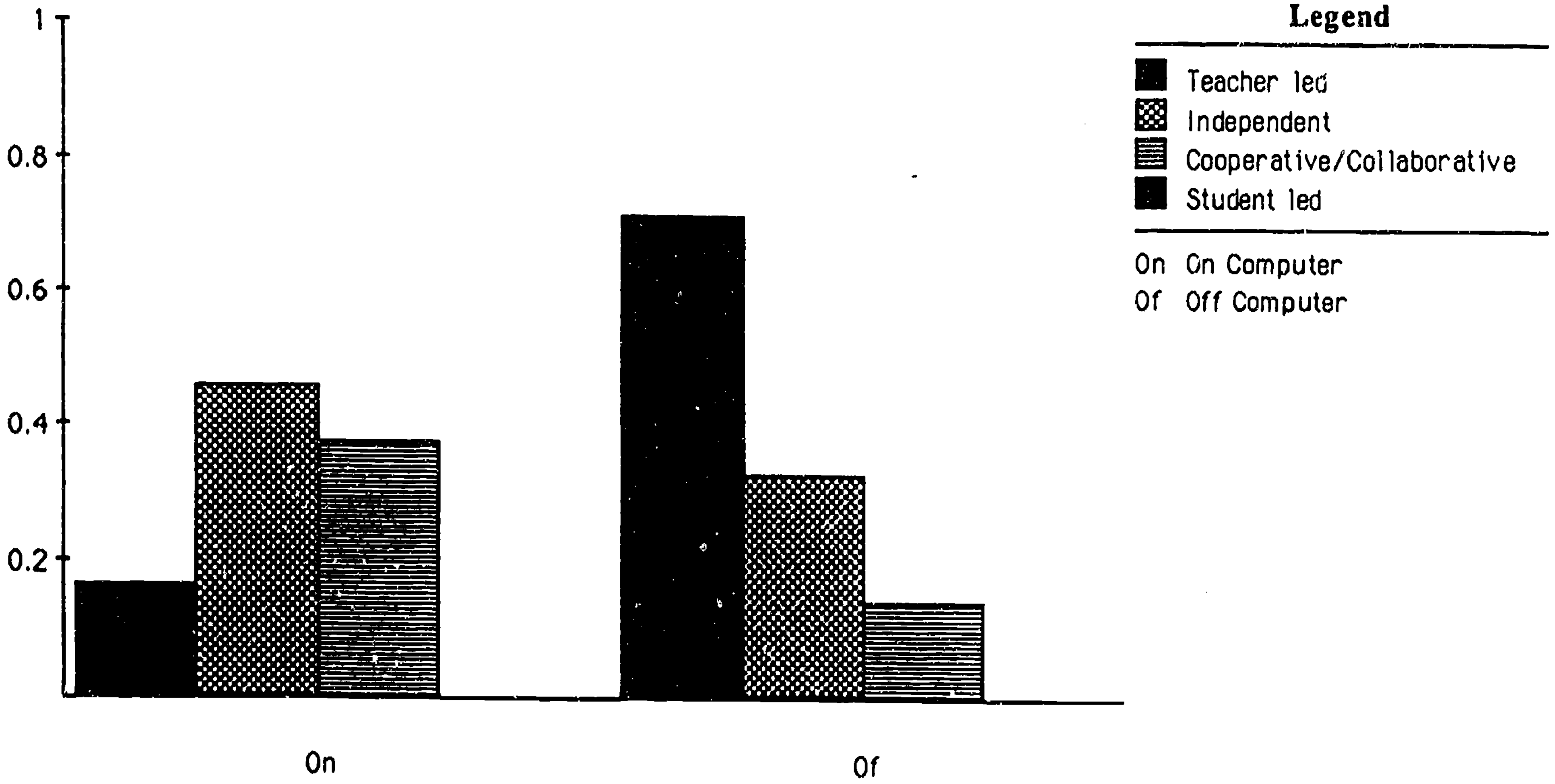

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Figure 5

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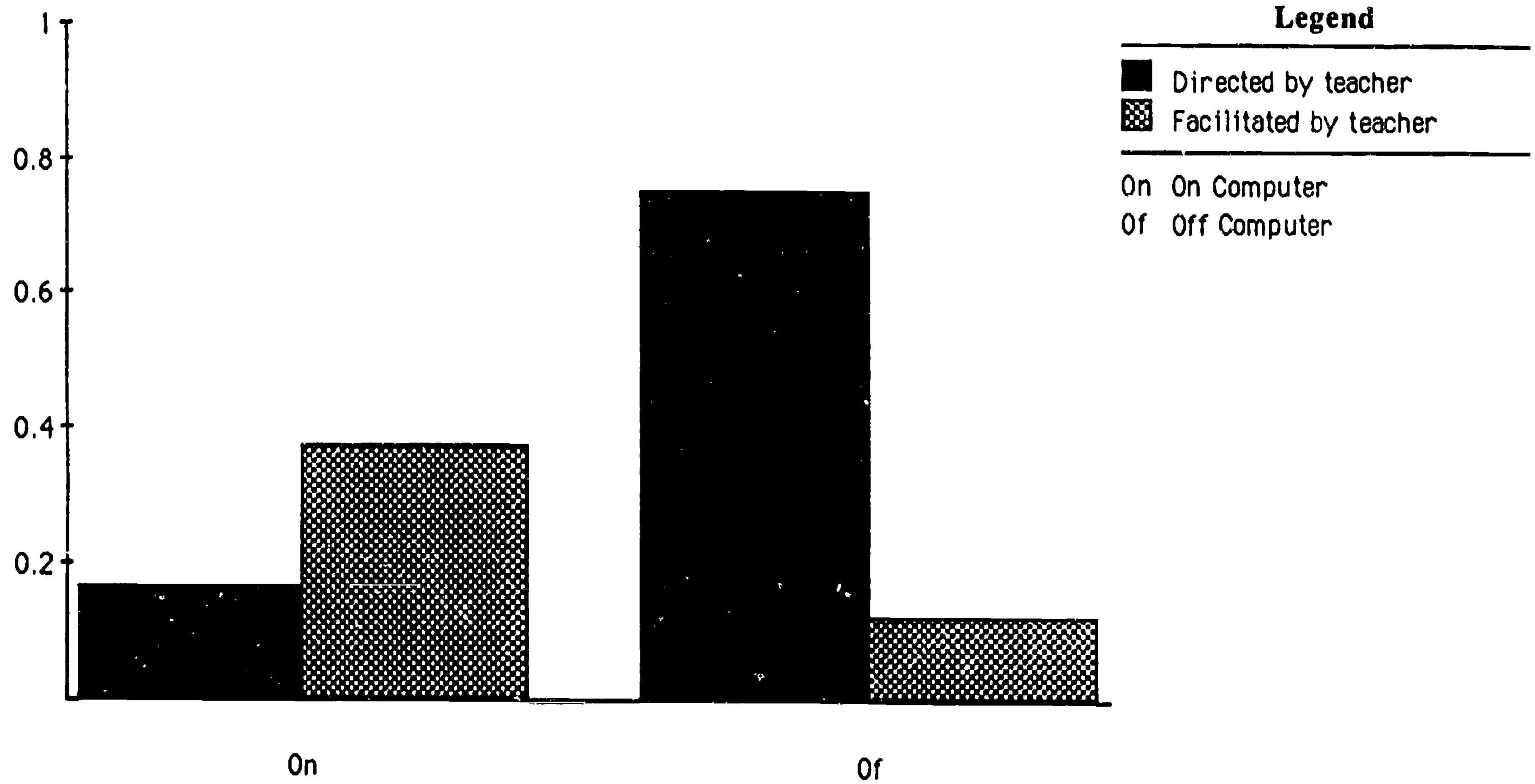
Adult Role Across Resource Contexts -- Mathematics

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 6

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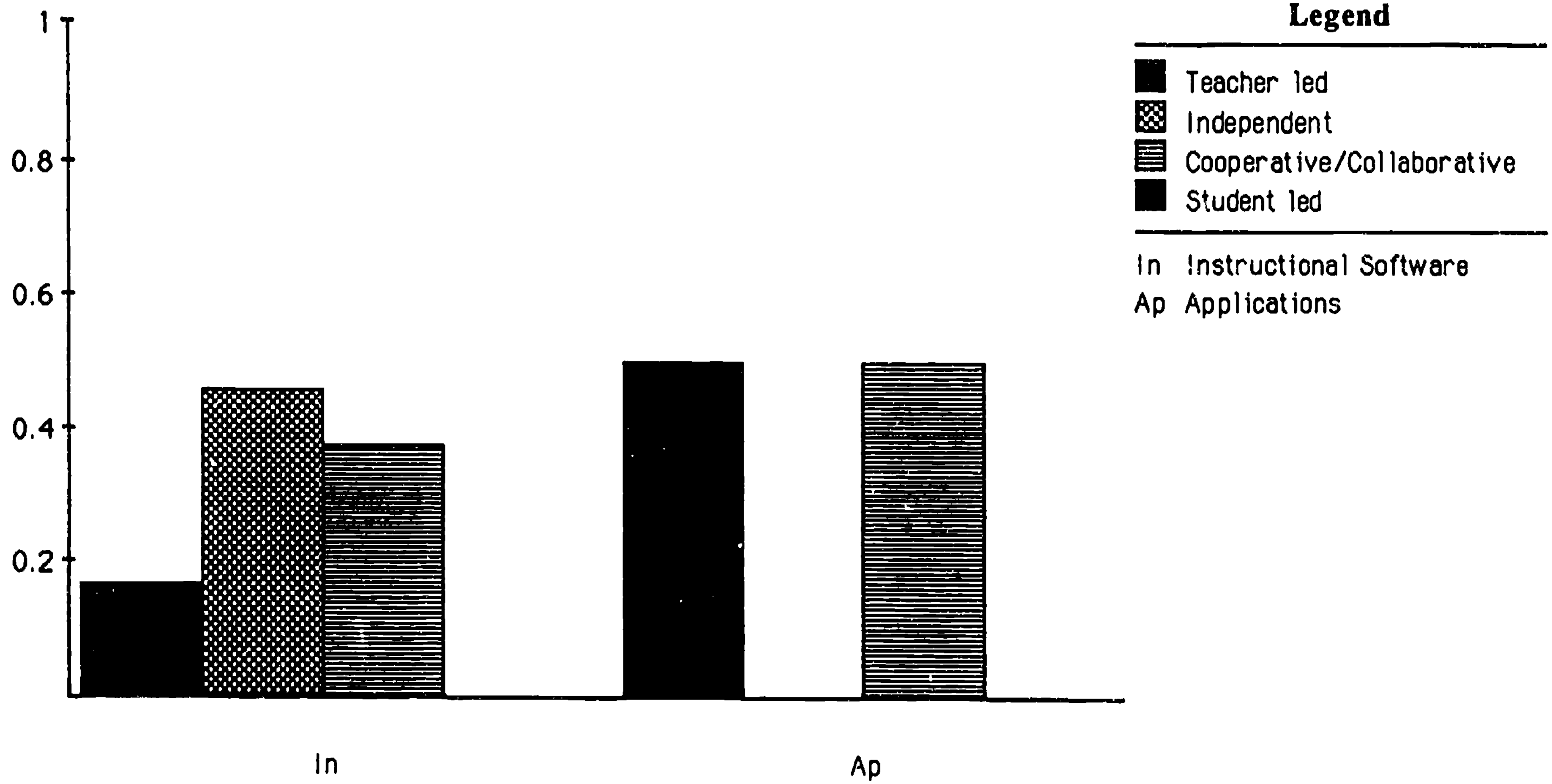
Classroom Organization Across Resource Contexts - Mathematics

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 7

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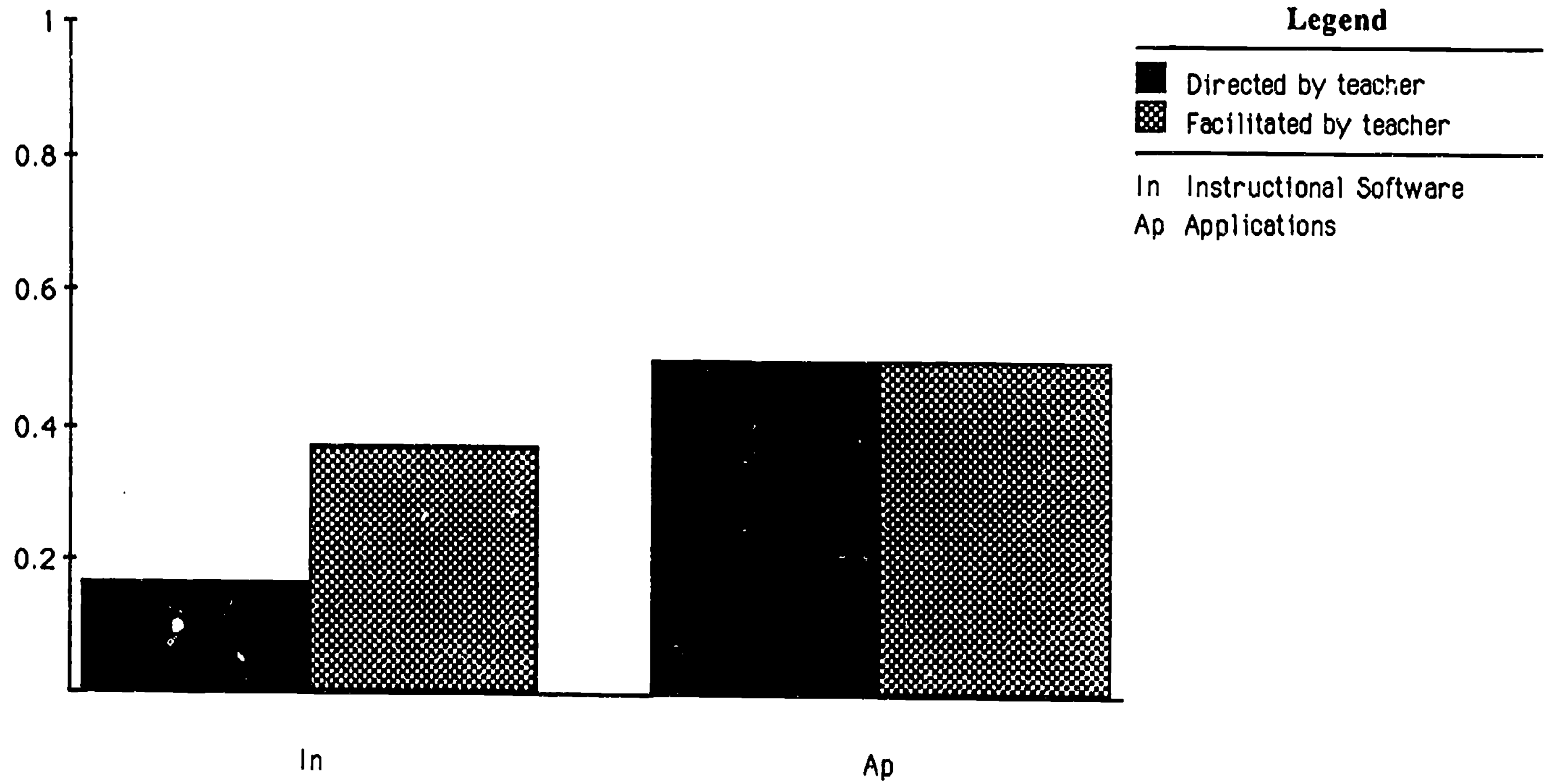
Adult Role Across Resource Contexts -- Mathematics

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 8

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Reports that technology use supports more challenging student work were supported only by our pilot data for language arts: When computers were in use (when students were using word processing for writing), tasks were somewhat more challenging (Figure 9) and longer in length (Figure 10). In contrast, mathematics tasks were somewhat less challenging (Figure 11) and shorter in length (Figure 12) on computer; students were using instructional software to practice basic mathematics skills.

In summary, instructional patterns observed in these high access classrooms differed both by subject area and by the nature of computer use.

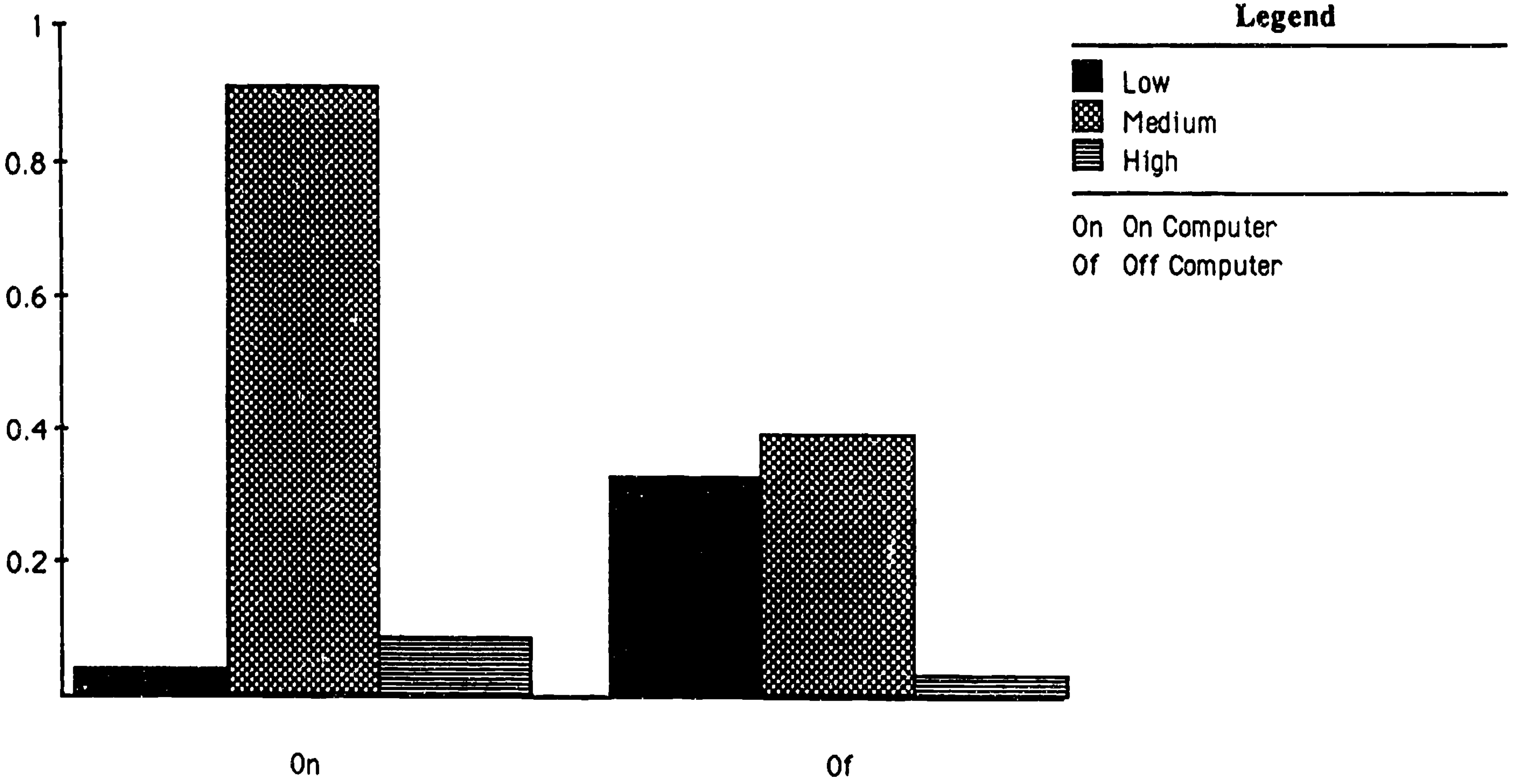
Model-Driven Descriptions of Instructional Change

Our instrument is designed to provide documentation of instructional practices associated with technology use and changes in instructional practices over time. The value of the descriptions we produce is markedly enhanced when descriptions are guided by a model of instructional change. If patterns change over time as predicted by a model, our results provide validation for the model; if patterns are inconsistent with a model of change, our results suggest needed revisions in the model.

In this section, our examples illustrate an approach we are taking to model-driven methods of data analysis. We have drawn from two frameworks to help us articulate our expectations for instructional impact of high technology access.

Level of Processing Across Resource Contexts - Language Arts

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 9

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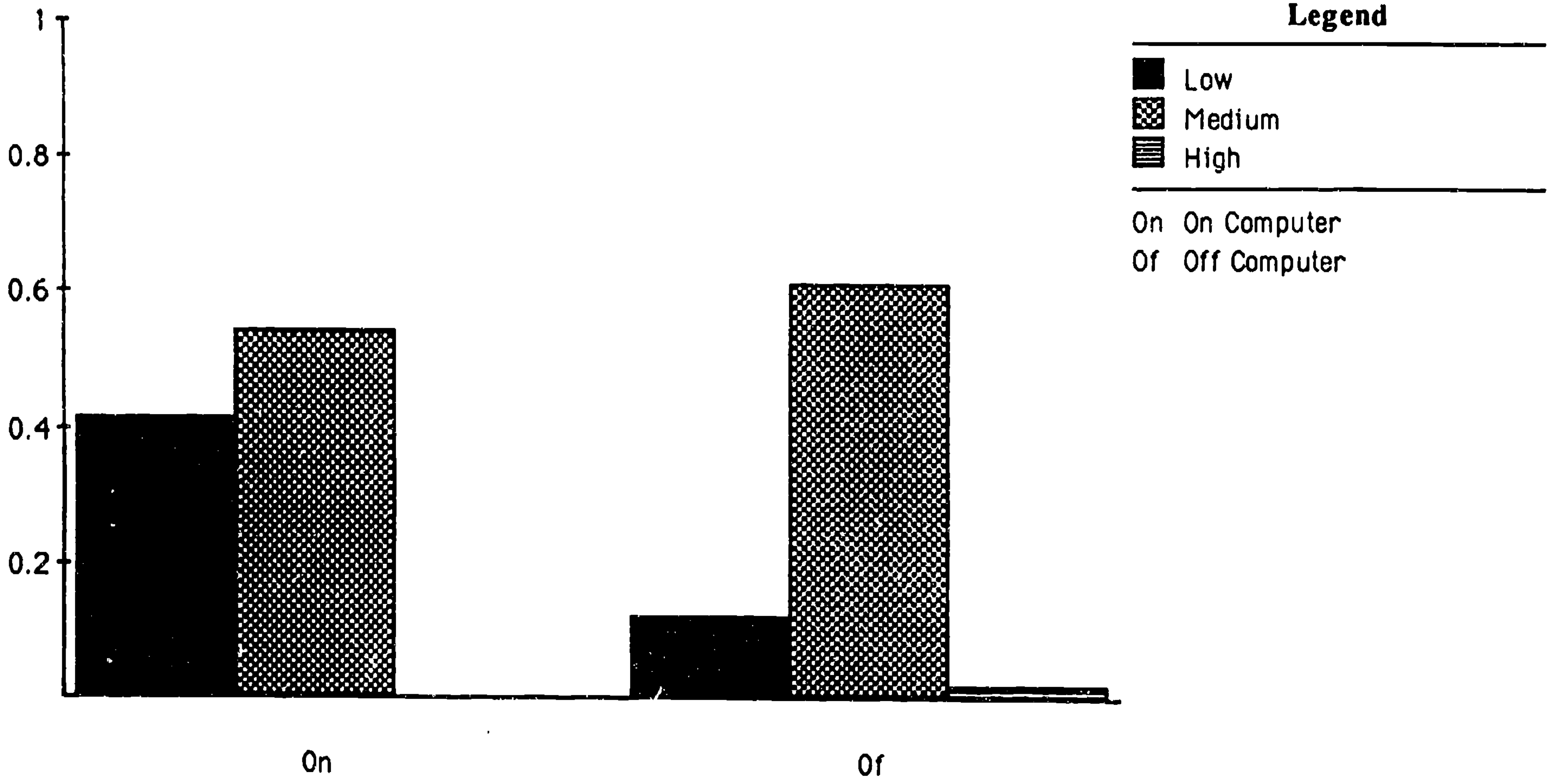
Level of Processing Across Resource Contexts - Mathematics

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 10

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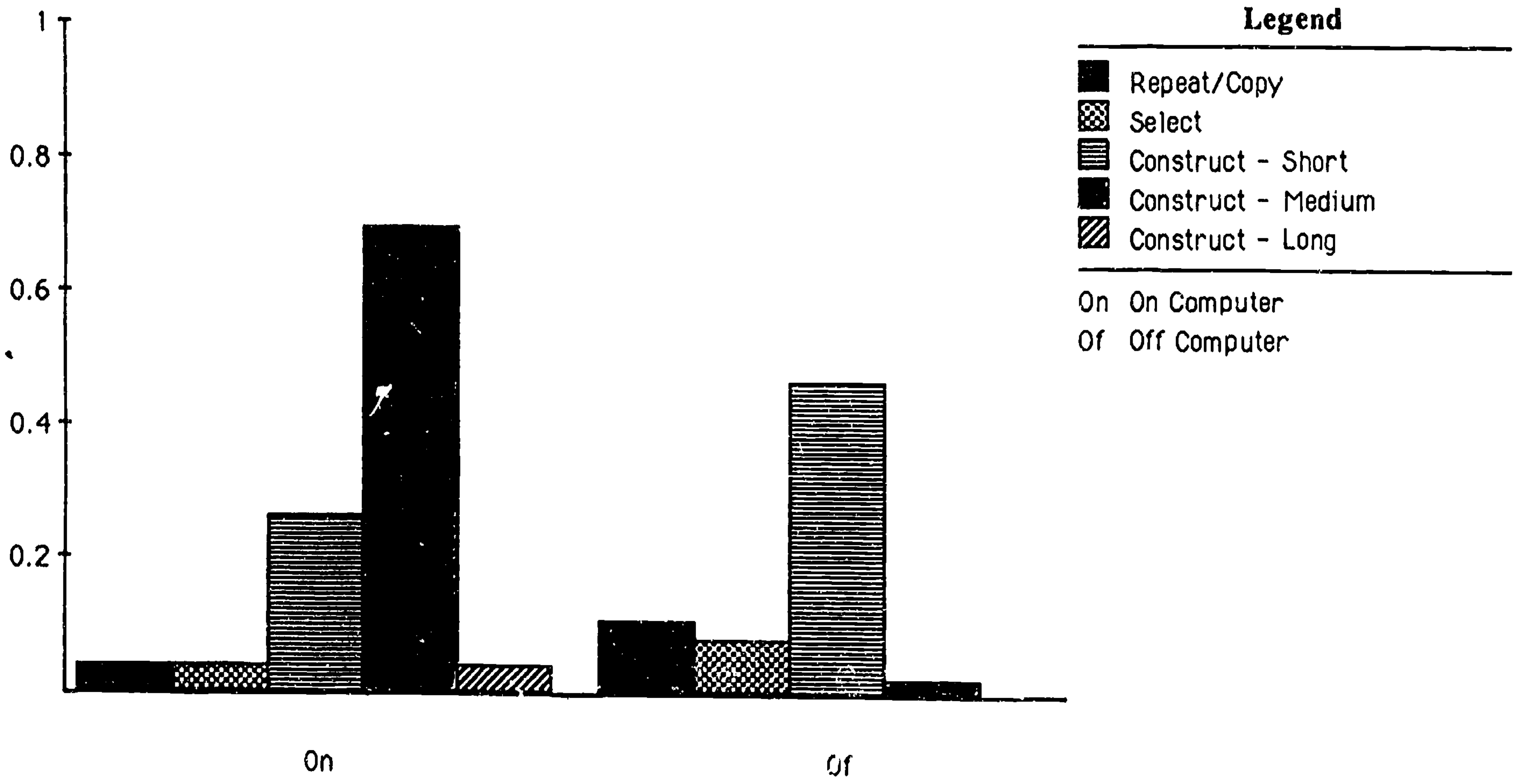
Product Item Length Across Resource Contexts - Language Arts

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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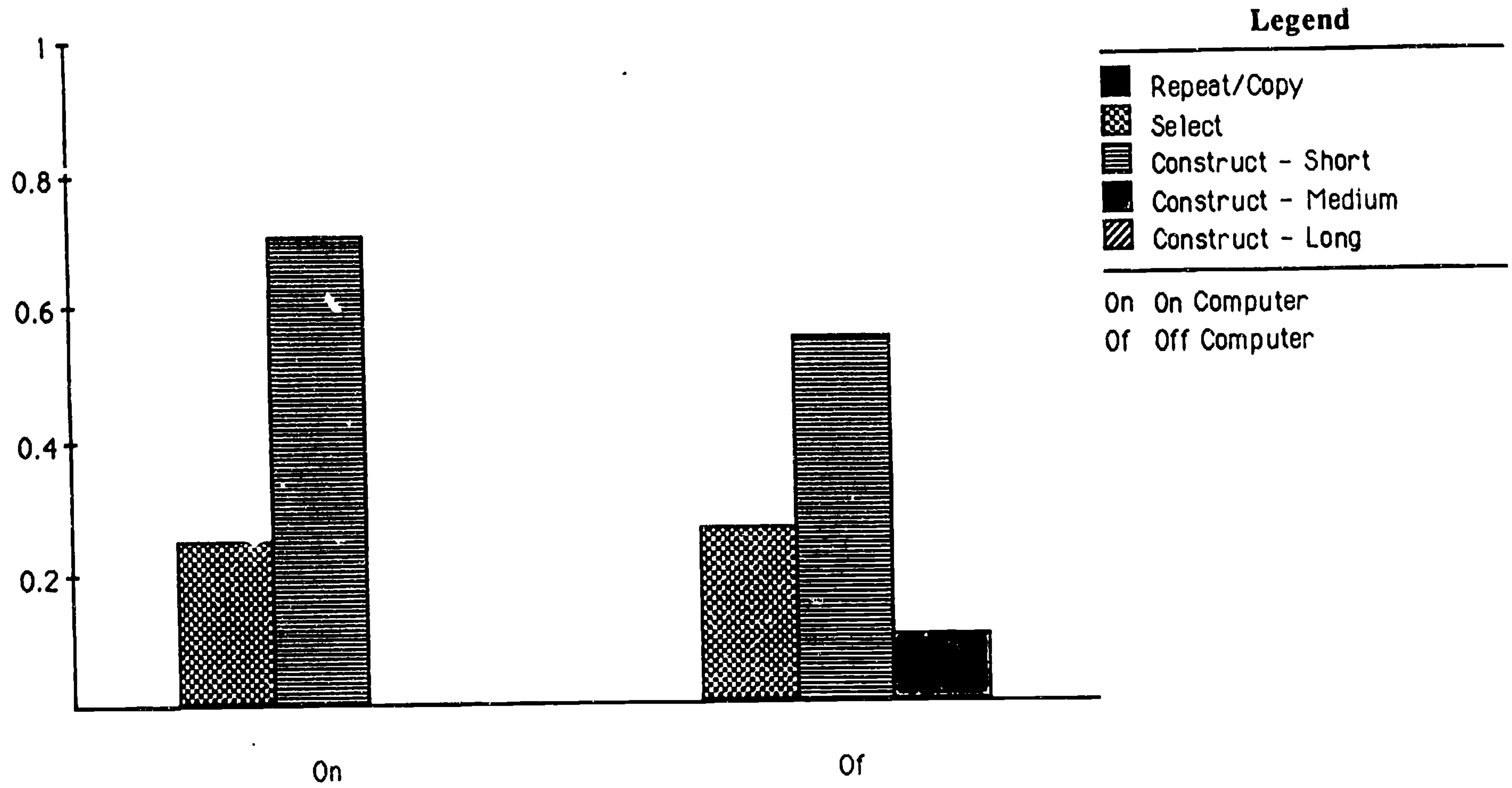
Figure 11

Product Item Length Across Resource Contexts - Mathematics

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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Figure 12

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Toward a model of instructional change: Two key frameworks. David Dwyer, Cathy Ringstaff, and Judy Sandholz (Dwyer, Ringstaff, & Sandholz, 1990) have proposed a model of ACOT teacher change based on analyses of ACOT teachers' regularly dictated audiotape records of their ACOT experience. Dwyer and his colleagues propose a five-phase process of instructional change:

- **Entry**: the technology is implemented and a team of teachers selected
- **Adoption**: basic instructional patterns are maintained, with technology support for drill, practice, and word processing
- **Adaptation**: teachers find that their instructional program is completed more rapidly and efficiently, freeing time for exploration of new curricula and pedagogy
- **Appropriation**: computer expertise enables experimentation
- **Invention**: teachers invent and implement fundamentally new forms of learning and teaching

These phases of instructional change can be interpreted as phases in which "technology push" leads to a succession of newly emerging instructional goals (cf. Baker, 1988). The phase descriptions do not point consistently to particular causes or contexts of change, however. For example, "efficiency" is cited in the transition from adoption to adaptation, but it is not clear how teachers recognize it or choose then to depart from traditional practices. Nor is a particular model of "new forms of learning and teaching" proposed.

To provide that model—and thus a model for the final "invention" phase in Dwyer et al.'s (1990) framework—we have adapted the analysis of "inquiry environments" proposed by Marlene Scardamalia and Carl Bereiter (Scardamalia & Bereiter, in press; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). In their analysis of visionary, technology-supported instructional environments, technology is a valued resource that can support (a) "learning goals" rather than "task goals" and, (b) depth and breadth of knowledge construction among students and teachers rather than simply information delivery and retention. Adapting the constructs contained in our observation instrument (Table 1), we characterized activities in these classrooms as follows. Projects are organized across disciplines which share corresponding or interconnected core concepts. Resources permit active construction of understandings via multiple and flexible representations of content. Students' work requires considerable initiative and construction of understandings; students' compositions are often lengthy. Learners use a variety of resources among themselves and the help of supportive adults. Students are often working cooperatively and teachers are often facilitating rather than delivering or directing instruction.

Table 1. Observation categories applied to final Invention phase in Dwyer et al.'s model (1990)

OBSERVATION	INVENTION learning as inquiry knowledge-building community
Subject areas	Integrated Interdisciplinary
Resources	Multimedia Interactive Multi-representational
Task characteristics	Technology-supported activities requiring considerable student planning, inference, integration, application, and construction
Classroom organization	Common use of technology-supported cooperation and collaboration
Instruction and support roles	Common uses of a range of facilitating roles, including conferencing and joint problem-solving Use of supportive telecommunications

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How might our instrument provide descriptions of instruction that could validate—or suggest revisions—in Dwyer et al.'s phases of instructional change? Table 2 is an outline of instructional characteristics that can be documented with our instrument and that fit three illustrative phases of Dwyer's model, including a Scardamalia & Bereiter-like interpretation of Dwyer's "invention" phase.

Illustrative results. Comparisons between language arts instruction at our elementary site and English instruction at our secondary site illustrate how inferences can be made regarding the "fit" of our observations to various stages. The database consisted of 145 5-minute intervals at the elementary level (12 hours) and 45 10-minute intervals at the secondary level (7.5 hours). Again we must stress that the results represent illustrations of approaches to analysis, not results that we necessarily expect to remain with more extensive data collection. The patterns we found suggested an association between school level and degree of instructional innovation. Compared with the secondary teachers, the elementary level teachers in our samples appeared to be considerably further from the visionary model of inventive, instructional inquiry environments sketched above.

Subject area. At the elementary school level, only one core subject—science—was ever double-coded with language arts. Field notes indicate that students were engaged in science writing (Figure 13). In contrast, at the secondary

Table 2. Observation categories applied to three proposed phases of instructional change (Dwyer et al., 1990)

	Proposed phases of instructional change		
OBSERVATION	**ADOPTION** traditional instruction instructional software word processing	**APPROPRIATION** computer expertise enables experimentation with curriculum and pedagogy	**INVENTION** learning as inquiry knowledge-building community
Subject areas	Isolated	Experiments in technology-supported integration	Integrated Interdisciplinary
Resources	Traditional/texts Instructional software Word processing	Declining reliance on texts and instructional software Word processing Experiments in multiple media and representations	Multimedia Interactive Multi-representational
Task characteristics	Structured = Basic skills,inference in well structured contexts, brief answers	Structured Experiments with some technology-supported activities requiring higher-level reasoning and student construction	Technology-supported activities requiring considerable student planning, inference, integration, application, and construction
Classroom organization	Teacher-led Independent	Teacher-led Independent Experiments in cooperation and collaboration (some technology-supported)	Common use of technology-supported cooperation and collaboration
Instruction and support roles	Directing Facilitating	Directing Facilitating, with experiments in specific techniques such as conferencing	Common uses of a range of facilitating roles, including conferencing and joint problem-solving Use of supportive telecommunications

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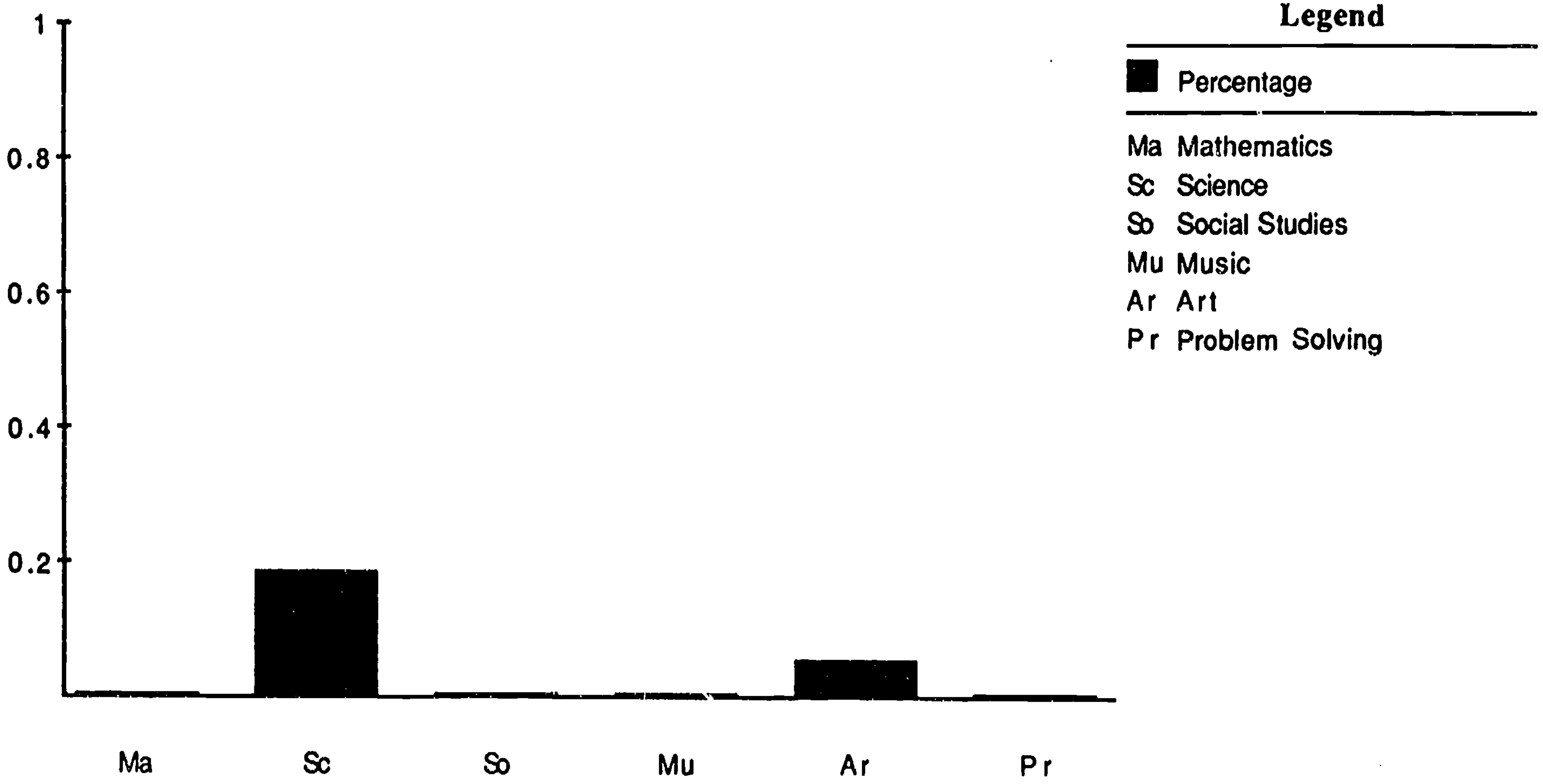
Double-coding With Language Arts Within Each Subject Area - Elementary Level

Percentage of periods in which Language Arts was double-coded with each subject



Illustrative Findings
Wednesday September 05, 1990 11:02.12 AM
Figure 13

47

48

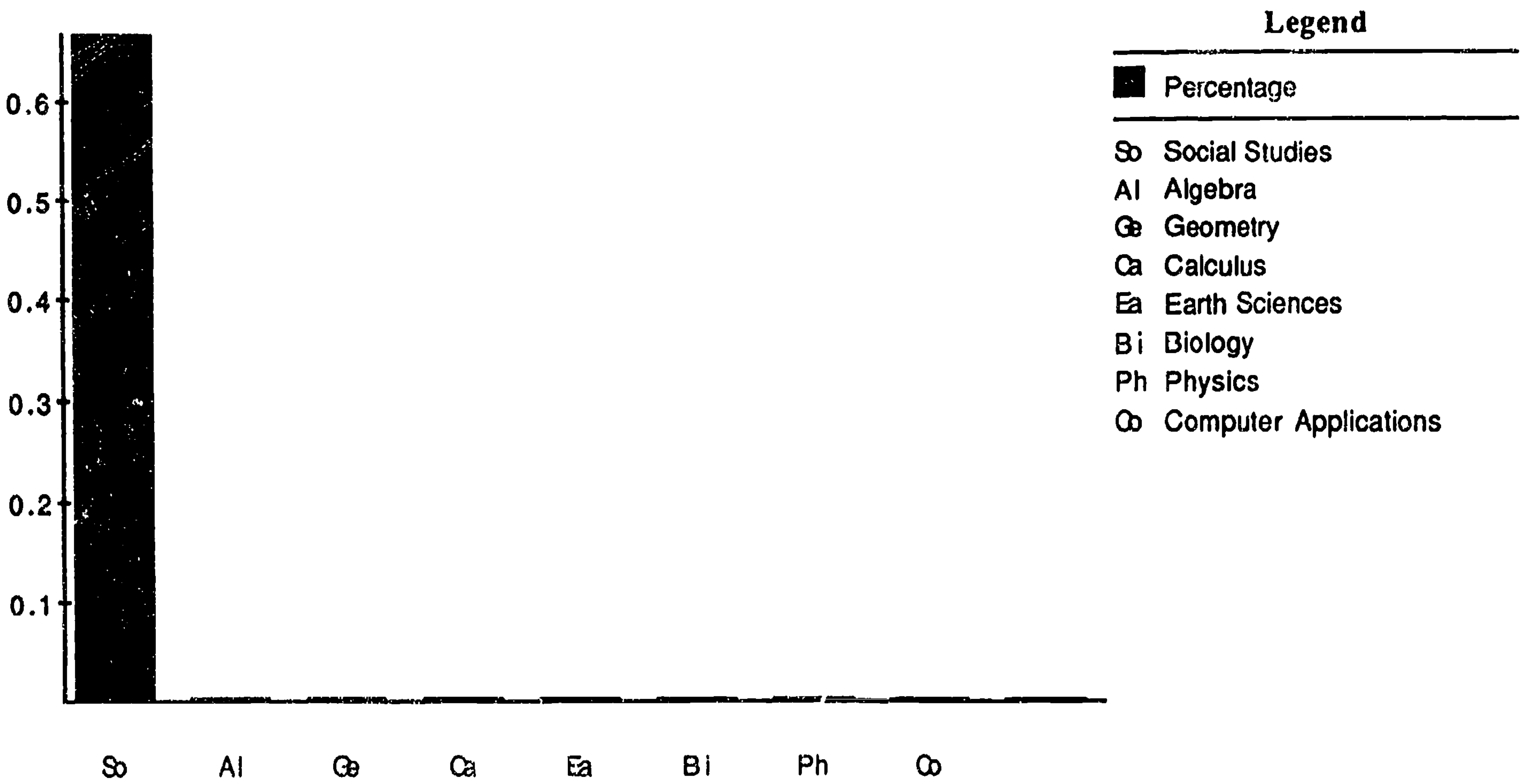
site, English was judged as integrated with another subject–social studies–70% of the time (Figure 14).

Resources in use. At the elementary level, the resources in use tended to be textual and not technological. Computers were in use slightly less than 20% of the time (Figure 15). Computer uses, however, were exclusively applications rather than instructional software; constructive writing tools–word processing–were the applications in use (Figure 16). There were no observations of software providing other forms of representation (e.g., graphics) or multi-representational technologies such as laserdisc, video or audio (Figure 17). Since children were in fact engaged in art and music activities associated with their language arts curriculum, our findings revealed that the teachers were not yet exploiting the potential of technology to support these same activities.

At the secondary site, the resources in use were also more often textual than technological. Computers were in use here about 35% of the time (Figure 18), again exclusively for applications rather than for presentation of instructional software. There was some variety in type of applications–word processing, HyperCard, and graphics (Figure 19). In addition, occasional use of interfacing multi-representational technologies was noted–audio and scanners (Figure 20). Thus at the secondary site we did observe some technology-based tools for multi-representational activities.

Double-coding With English Within Each Subject Area - Secondary Level

Percentage of periods in which English was double-coded with each subject



Illustrative Findings

Tuesday September 04, 1990 1:48.44 PM

Figure 14

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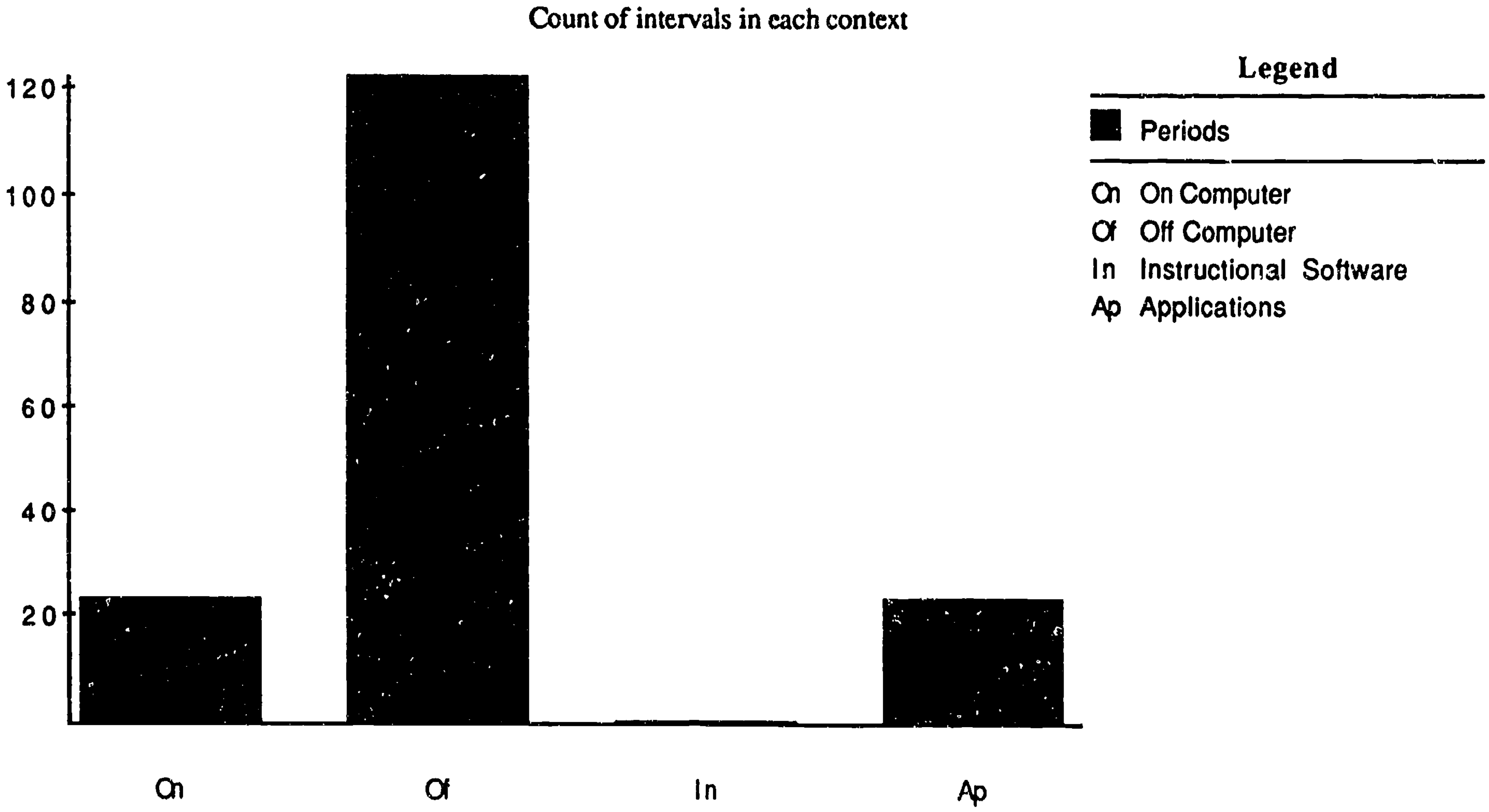
Number of Intervals Observed Within Each Resource Context - Elementary Level



Illustrative Findings
Tuesday September 04, 1990 1:24.27 PM
Figure 15

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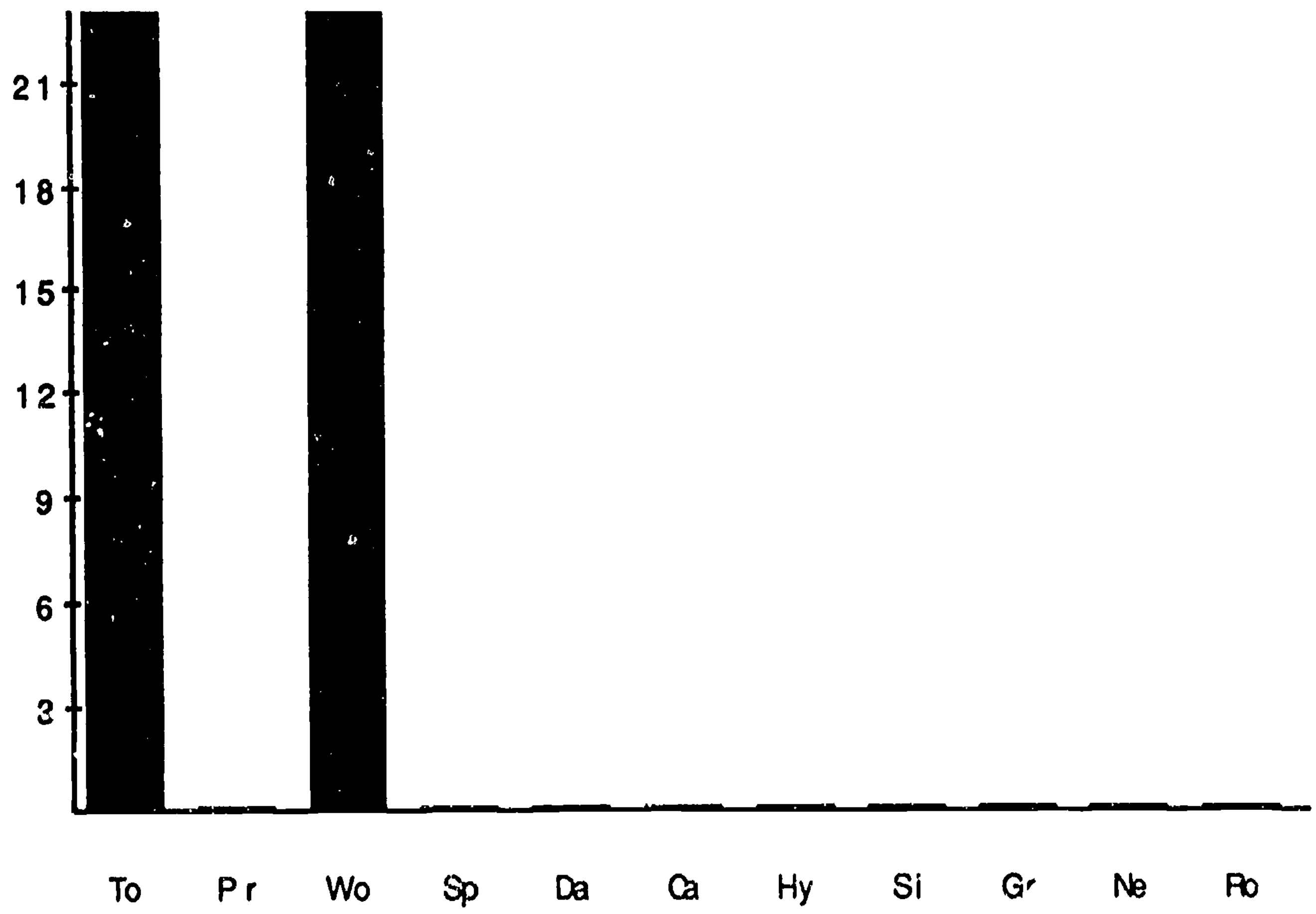
52

Number of Intervals in which Computer Applications were Observed - Elementary Level

Total number of intervals observed and number of intervals in which each application was observed



Legend

Number of intervals

To Total Applications
Pr Programming
Wo Word Processing
Sp Spreadsheet
Da Database
Ca Calculator
Hy HyperCard
Si Simulation
Gr Graphic/Art
Ne Network
Ro Robotics

Illustrative Findings

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Figure 16

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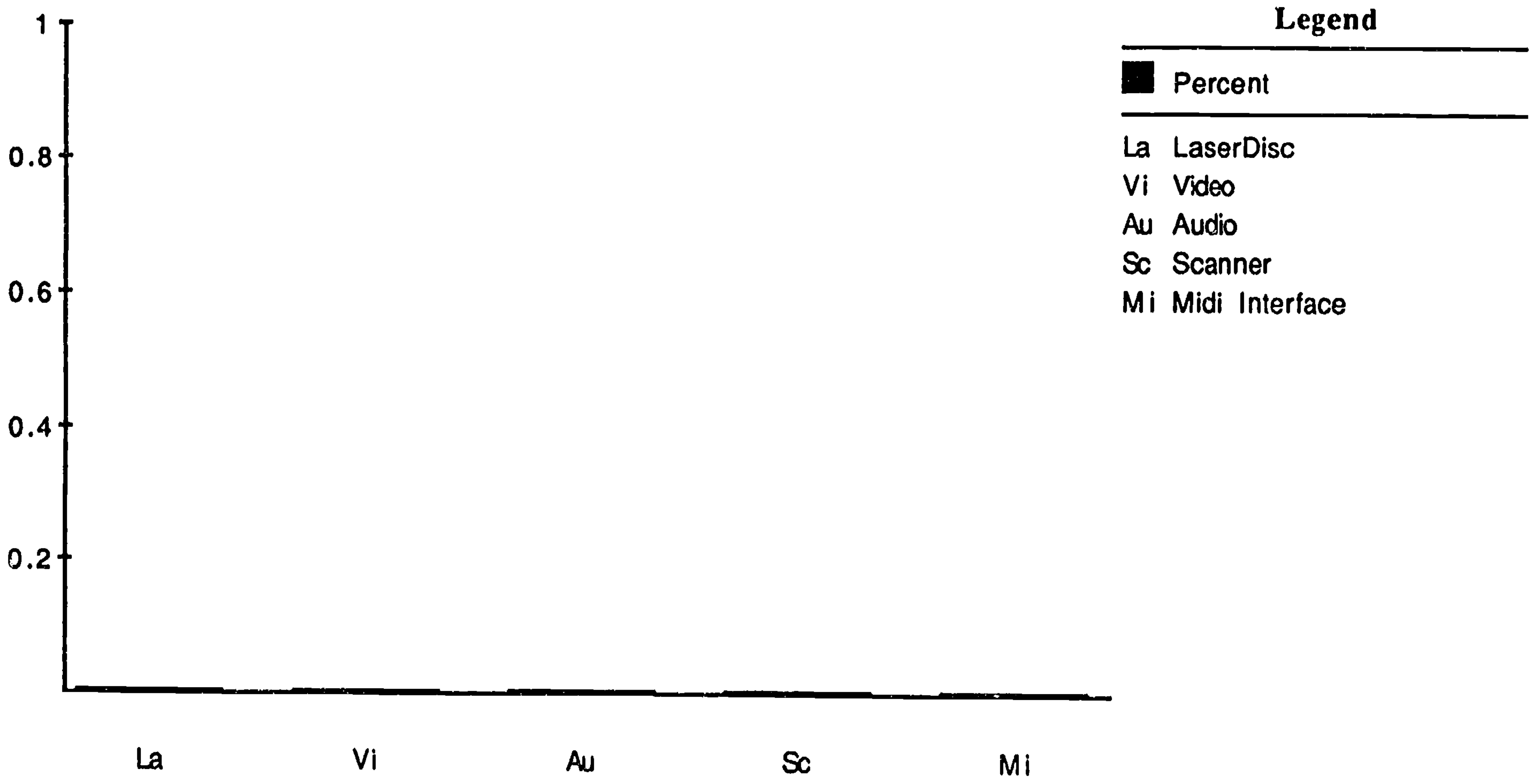
Percentage of Intervals in which HyperMedia were Observed - Elementary Level

Percentages of total intervals in which computer applications were observed with other technologies



Illustrative Findings
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Figure 17

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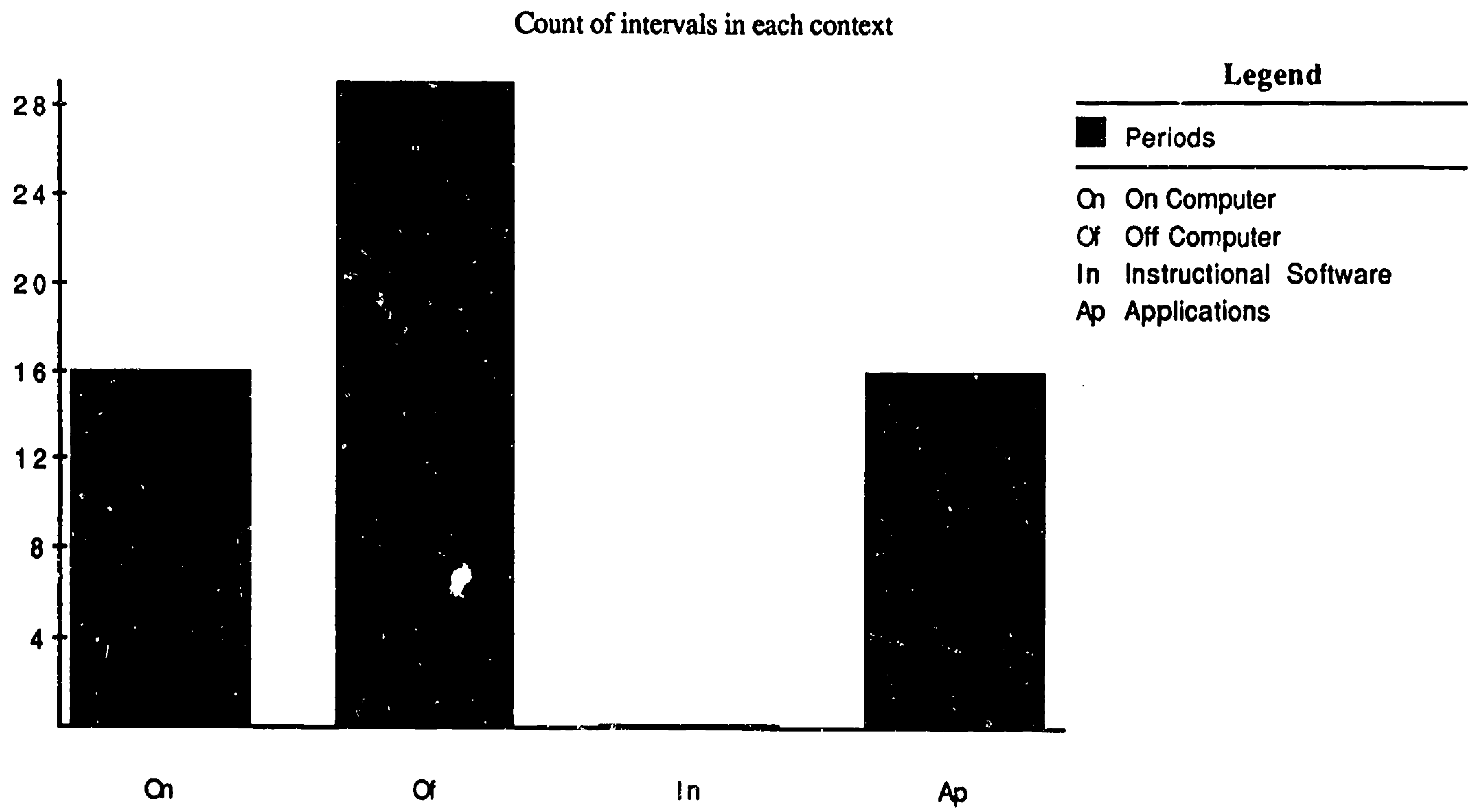
Number of Intervals Observed Within Each Resource Context - Secondary Level



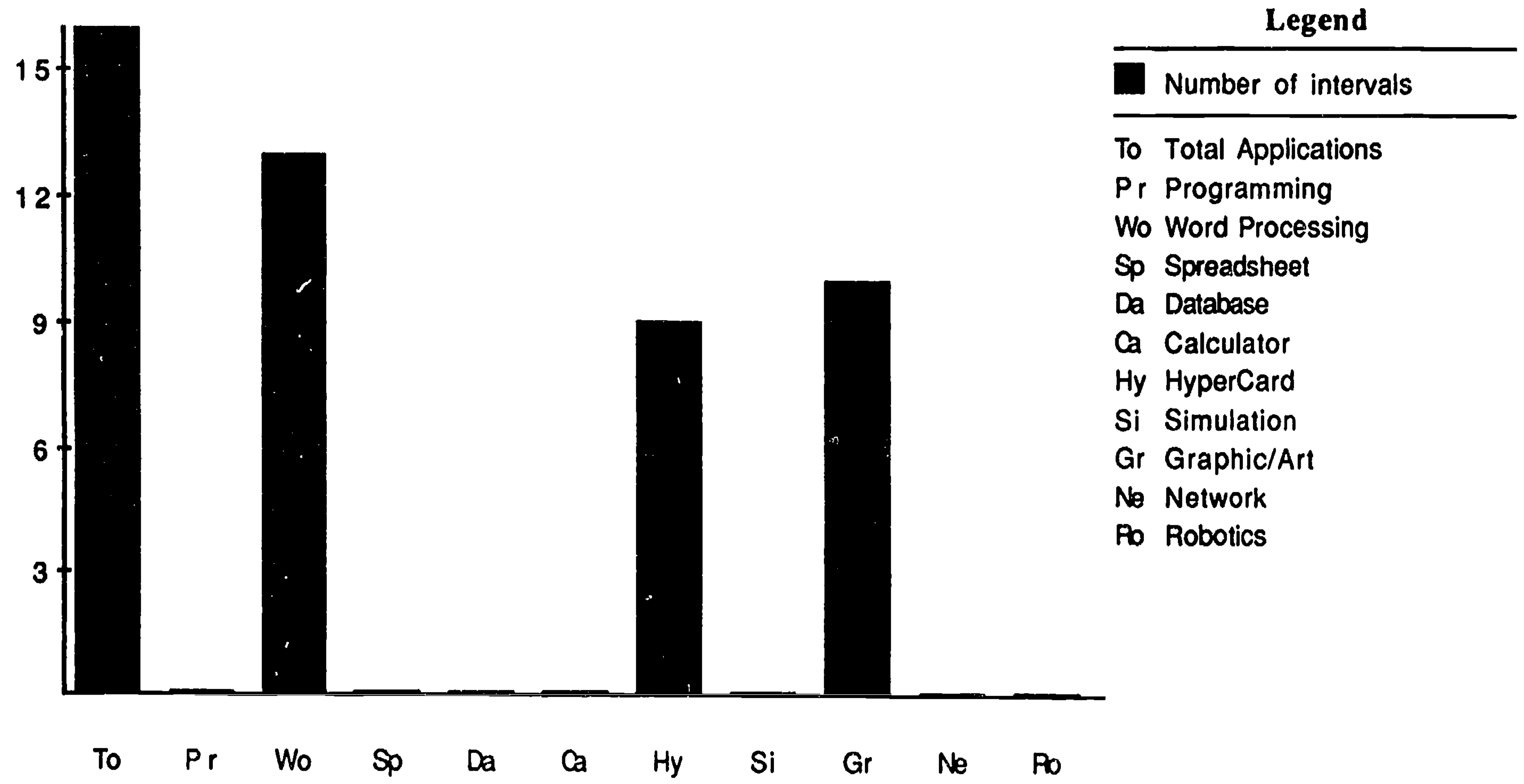
Illustrative Findings
Tuesday September 04, 1990 1:20.53 PM
Figure 18

58

59

Number of Intervals in which Computer Applications were Observed - Secondary Level

Total number of intervals observed and number of intervals in which each application was observed



Illustrative Findings
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Figure 19

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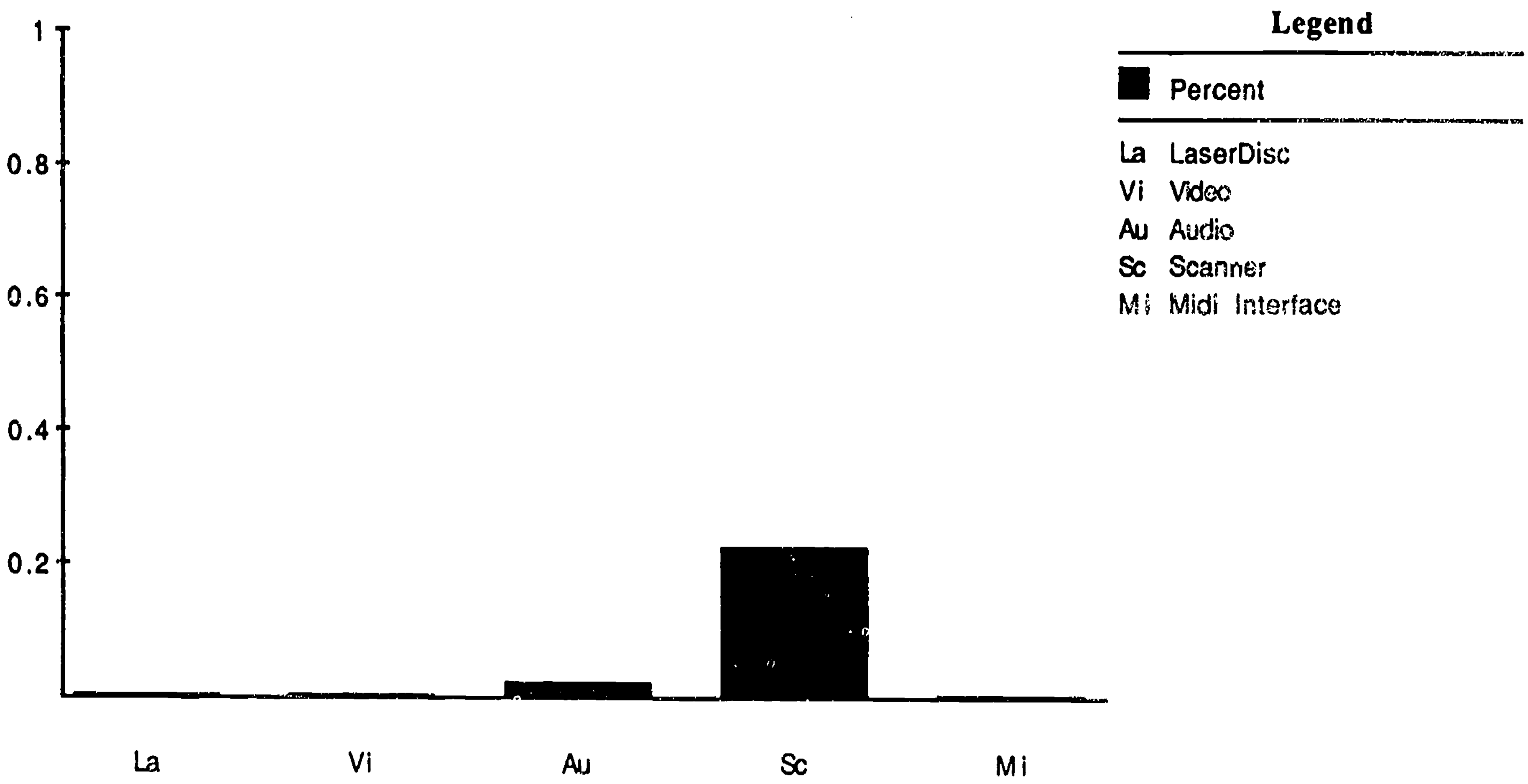
Percentage of Intervals in which HyperMedia were Observed - Secondary Level

Percentages of total intervals in which computer applications were observed with other technologies



Illustrative Findings

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Figure 20

62

63

Nature of students' work. At the elementary level, the language arts tasks were rated predominantly as either medium or low in level of processing—thus, well structured activities with teacher-defined criteria for completion (Figure 21). While teachers were utilizing word processing as support for students' writing, activities in which students participated substantively (in planning and coordinating the work) were rarely observed. Similarly, tasks were generally either short or medium in length and while task length tended to be longer with computer support, it was rarely judged as long in any resource context (Figure 22).

At the secondary level, while well-structured activities with teacher defined criteria for completion were most common, ill-structured activities (high) were not uncommon (Figure 23). The very low frequency of any code "off-computers" reflects the finding that students in the secondary classrooms were rarely producing any assigned product without computer support.[5] Similar to the results for *Level,* tasks were rated at all possible lengths, including "long" (Figure 24). (These indices total more than 100% because multiple-coding within activity is permitted.)

Classroom organization. At the elementary level in language arts, classrooms were generally organized for independent work, and teachers utilized computers heavily as support for independent work (Figure 25). Cooperative work

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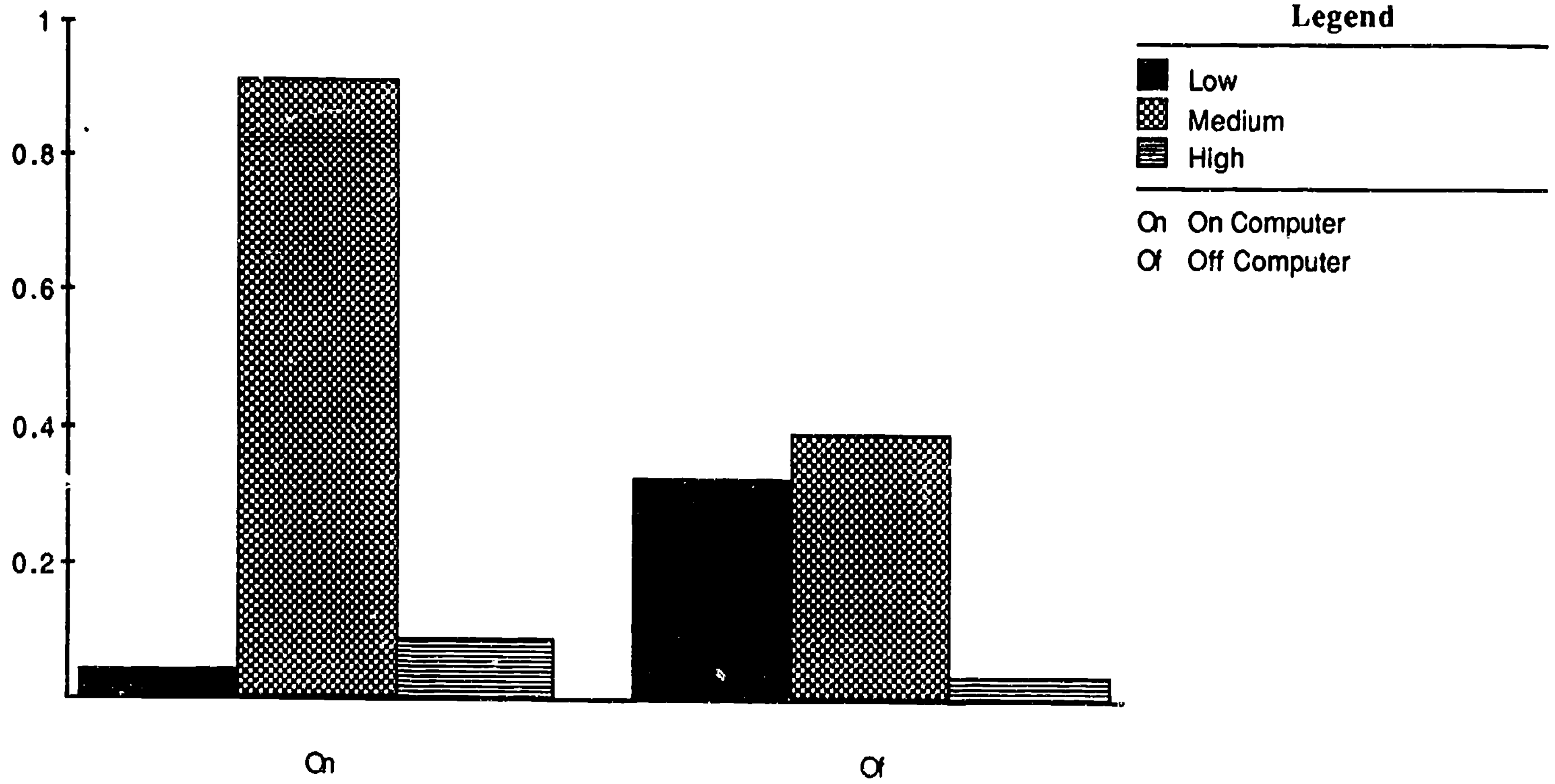
[5] When students are engaged in listening, reading, watching, or taking notes, we do not code their participation for 'Length' or 'Level of challenge'.

Level of Processing Across Resource Contexts - Elementary Level

Percentage of intervals within each resource context that each variable was observed



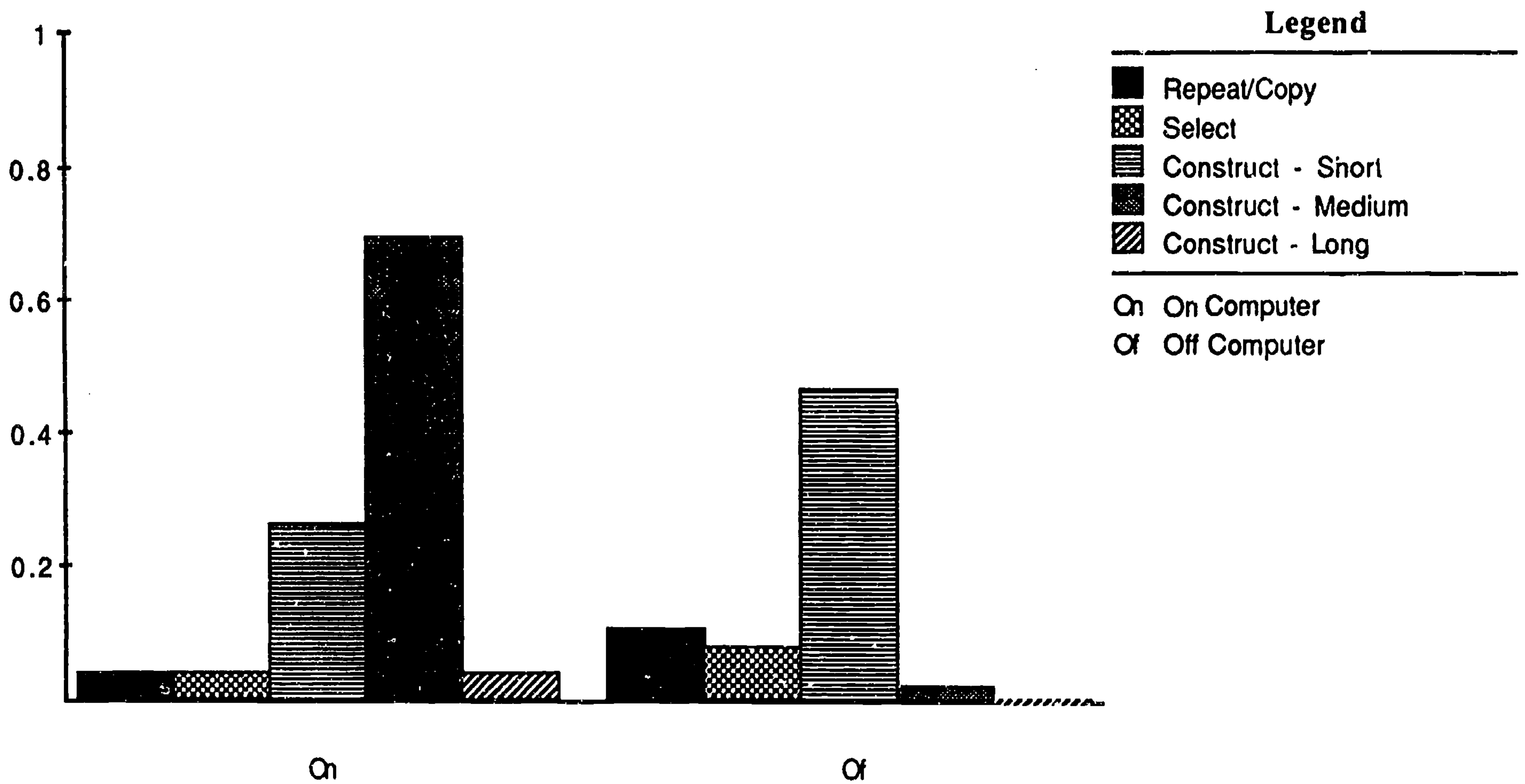
Illustrative Findings

Tuesday September 04, 1990 4:22.26 PM

Figure 21

Product Item Length Across Resource Contexts - Elementary Level

Percentage of intervals within each resource context that each variable was observed



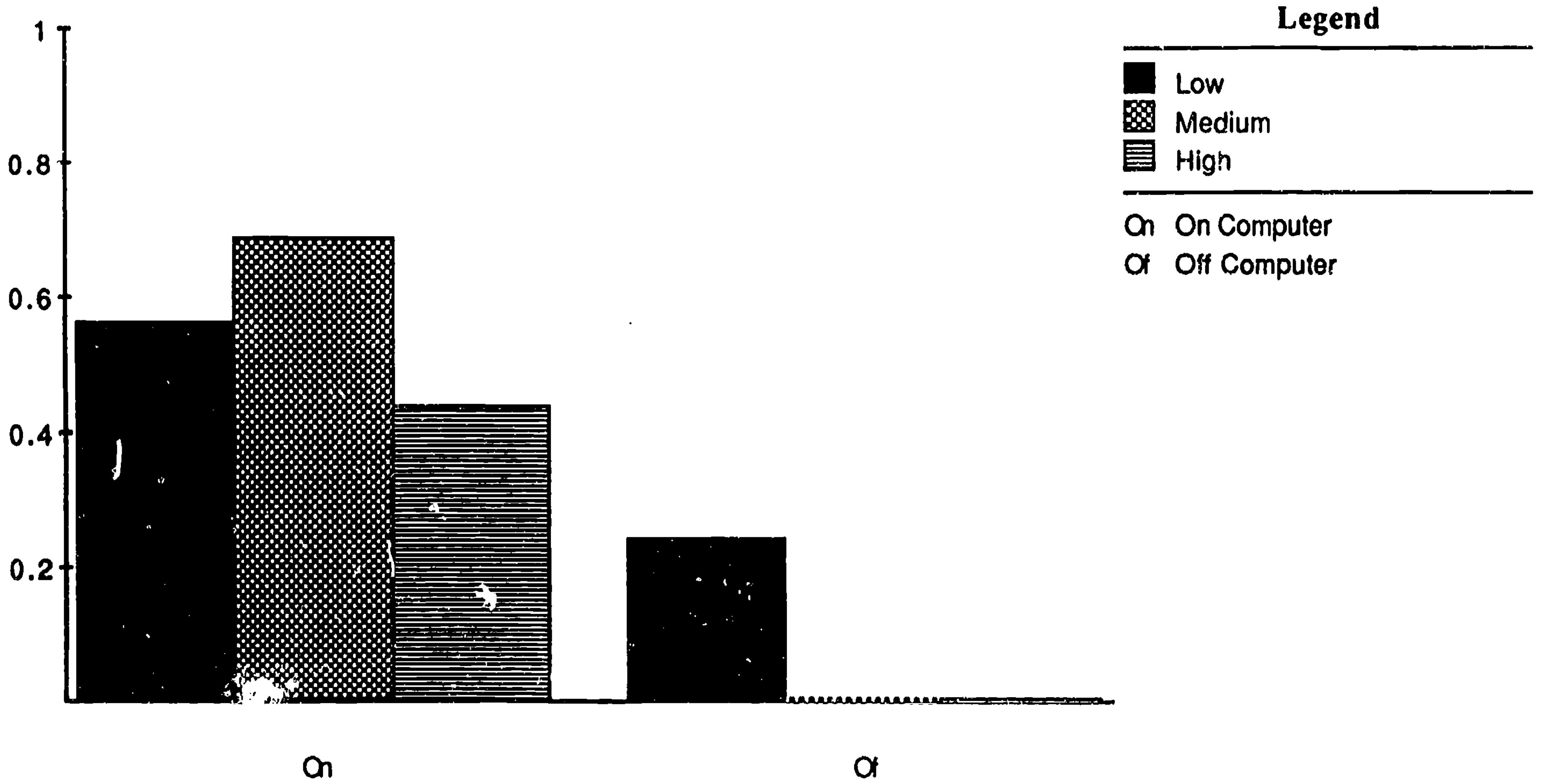
Illustrative Findings
Tuesday September 04, 1990 4:23.32 PM
Figure 22

67

68

Level of Processing Across Resource Contexts - Secondary Level

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings

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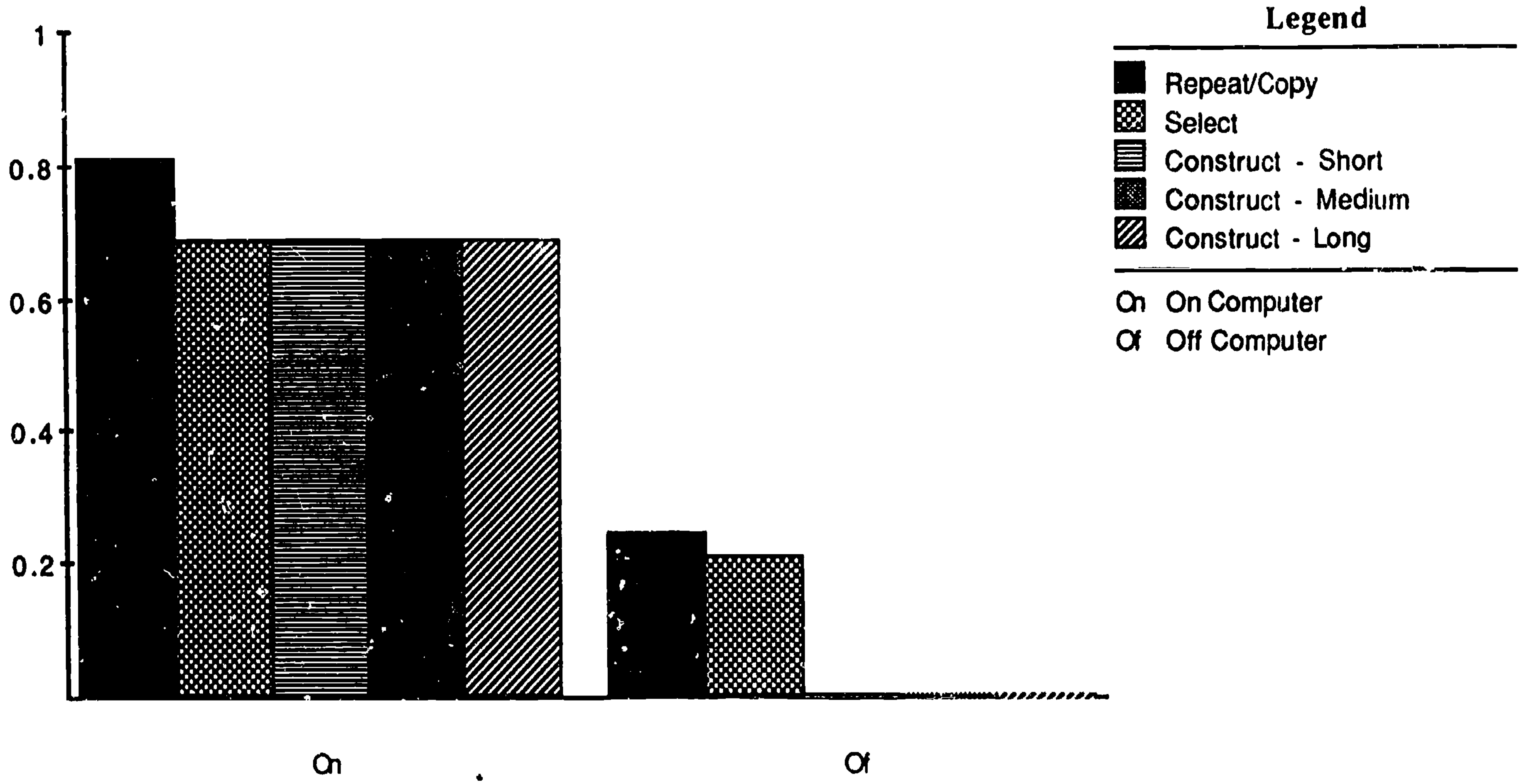
Figure 23

69

70

Product Item Length Across Resource Contexts - Secondary Level

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
Tuesday September 04, 1990 4:28.56 PM
Figure 24

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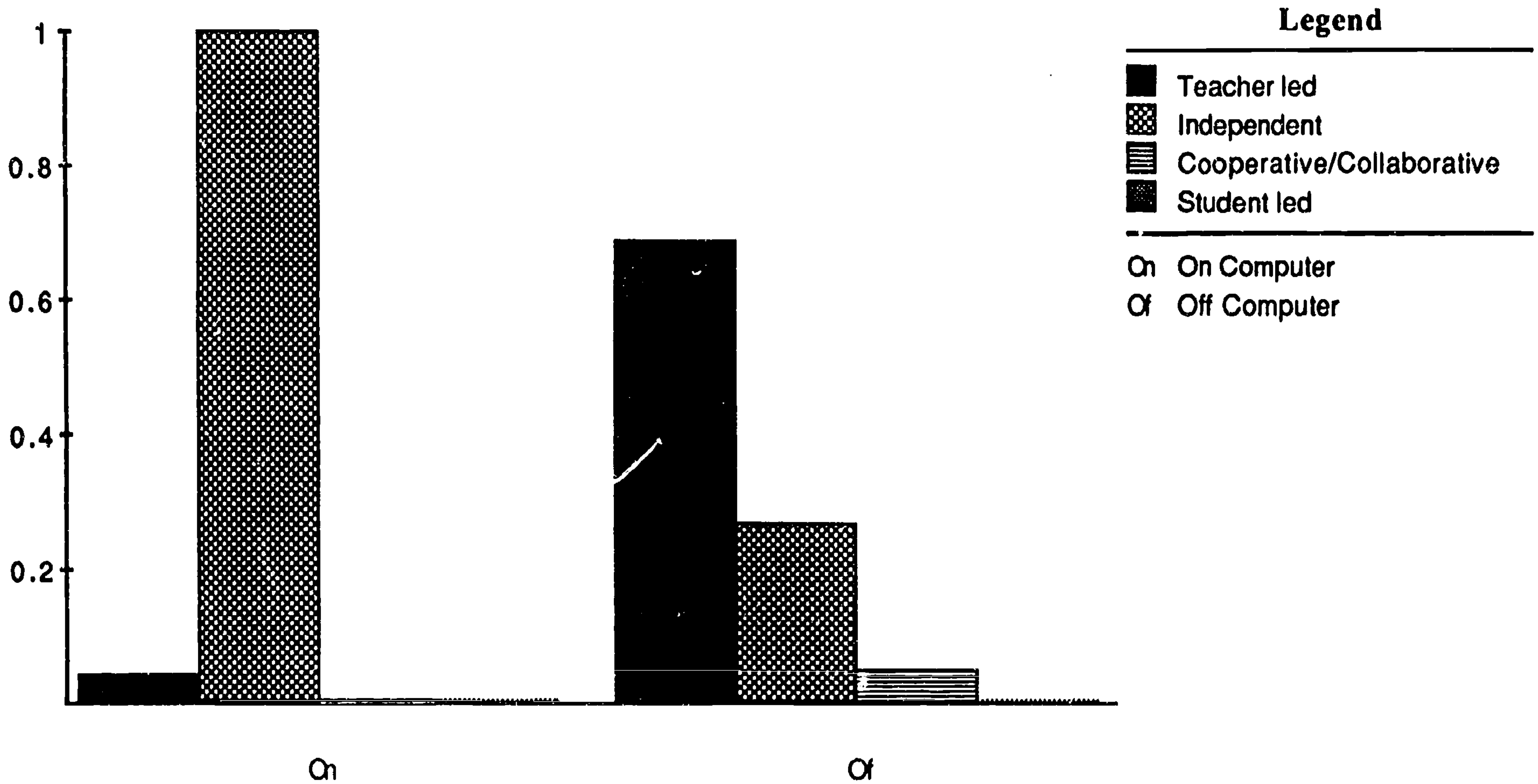
Classroom Organization Across Resource Contexts - Elementary Level

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
Wednesday September 05, 1990 11:29.03 AM
Figure 25

74

73

was very rare, and although truly collaborative projects were observed (jointly-produced products), these activities were not technology-supported (Figure 26). At the secondary level in English, classrooms were generally organized for independent work with computer use, and teacher-led instruction off-computer (Figure 27). Although cooperative activities were not uncommon on-computer, none of these was a collaborative activity (Figure 28).

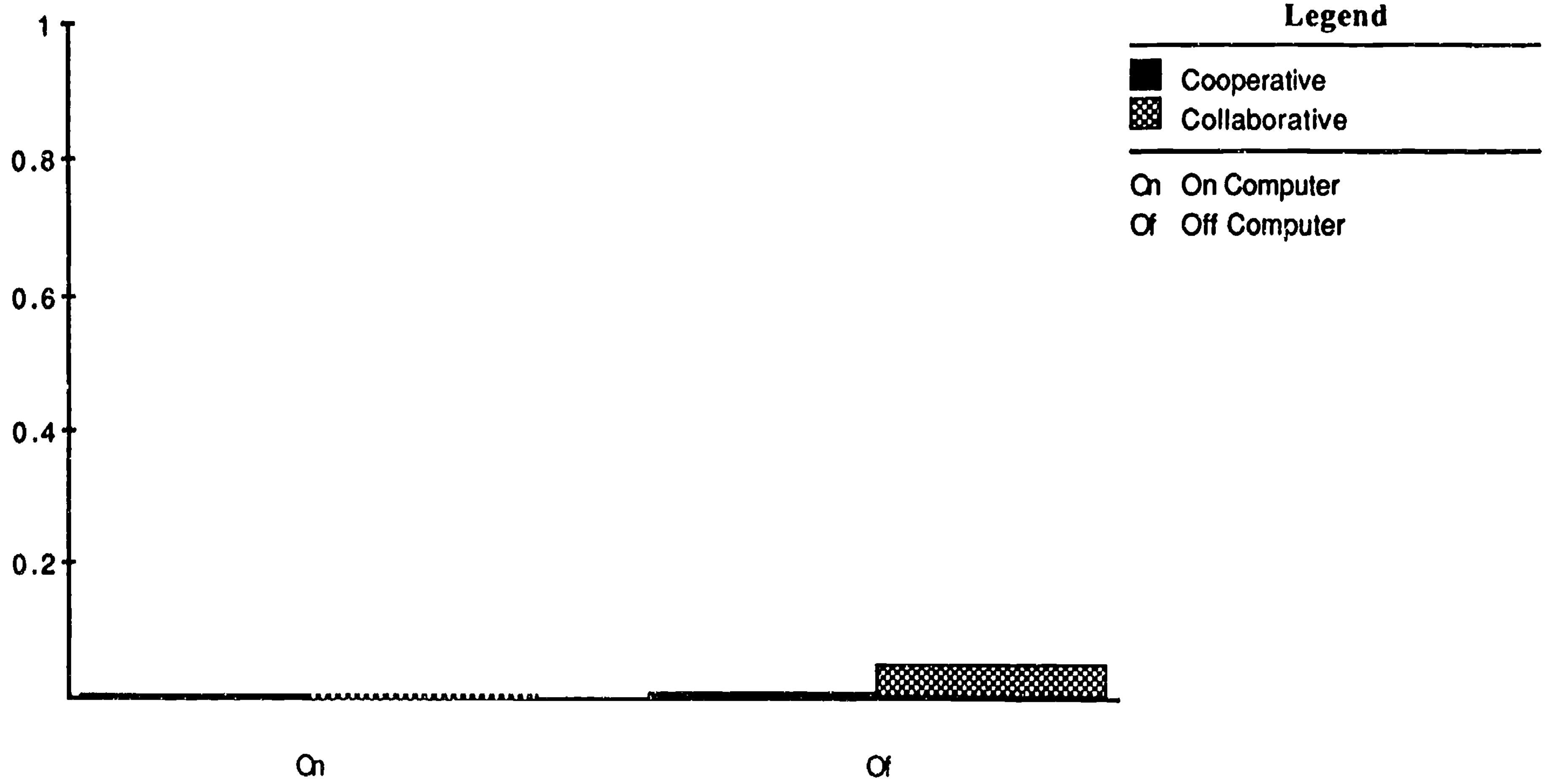
Instruction and support roles. At both the elementary and the secondary levels, teachers were predominantly facilitating instruction when students were on-computer and directing instruction when off-computer (Figures 29 and 30). Students were engaged in productive peer interaction more often with computer support (Figures 31 and 32).

Interpretation: A role for subject matter expertise in teaching. Why might secondary teachers be more able to create opportunities for technology-supported, constructive student work? To provide a possible explanation for the results, and therefore a possible explanation for instructional change as described by a model like Dwyer et al.'s phase model, we return again to work of Scardamalia and Bereiter.

Scardamalia and Bereiter (in press) argue that students engaged in constructive inquiry must be provided with resources representing multiple kinds of expertise. The kinds of expertise articulated—subject matter, curriculum, and pedagogical—can be distributed among teachers, students

Classroom Organization Across Resource Contexts - Elementary Level

Percentage of intervals within each resource context that each variable was observed



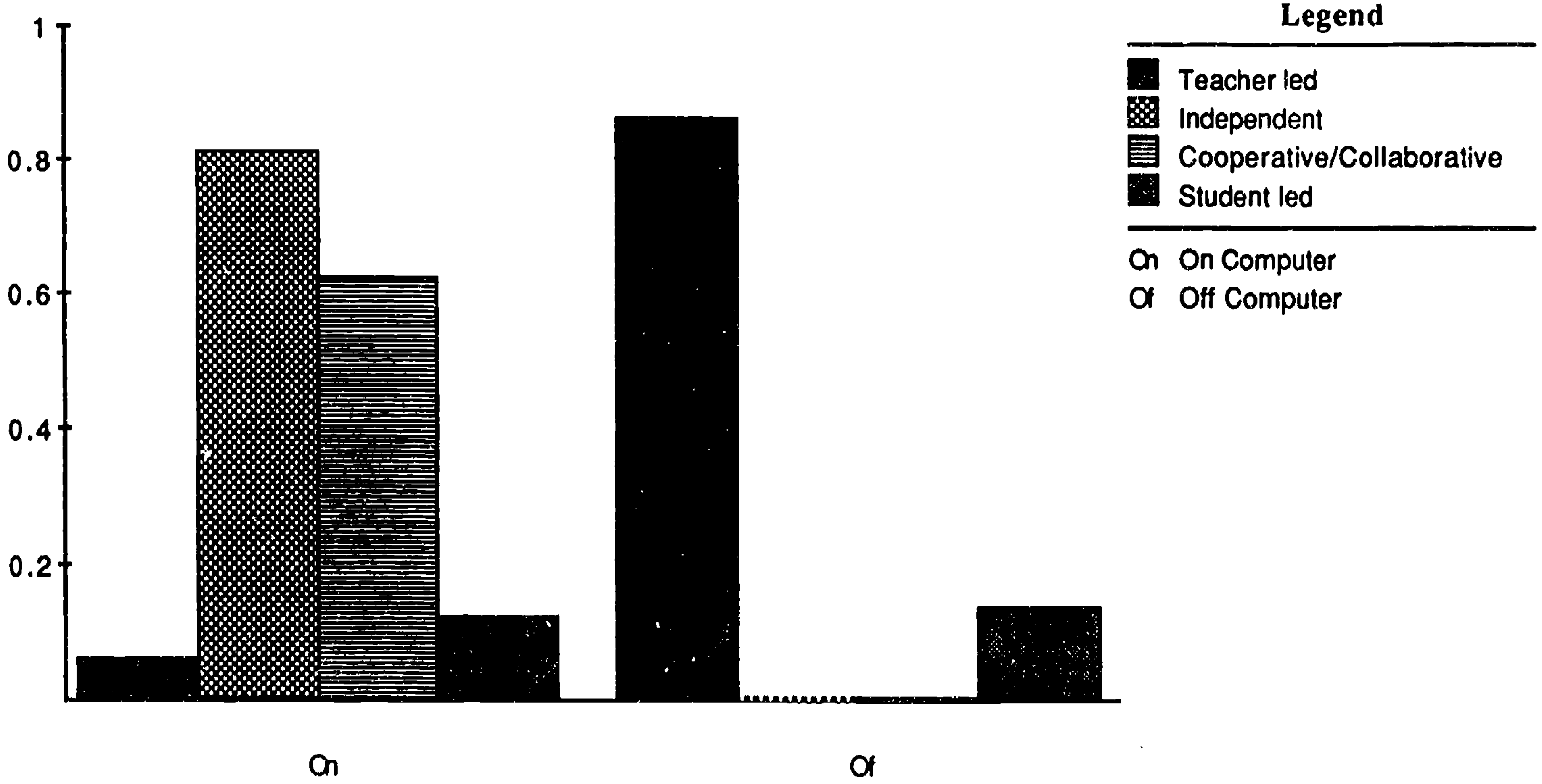
Illustrative Findings
Wednesday September 05, 1990 11:31.56 AM
Figure 26

76

77

Classroom Organization Across Resource Contexts - Secondary Level

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
Wednesday September 05, 1990 11:40.43 AM
Figure 27

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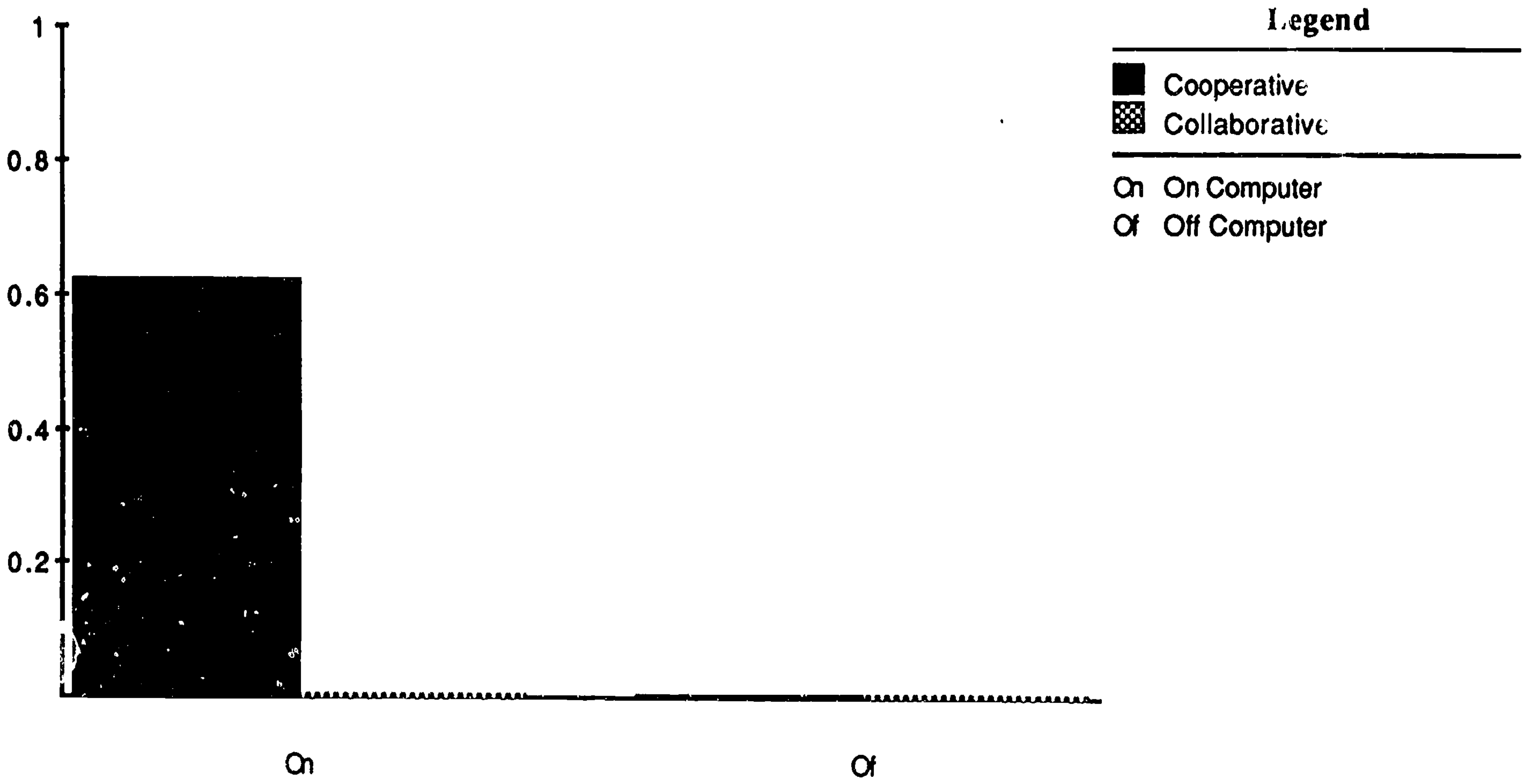
Classroom Organization Across Resource Contexts - Secondary Level

Percentage of intervals within each resource context that each variable was observed



Illustrative Findings
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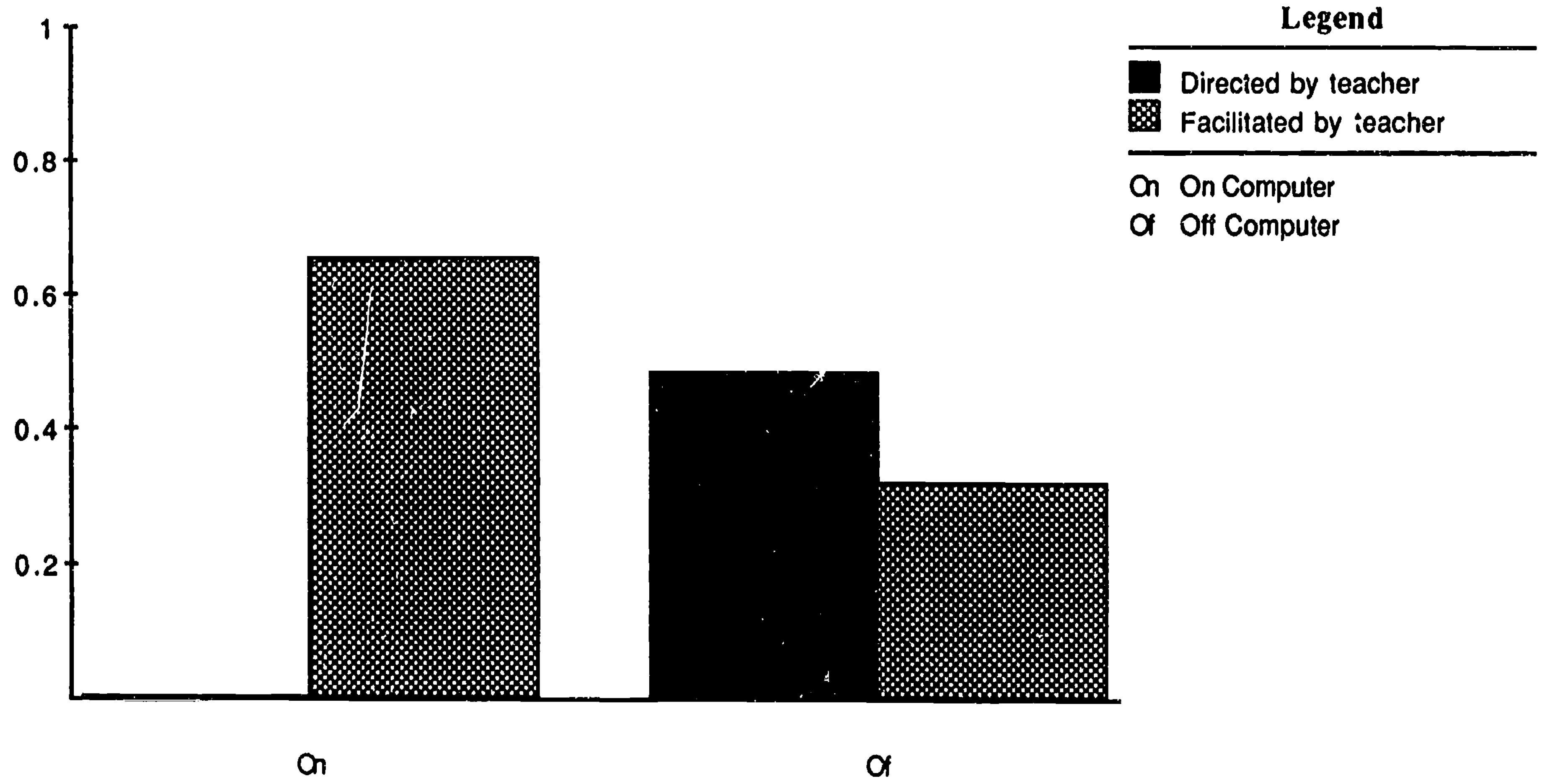
Figure 28

80

81

Adult Role Across Resource Contexts - Elementary Level

Percentage of intervals within each resource context that each variable was observed



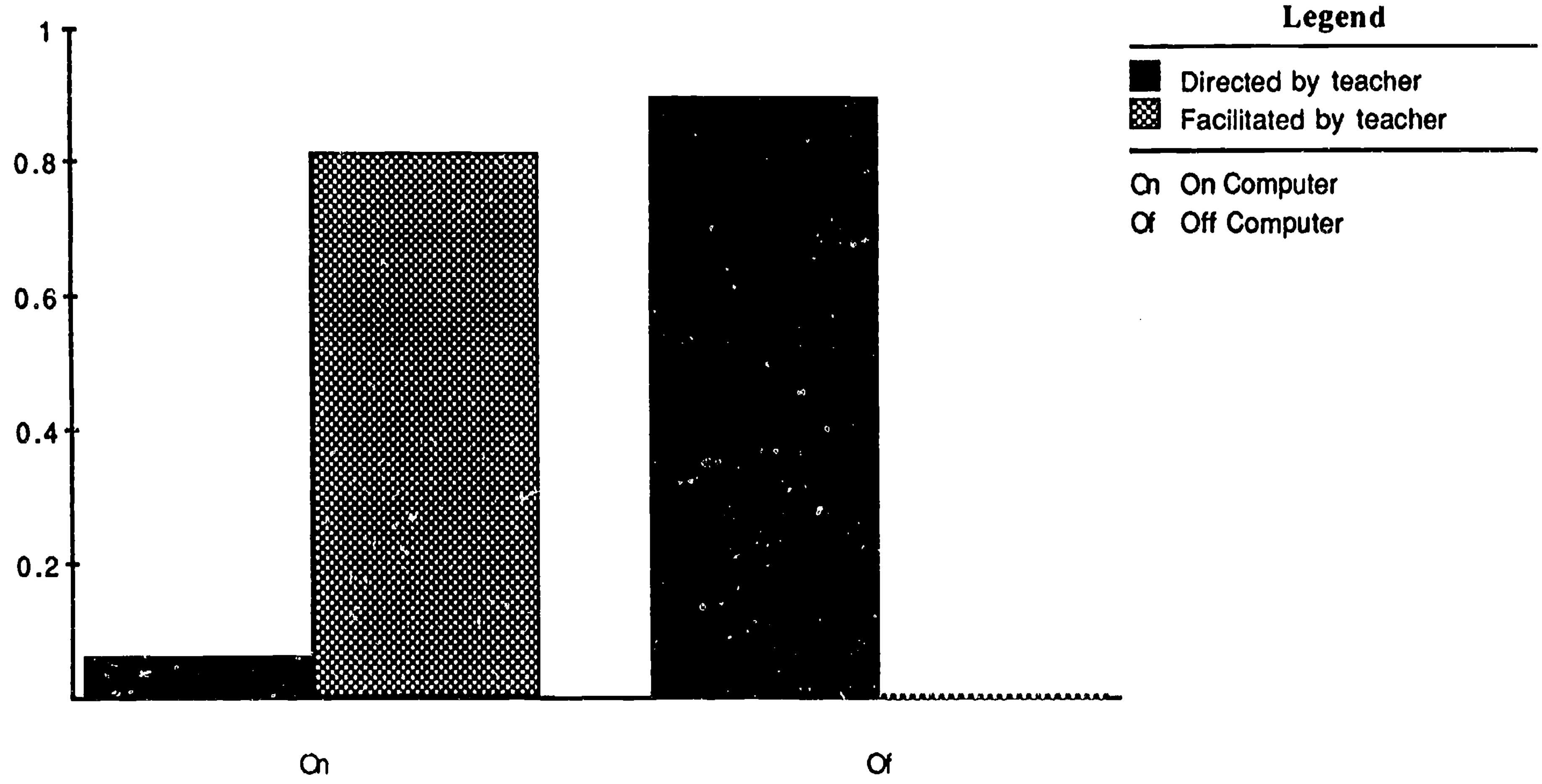
Illustrative Findings
Wednesday September 05, 1990 11:34.08 AM
Figure 29

82

83

Adult Role Across Resource Contexts - Secondary Level

Percentage of intervals within each resource context that each variable was observed

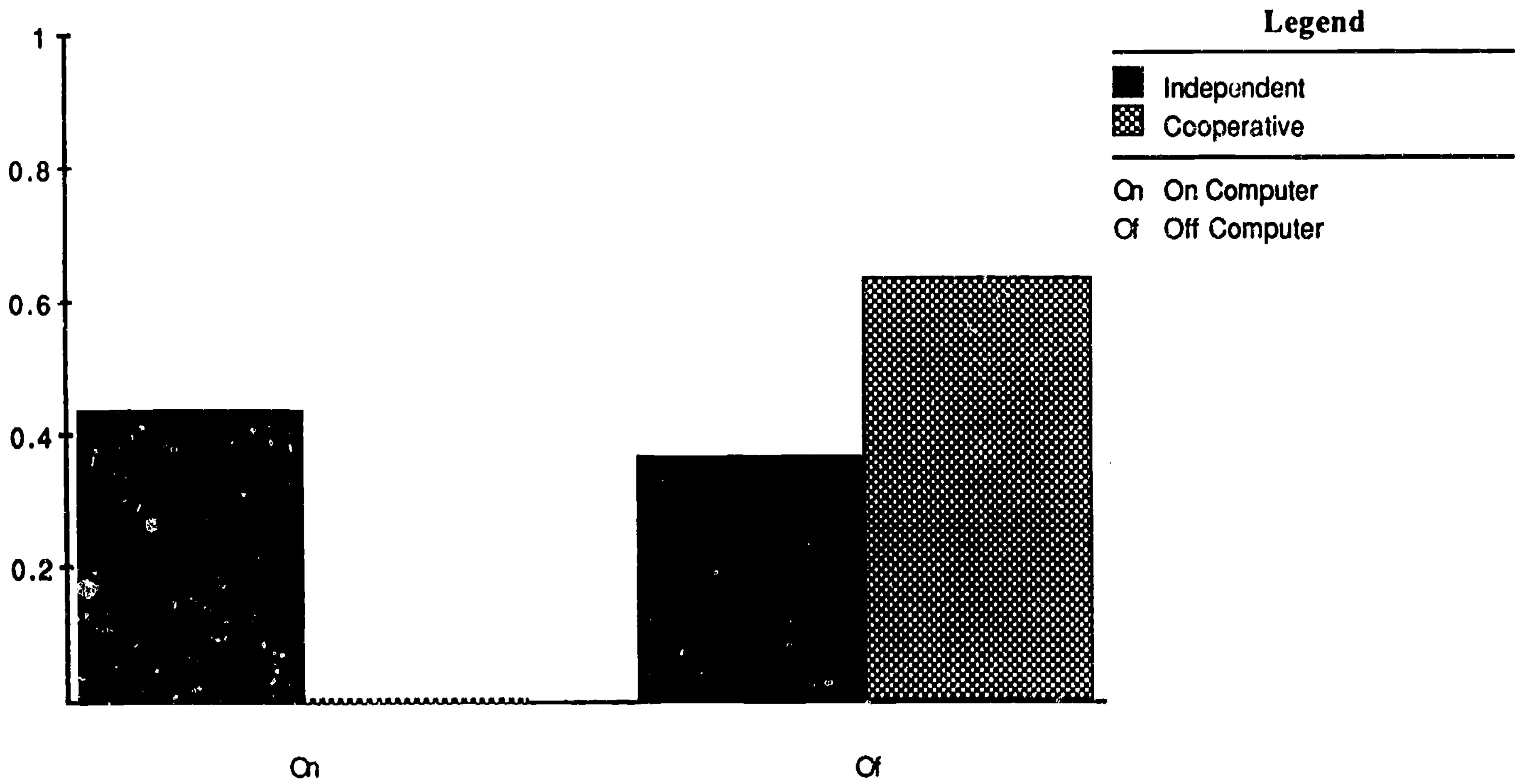


Illustrative Findings
Wednesday September 05, 1990 11:41.30 AM
Figure 30

84 85

Task-related Student Interaction Across Resource Contexts - Elementary Level

Percent of students exhibiting task-related interaction within each resource context



Illustrative Findings
Wednesday September 05, 1990 11:38.59 AM
Figure 31

86

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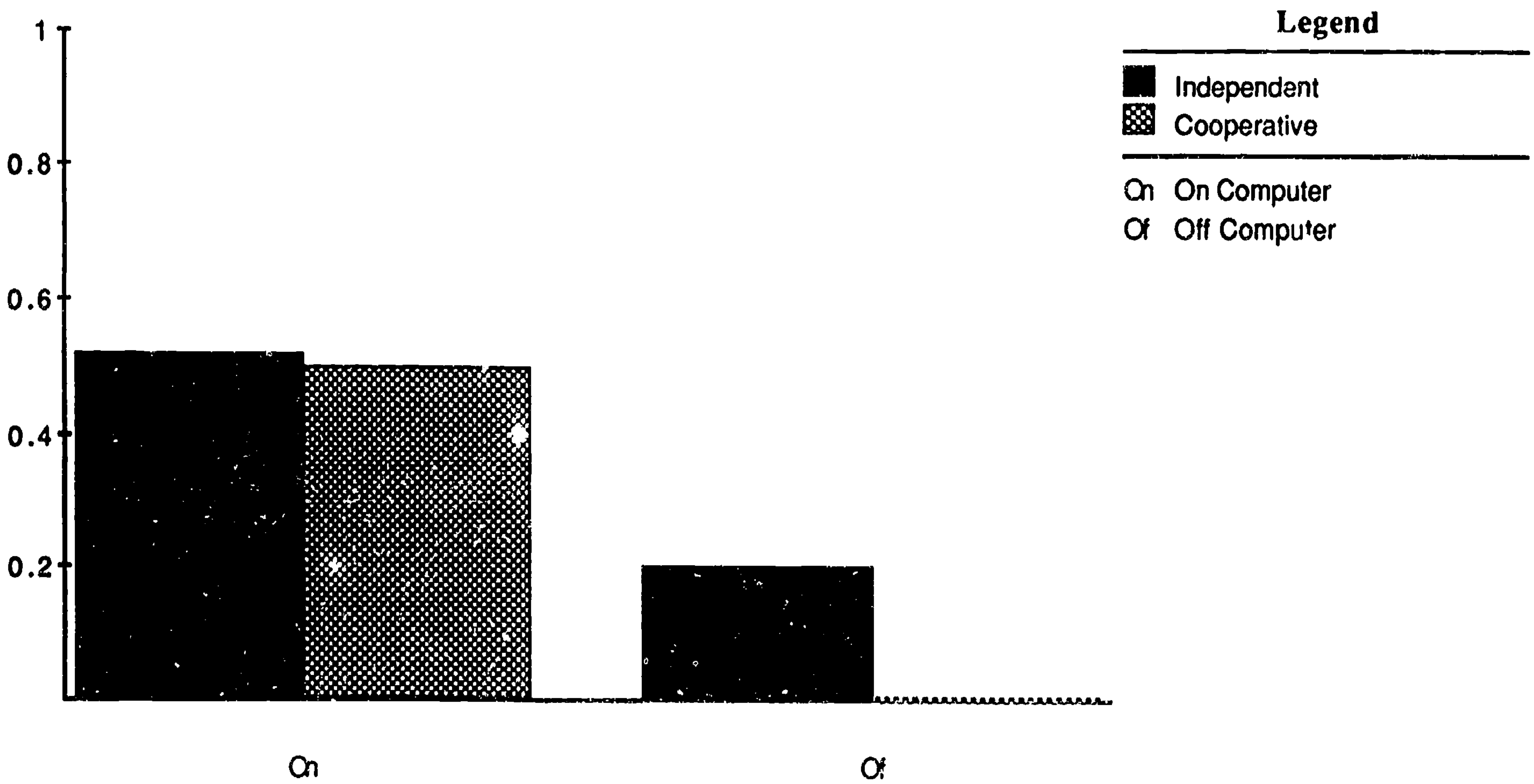
Task-related Student Interaction Across Resource Contexts - Secondary Level

Percent of students exhibiting task-related interaction within each resource context



Illustrative Findings

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Figure 32

88

89

themselves, and instructional materials. Thus teachers are not seen as solely responsible for providing expertise, but as contributors to the design of instructional environments; their expertise certainly helps them to know what is needed to support a given project. Moreover, teachers' own engagement in building personal scholarship—subject matter expertise—provides a model to students of knowledge-building activities.

Scardamalia and Bereiter do not address directly how kinds of expertise can support constructive uses of technology. It is reasonable to assume, however, based on their arguments, that understandings of a subject's concepts and methods enable teachers to envision how technology might support inquiry within that discipline. If so, then the differences we found in technology use between the elementary and secondary level teachers are not surprising given typical differences in subject area training and specialization for teachers at each level. Elementary teachers are curricular and pedagogical generalists within a tradition where curriculum has been defined as a set of discrete facts and concepts not typically based on disciplinary expertise. The secondary teachers are likely to have somewhat greater subject matter knowledge by virtue of the training required of them for certification. Secondary teachers also focus their curriculum development efforts within one subject area. It is likely, then, that subject matter expertise, together with an instructional focus within one subject area, supported ACOT secondary teachers' appropriation of technology's capabilities to support knowledge building and inquiry.

Both sets of teachers, however, have yet to exploit the full potential of technology for fostering deep understanding of subject matter content. There was evidence of some instructional innovation at the secondary level, but the patterns tended to suggest local experimentation (adaptation/appropriation) rather than comprehensive revision (invention). Further work is needed to understand how subject matter expertise, among a range of other factors, plays a role in teachers' construction of new conceptions of instructional environments.

Conclusions and Future Directions

Our goal is to develop tools that enable us to document the impact of technology on classroom instruction and on student, teacher, and parent outcomes. In this paper, we described one new tool—our new classroom observation instrument—and we demonstrated its value for documenting instruction. We provided two illustrations of its potential uses: documenting commonly-reported observations of instruction in high access classrooms, and validating models of the role of technology use on instructional change.

The usefulness of our instrument will ultimately depend on both coordination with other kinds of qualitative data gathering and validation of the instrument through planned contrasts, either with classrooms utilizing technology in

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