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Campus-based university students' use of dialogue

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This investigation explores the kinds of study strategies used by campus-based university students in terms of the dialogues they engaged in while learning physics and chemistry in both large and small classes. Research objectives were threefold: (1) to document what dialogue types, mediated through which resources, were generally utilized by students as they learned, (2) to document what dialogue types, mediated through which resources, were specifically utilized by students to solve problems, and (3) to compare these findings with previous ones obtained from distance education students. It was found that campus-based students in small classes learned in a highly interactive environment characterized by interpersonal dialogue, especially with the lecturer. It was also found that campus-based students in large classes learned primarily through individual study, characterized as intrapersonal dialogue. Both college and university students opted for interpersonal dialogue, especially with peers, when faced with insoluble problems. Findings about students in large campus-based lecture courses replicate earlier findings obtained from distance education students, thereby highlighting similarities between the two seemingly different instructional systems.

Introduction

Over the past 30 years, students' 'study strategies' have been investigated primarily in terms of the approach they adopted, either deep-level or surface-level (e.g. Marton & Säljö, 1976; Biggs, 1987; Brown & Atkins, 1988; Richardson *et al.*, 1999; Lawless & Richardson, 2002). Brown and Atkins (1988) characterized the deep approach as an active search for meaning, and found that this approach results in a more thorough understanding of the material, as well as a better recall of detail even after a long period of time (five weeks and more). They also found that students using the surface approach often rely on the memorization of specific, and many times, unrelated facts that may, in turn, result in a limited understanding of the subject matter.

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Furthermore, it has been found that students' approaches to studying depend on their perceptions of the academic environment; that is, the content, context and the demands of the specific learning tasks (e.g. Laurillard, 1979; Ramsden, 1979; Ramsden & Entwistle, 1981; Brown & Atkins, 1988; Meyer, 1988; Meyer & Muller, 1990; Eley, 1992; Gibbs, 1992; Ainley & Long, 1994; Hambleton *et al.*, 1998). In addition, Ramsden and Entwistle (1981) found that students' perceptions of a heavy course workload were correlated with a surface approach, while Brown and Atkins (1988) found that 'different students will use different strategies on different tasks' (p. 155). Eley (1992) found that the *same* students used different approaches to studying in different courses, and that there was considerable variation in how different students perceived the same courses. These analytic methods yielded useful information regarding students' study strategies. Indeed, based on these and other findings, instructional strategies were developed to enhance the use of deep-level approaches by students (Gibbs, 1992).

This article recounts a research study aimed at exploring individual accounts of the 'study strategies' used by campus-based students as they learned introductory level university physics and chemistry. It does so, however, by adopting a different analytic method derived from a theoretical framework of instruction articulated by Gorsky and Caspi (2005). The framework assumes the centrality of dialogue in instruction and views elements of an instructional system as either dialogues or as resources that support dialogue. Within this framework, students' study strategies and practices are viewed in terms of the kinds of dialogues they engaged in, and the resources they used to realize these dialogues. This analytic method affords some new insights into how students learn and opens some courses of action for enhancing such learning. A brief review of the framework follows.

Dialogue: a theoretical framework for instructional systems

The theoretical framework, and the analytic methodology upon which it is based, take into account that modern campus-based and distance universities include a diverse array of resources for learning. Such resources include lectures, tutorials, conventional texts, self-instruction texts and materials, audio and video cassettes, Web-based instructional systems, etc. In addition, there are many and diverse resources for interpersonal dialogue (teacher–student and student–student), such as face-to-face meetings, telephones, email, and websites for synchronous and asynchronous interaction.

The framework was initially formulated to provide a theory of instruction, centered on dialogue, for describing learning activities in distance education systems. The framework may be generalized, however, to encompass both distance and conventional campus-based instructional systems. Any instructional system (e.g. a university program, course or lesson) may be analyzed in terms of instructional dialogues and the resources that make them possible. The framework offers three advantages: (1) a unified, coherent and simple description of the mechanisms at play

in instructional systems, (2) clear-cut operational definitions for the variables that comprise instructional systems, and (3) hypotheses that may be investigated empirically. The framework is discussed here in general terms only; a specific, detailed analysis may be found in Gorsky and Caspi (2005).

The key element of the framework is *learning*—not the student, not the teacher and not the physical, temporal or transactional constraints separating them. Five basic assumptions underlie the framework:

1. Instruction is a set of purposeful activities directed toward achieving learning.
2. Learning is an individual activity characterized by internal mental processes.
3. Learning is *mediated* by intrapersonal dialogue.
4. Learning is *facilitated* by interpersonal dialogue.
5. Dialogue is enabled by structural and human resources.

Structural resources for intrapersonal dialogue include all materials of any kind that students may learn from. Structural resources for interpersonal dialogue include all available communications media and the availability of teachers and fellow students. Human resources for interpersonal dialogue, within the domain of an instructional system, are the teachers and students who may engage in instructional dialogue, or not. Students may, of course, engage in dialogues with significant others such as parents, friends and employers. Since these human resources lie beyond the domain of instructional systems, they are not taken into account. Students may utilize instructional resources as they see fit, in accord with their goals, abilities and needs.

Given these assumptions, *all* study strategies and practices used by students may be viewed and analyzed in terms of the *dialogues* they engage in and the *resources* that make the dialogues possible. Three illustrations follow:

1. A student reads a text. The text is a structural resource that enables intrapersonal dialogue.
2. Student X seeks help in solving an assigned exercise by posting a message in an asynchronous discussion group. Student Y responds. The discussion group is a structural resource for interpersonal dialogue, while Students X and Y are human resources.
3. A student solves assigned exercises at home and submits them to the instructor. The instructor grades the exercises and returns them to the student who then reads the graded exercises. The assigned exercise is a structural resource that enables both intrapersonal dialogue and interpersonal instructor–student dialogue. The dialogue is intrapersonal as the student solves the exercises at home. It becomes interpersonal when the student submits the completed exercise to the instructor, thereby closing the loop—instructor to student, student to instructor. An additional interpersonal link (or thread) occurs when the instructor returns the graded exercise to the student. A further *intra*personal dialogue may occur if the student reads the corrected exercises with the intent to learn from his or her mistakes.

The model of intrapersonal instructional dialogue

The construct 'intrapersonal instructional dialogue' refers to the interaction between student and subject matter as the student is purposefully trying to learn. Learning theorists may term the internal mental processes that occur as 'assimilation' or 'accommodation' (Piaget, 1970), as 'accretion', 'structuring' or 'tuning' (Rumelhart & Norman, 1978), as 'intra-psychological processes' (Vygotsky, 1978), or as 'internal didactic conversations' (Holmberg, 1989). From our point of view, when students read texts, listen to lectures or audiotapes, view educational films, solve problems or manipulate computer simulations with the intent to learn, they are said to be engaged in intrapersonal instructional dialogue. Defining particular learning skills, as well as accounting for their acquisition and development, are beyond the domain of the instructional theory; these issues are delegated to learning theorists and educational psychologists. Furthermore, dialogue may occur without the physical presence of instructional materials; for example, a student jogging *and* thinking about subject matter is engaged in intrapersonal instructional dialogue.

Students utilize structural resources as they see fit. The quality and availability of the resources may make a significant impact on learning outcomes. However, Gorsky and Caspi (2005) contend that the most significant resource in intrapersonal dialogue is the human being, the learner, not the structural resources. They state:

> Each individual learner is characterized by a constellation of variables that include his or her goals for the course, prior knowledge, motivation, intelligence, and anxiety, among others. These variables differ for each learner and they determine the extent of intrapersonal dialogue that occurs and its quality. (p. 139)

This constellation of variables is dynamic and may change even over short time intervals.

The model of interpersonal instructional dialogue

Ultimately, all learning is *mediated* directly by intrapersonal processes, even learning *facilitated* by interpersonal dialogue. Despite this, interpersonal dialogue is afforded a prominent position in the theory.

Dialogue. An interpersonal instructional dialogue is defined as a discursive relationship between two or more participants characterized by thought-provoking activities such as questioning, hypothesizing, interpreting, explaining, evaluating and rethinking issues or problems at hand (see Gorsky & Caspi, 2005). A dialogue is said to have occurred if one or more of the activities listed above is manifested in an interaction, either teacher–student or student–student. This is a judgment based on a qualitative analysis of data from sources such as observations, videos, transcripts, interviews and questionnaires (see Silverman, 2001).

There are different kinds of dialogue with different specific aims that, in turn, derive from different philosophical stances. Dialogue may be used as a means to increase student understanding, or to sharpen students' analytic skills, or as an evaluation tool.

Burbules (1993) listed four types of dialogical engagement: inquiry, conversation, instruction and debate. Each may be either teacher–student or student–student dialogue. The teacher, characterized by 'conceptions of teaching' and 'approaches to teaching' (Kember, 1997) and facilitation skills (Rogers, 1969), plays a critical role in creating and maintaining dialogue, both in conventional and in distance education programs (Dewey, 1916; Bruner, 1966). The student, characterized by prior knowledge, motivation, anxiety, autonomy and other traits, will participate in interpersonal dialogue to greater or lesser degrees.

Learning outcomes. Three learning outcomes, achievement, attitudes and student satisfaction, are included in the framework. A direct, causal relationship between dialogues and learning outcomes, which may be investigated empirically, is hypothesized, although not investigated in this study.

The context for this study

Students' use of dialogue was studied in two very different instructional environments. The first was at a relatively large university (about 22,000 undergraduate students), while the second was at a relatively small academic teachers' training college (about 1000 undergraduates). Preliminary inquiries confirmed that instructional strategies in the two environments were indeed very different. The university courses under study had a large number of participants and were lecture oriented, while the college courses had a small number of participants and were discussion oriented. This distinction enabled us to view students' use of dialogue as a function of instructional strategy that, in turn, was derived from group size. Neither institution had required texts. In other words, the primary mode of instruction was the oral presentation of subject-matter material, either in the form of lecture or discussion. At both institutions, senior faculty members holding the rank of professor (henceforth referred to as 'lecturers') were responsible for the curriculum and also made the oral presentations.

Students' use of dialogue was investigated in introductory-level physics and chemistry courses. Their dialogic behavior in the laboratory was not investigated. At the large university, students who participated in the study had completed *either* Physics 1 (Mechanics) and Physics 2 (Electricity) *or* General Chemistry 1 and General Chemistry 3. Each of these courses had five hours of weekly instruction, two lectures (two academic hours) and one tutorial (one academic hour). Each course had more than 200 registered students and each included a lecturer, a professor, who was responsible for the lectures and examinations, and an instructor, usually a graduate student, who was responsible for the tutorials. Estimated average attendance per lecture was about 175 students while estimated attendance at tutorials, where answers to the previous week's exercises were reviewed, was about 40 students. Students could meet with lecturers and instructors in their respective offices, whose telephone numbers and email addresses were available to them. In

addition, instructors were generally available to students both prior to class and afterwards, while professors were generally not.

At the small college, students participating in the study had completed courses parallel to Physics 1 and Physics 2 (no chemistry program exists at the college). These courses each had about 10 registered students and, on average, estimated attendance per class session was about 8–9 students. Courses had two weekly class sessions each lasting two academic hours. Tutorials, as such, were not offered at the college. However, the lecturers also fulfilled this task by reviewing solutions to the assigned exercises with the students. Lecturers were generally available both prior to the scheduled class and afterwards. Students could meet with lecturers, whose telephone numbers and email addresses were available to them, in their offices.

Student assessment at both the university and college was similar—weekly written exercises accounted for 10% of the grade, while the final examination accounted for the remaining 90%. Table 1 summarizes the human and structural resources available at the two institutions.

Research aims

Research objectives were threefold: (1) to document what dialogue types, mediated through which resources, were generally utilized by students as they learned, (2) to document what dialogue types, mediated through which resources, were specifically utilized by students to solve problems, and (3) to compare these findings with previous ones obtained from distance education students (Gorsky *et al.*, 2004a, b).

Table 1. Availability of human and structural resources

Dialogue types	Human resources	Structural resources: large university	Structural resources: small college
Intrapersonal	Student	Lectures Tutorials Recommended texts Website materials Exercises	Lectures Recommended texts Exercises
Interpersonal	Lecturer–Student	During lectures Telephone Email Personal meetings Final examination	During lectures Telephone Email Personal meetings Final examination
	Instructor–Student	During tutorials Telephone Email Personal meetings Submitted exercises	(not relevant)
	Student–Student	Telephone Email Personal meetings	Telephone Email Personal meetings

Methodology

Rationale

Investigating a phenomenon as subtle and complex as student learning requires both: (1) an in-depth examination of individual learners in order to produce preliminary findings, and (2) large-scale evaluation techniques to reach a much wider population in order to assess the validity of such findings. A grounded theory approach (Glaser & Strauss, 1967; Glaser, 1978; Hitchcock & Hughes, 1989; Cohen & Manion, 1989; Charmaz, 1995; Strauss & Corbin, 1998) generally begins with small naturalistic studies carried out in order to generate models and hypotheses, that can then be tested on larger populations using conventional statistical techniques. Taber (2000) wrote that 'grounded theory may be used to bridge between case studies and large-scale surveys, which enables the strengths of both to be combined in the same research programme' (p. 470). Unlike most qualitative methodology, the intent of the grounded theory approach is to produce models and hypotheses that include testable outcomes.

This study is the third in a series of small-scale naturalistic inquiries designed to investigate university students' utilization of dialogue in accord with the model generated by two previous studies (Gorsky *et al.*, 2004a, b). The two previous studies dealt with distance education students, while this one deals with campus-based students. All three studies are part of an overall research program whose primary goal is to document how students learn in different instructional systems, especially technology enhanced ones, when their behavior is viewed in terms of dialogue and the resources that mediate it.

Participants

Three physics lecturers participated in the study: two from the college and one from the university. These lecturers taught the courses being investigated. A total of 14 students participated in the study: four physics majors and four chemistry majors from the large university alongside six physics majors from the small college. Students were selected according to the following criteria: all expressed willingness to explore and to articulate their own learning processes, and all had completed successfully at least five science courses in a previous semester. The latter criterion ensures that students had amassed enough experience so that dialogue preference would be the result of practical experience, and not the result of random trial and error; that is, they have acquired a sense of knowing how and what to learn based on direct personal experience.

Methods of data collection and analysis

Data were gathered from semi-structured interviews wherein faculty and students were interviewed personally in a natural, open and non-threatening context. Personal learning and teaching practices, described in the participants' own words, should

provide a range of data for understanding their perceptions about the use of different dialogue types, and the resources through which these dialogues were mediated. Initial phases of data analysis involved classifying data in accordance with the research questions. Data generated by each student were analyzed in terms of research questions 1 and 2 for purposes of pattern formation and pattern matching. Preliminary patterns are formed from initial data and then modified and refined to match new data. Pattern matching involves looking for similarities in the reactions, thoughts, and actions of the participants (Ericsson & Simon, 1984; Hill & Hannafin, 1997). Patterns may lead to a model or to a set of related models that can describe *and* explicate students' use of dialogue and instructional resources in specific instructional settings. In order to achieve this goal, a constant comparative method (Silverman, 2001) was used in which initial, preliminary patterns (hypotheses) were proposed and then tested in subsequent interviews with different students. This process was carried out until no more new knowledge was gathered.

Interviews with students. Each participant was interviewed once, toward the end of spring semester 2004, in a semi-structured, tape-recorded interview that took about 40–60 minutes. The interviewer made brief notes during the session and extensive notes immediately upon completion of the interview. Interviews sought participants' accounts of their communicative behaviors, both internal and interpersonal, and of reflections on their learning experiences. Participants were asked questions aimed to be as neutral and open-ended as possible, while probing for particular, idiosyncratic aspects of experience. For example,

- Did you attend lectures? Why? Why not? How often?
- Did you write notes during the lecture? Did you ask questions? Did you pay attention to answers given to questions asked by other students?
- What did you do at home or in the dorm when you couldn't solve a problem?
- Did you personally communicate with the lecturer, the instructor or with other students? How? Why? When? Where?
- Did you post messages on the Website? Why? Why not?

Interviews with faculty. Interviews took place after completion of the course, after students' final grades had been recorded and after the interviews with students. The lecturers discussed their perspectives about instructional strategies, the relative difficulty of tests and assignments, and the quality and amount of interactions and dialogues that occurred with students.

Research findings

The first set of findings reported are those that emerge from interviews with faculty. Additional findings, generated by students, deal with how they learned generally and how they dealt with the inability to solve problems specifically. The final research issue, comparing these findings with previous ones obtained from distance education students, is dealt with in the discussion.

Faculty: the impact of group size on instructional strategy and the impact of instructional strategy on the dialogic behavior of students

Two experienced physics lecturers from the college were interviewed. One had taught 'mechanics', while the second had taught 'electricity'. Both emphasized the exceptional circumstances of their courses; that is, the extremely *small* number of participants. This small group environment was typical of the college and enabled an instructional strategy based on a highly interactive lecture format that included a great deal of discussion. Not only were students encouraged to ask questions freely at any point, but also lecturers asked students questions in order to verify that the material was indeed understood. The lecturers believed that all or almost all the students present asked one or more questions during class, and that they, in turn, on their own initiative, managed to communicate with each of the students, at least once per class session. Both lecturers seemed to pride themselves on their availability and willingness to help 'their' students.

The highly interactive instructional strategy and the familiarity with the students were possible because of the small group size. Despite this, the lecturers reported that for most students, the courses were very difficult. Difficulty, they believed, was due to the courses including a large number of basic concepts which were very abstract in nature. The mathematical representation of the concepts added to the perceived difficulty. The lecturers felt that they were 'utilized' by the students to a very high degree. Nearly all personal communication with the students was by face-to-face encounters before and after the classroom sessions. Very few students met with them in the office regarding subject-matter issues, and even fewer, if any at all, called by telephone or sent emails.

One experienced physics lecturer from the university was interviewed. He taught mechanics and emphasized the exceptional circumstances of his courses; that is, the extremely *large* number of participants. This large group environment was typical of the university, and dictated an instructional strategy based on a lecture format that included only a limited number of questions and answers. Given his experience with teaching the course, the lecturer felt he knew what topics were especially difficult and devoted more time to explanation. Although students were free to ask questions at any point, the lecturer often used a 'friendly' hand gesture to convey 'not now'. He reckoned that during a typical lecture he answered about 10–15 questions. Assuming that different students asked the questions, only about 7–8% of the students present at any given lecture actually posed questions that the lecturer addressed. In other words, for more than 90% of the students, the lecture was a structural resource for intrapersonal dialogue and for interpersonal student–student dialogue mediated by whispering and/or note passing. Although students could meet with the lecturer in his office, very few did so for the purpose of discussing subject-matter issues and none, as recollected, telephoned or sent an email.

The lecturer was aware that for most students the course was very difficult. Like his colleagues at the college, this difficulty, he believed, was due to the courses including a large number of basic, non-intuitive abstract concepts represented mathematically.

The lecturer felt that students 'utilized' the resources of the course to a very high degree, especially the tutorials.

How students generally learned

At both institutions, the spoken word was the predominant means by which students were expected to acquire concepts. University students interacted with subject matter through lectures, while college students interacted through a lecture/discussion format. The written word, the assigned weekly exercises and the final examination were utilized for purposes of assessment.

All 14 students, even the very good ones, perceived the courses under investigation as difficult. The major source of difficulty seemed to be a lack of connection between theory and problem-solving skills. Both physics and chemistry students made this observation. The utilization of the structural and human resources available to the university students appears in Table 2.

Findings may be summarized as follows:

1. University students believed that they fully utilized all available structural resources for intrapersonal dialogue. They:

Table 2. Utilization of human and structural resources by university students (very high, high, moderate, low, very low or none)

Dialogue types	Human resources	Structural resources: large university	Extent of utilization by students
Intrapersonal	Student	Lectures	Very high
		Tutorials	Very high
		Recommended texts	Very high
		Website materials	Very high
		Exercises	Very high
Interpersonal	Lecturer–Student	During lectures	Very low (about 10%)
		Telephone	Very low or none
		Email	Very low or none
		Personal meetings	Very low or none
		Final examination	Very high*
	Instructor–Student	During tutorials Telephone	Very low or none
		Email	Very low or none
		Personal meetings	Very low or none
		Submitted exercises	Very high
		Moderate (about 50%)	
	Student–Student	Telephone	Very high
		Email	Very low or none
		Personal Meetings	Moderate

*The 'utilization' is 'very high' in the sense that all, or nearly all, students participated in this form of interpersonal dialogue. That is, a dialogue loop (lecturer–student–lecturer), mediated through the written word, was completed.

- attended lectures and tutorials regularly and made written notes;
- used recommended texts to help solve difficult exercises;
- generally solved and handed in the assigned exercises;
- used the website for downloading sample examinations and exercises.

2. University students had little or no dialogue of any kind with their lecturer concerning subject-matter issues. Although students could theoretically ask questions during lectures, a large majority (more than 90%) at any given lecture did not. In the light of this behavior, for most students, lectures were a structural resource utilized primarily for intrapersonal dialogue and possibly for some limited student–student dialogue. Personal meetings during office hours as well as telephone and email connections were generally not utilized.
3. At tutorials, between one-third to one-half of the students present at any given tutorial questioned the instructor. Students also spoke with the instructor prior to and after the class sessions. For these students, tutorial sessions were structural resources for interpersonal dialogue, as well as a structural resource for intrapersonal dialogue.
4. University students utilized fellow students as human resources for interpersonal dialogue to a very high degree. Telephones were the primary structural resource utilized for communicating followed by face-to-face meetings, usually on campus during breaks.

The utilization of the structural and human resources available to the college students appears in Table 3.

Findings may be summarized as follows:

1. College students fully utilized all available structural resources for intrapersonal dialogue. They attended class regularly, made written notes, solved and handed

Table 3. Utilization of human and structural resources by college students (very high, high, moderate, low, very low or none)

Dialogue types	Human resources	Structural resources: small college	Extent of utilization by students
Intrapersonal	Student	Lectures	Very high
		Recommended texts	Very high
		Exercises	Very high
Interpersonal	Lecturer–Student	During lectures	Very high (about 100%)
		Telephone	Very low or none
		Email	Very low or none
		Personal meetings	Very low or none
		Submitted exercises	Very high
		Final exam	Very high
	Student–Student	Telephone	Very high
		Email	Very low or none
		Personal meetings	Moderate

in the assigned exercises, and used the recommended texts nearly exclusively for aid in solving difficult problems.
2. Students also utilized the lecturers as human resources for interpersonal dialogue to a very high degree.
3. College students also utilized fellow students as human resources for interpersonal dialogue to a very high degree. Like their university counterparts, telephones were the primary mode of communication followed by face-to-face meetings on campus.

How students dealt with insoluble problems

Written problem solving (weekly exercises and a final examination) was the only means by which students were formally evaluated in both the physics and chemistry courses. Both at the university and at the college, students had to solve and submit about 10 problems a week. The different courses of action taken by students unable to solve problems are shown in Table 4. Communication modes, which appear in parentheses, are listed in order of preferred use.

The first course of action for all the university students and for two-thirds of the college students was intrapersonal dialogue; that is, individual study mediated by two

Table 4. Students' courses of action for solving problems (communication modes ordered by frequency of use appear in parentheses)

Institute	Name	Major	1st course of action	2nd course of action	3rd course of action
University	Cynthia	Chem	Lecture notes; Text	Peers (tel.)	Instructor (f2f* in class, email)
	Moshe	Chem	Lecture notes; Text	Peers (tel.)	Instructor (f2f* in class)
	Roie	Chem	Lecture notes; Text	Peers (tel.)	—
	Tali	Chem	Lecture notes; Text	Peers (tel.)	Instructor (f2f* in class)
	Eran	Physics	Lecture notes; Text	Peers (tel.)	—
	Agmon	Physics	Lecture notes; Text	Peers (f2f*, tel.)	—
	Haim	Physics	Lecture notes; Text	—	—
	Oded	Physics	Lecture notes; Text	Peers (f2f*)	—
College	Rania	Physics	Lecture notes; Text	—	—
	Oleg	Physics	Lecture notes; Text	Peers (tel.)	—
	Etai	Physics	Lecture notes; Text	Peers (tel.)	—
	Sivan	Physics	Peers (f2f*, tel.)	—	—
	Roie	Physics	Lecture notes; Text	Peers (f2f*, tel.)	Lecturer (f2f* in class)
	Amos	Physics	Peers (f2f*, tel.)	—	—

*f2f = face-to-face.

resources, lecture notes and recommended texts. If this course of action failed, the second course of action for both groups was interpersonal student–student dialogue, usually mediated by telephone, but sometimes face to face. If both courses of action failed, the third and final one for university students was interpersonal teacher–student dialogue. In this case, three students asked the instructor for help during the tutorial sessions. No university students asked the lecturer for help in solving problems. One college student asked the lecturer for help.

Discussion

In this section, three issues are discussed: (1) campus-based university students' use of dialogue, (2) comparisons between campus-based and distance education students' use of dialogue, and (3) the goodness-of-fit between research findings and the conceptual framework of dialogue cited above. Before beginning the discussion, we wish to reiterate that this study, and the two additional studies cited below, are based on small, non-representative samples. Conclusions are initial, tentative and highly restricted. This, however, is in accord with the grounded theory approach that seeks direction before engaging in research on a larger scale.

Campus-based university students' use of dialogue

Three main findings emerged from this study:

1. For university students participating in large, introductory level, lecture-based courses, interpersonal dialogue was not a significant dialogue mode engaged in while learning physics and chemistry in the classroom. Even though tutorials were more interactive than lectures, they constituted only 20% of total instruction time.
2. For college students participating in small introductory level courses, interpersonal dialogue was a significant dialogue mode engaged in while learning physics in the classroom.
3. For both college and university students, student–student dialogue was the primary *interpersonal* dialogue mode engaged in for the purpose of solving difficult problems. In other words, students, wherever they learned, after failing on their own through intrapersonal dialogue, turned to one another for help in problem solving.

These three findings are, to say the least, not surprising. What we believe important, however, is that these unsurprising and familiar findings may be grounded in theory. The first two findings illustrate clearly the impact of group size and instructional strategy on dialogue. The small group size at the college (a structural variable) afforded the *potential* for discussion-based class sessions, while lecturers (human variables) *chose* to implement this instructional strategy. Gorsky and Caspi (2005) pointed out that the cumulative effect of these two resources is to determine a potential, an upper limit of interpersonal dialogue that may occur in a classroom. This cumulative effect is defined as the variable '*potential dialogue*'. At present, it may be estimated prior to

the start of a program or course; eventually, through empirical research, it may be quantified to higher degrees of precision. Other structural resources (i.e. seating arrangements, the physical environment of the classroom, etc.) may influence potential dialogue in the classroom; however, so far as is known, their impact, if any, is minimal or yet to be studied.

Furthermore, the first conclusion illustrates clearly the tension between instructional theories, on the one hand, and actual practices engaged in by campus-based students participating in large lecture oriented courses, on the other. Instructional theories, such as those advanced by Bruner (1966) and Rogers (1969), often assign to interpersonal dialogue, especially between teacher and student, an importance that may not be realized in practice. Indeed, teacher–student dialogue in the large lecture courses was very limited in scope; by their sheer size, large groups and dialogue are generally incompatible.

The third finding illustrates the importance of peer dialogue in the learning process. Lecturers and instructors usually do not offer specific numerical answers when questioned about problem solving; they generally tend to explain concepts. Students, who want answers immediately, after failing on their own through intrapersonal dialogue, turn to other students. This generalization must be limited, however, by a key constraint imposed by the particular study. In discussions with colleagues at home and abroad, it appears that this finding may be limited to introductory-level courses. In personal discussions, colleagues noted that students in *advanced*-level physics and chemistry courses usually turned to the lecturer or instructor for help since very few, or sometimes none, of the students were capable of solving most of the assigned problems.

Comparing campus-based and distance education students' use of dialogue

In two previous small-scale, naturalistic studies ($n = 8$ and $n = 10$) that investigated the dialogic behavior of distance education students while learning physics and chemistry at the Open University of Israel, several findings were made (see Gorsky *et al.*, 2004a, b). First, a general approach to the use of dialogue was discerned. For all students participating in the two investigations, individual study, characterized by intrapersonal dialogue, was the primary and preferred study strategy. At the start of a course, self-instruction texts and tutorials were the primary resources utilized by learners. This general course of action, individual study through self-instruction materials, is indeed the paradigm of distance education at the Open University of Israel. Only when assigned problems could not be solved did students opt for contact with others, especially peers.

All distance education students who participated in the two studies followed the same path. Differences among students appeared on a time axis; that is, some learners experienced the inability to solve a problem earlier in the course than did others. Furthermore, it was found that student–student dialogues were the preferred dialogic mode, while instructor–student dialogues were generally used as a last resort. The preferred communication modes in such meetings were synchronous:

telephone conversations were most popular, followed by face-to-face meetings; email and both synchronous and asynchronous forums, although available, were utilized only marginally.

Within the constraints imposed by the limited sample sizes, there appears to be little or no significant difference between the behavior of distance and campus-based students participating in large lecture-based science courses, when their behavior is viewed in terms of dialogue utilization. That is, the undergraduate campus-based students in the large lecture-based science courses engaged initially in intrapersonal dialogue. Like distance education students, they used interpersonal student–student dialogue primarily for seeking help to solve problems. When analyzed in terms of the theoretical framework of dialogue, the only difference between the two student populations is in the particular structural resource that enabled intrapersonal dialogue: campus-based students generally *listen* to lectures and make notes while distance students generally *read* texts and highlight relevant segments. If these findings are supported by research on a larger scale, they may serve as the basis for a theoretical explanation of the 'no significant difference' phenomenon (Russell, 1999).

Goodness-of-fit between research findings and the framework of dialogue

The research questions in this study were formulated in terms of the elements of the theoretical framework of dialogue. It was possible to categorize all elements of the instructional systems at the university and at the college as variables in the model; that is, all activities engaged in by the campus-based students could be classified in terms of dialogue type and supporting resources (human or structural). These findings and those from the two previous studies offer support for a unified theory of instruction that subsumes both distance and campus-based systems.

The significance of the model, however, is not to be found merely in these acts of categorization. A model is judged in terms of how adequately it represents the functioning of a system and the goodness-of-fit between deduced hypotheses (predictions) and empirical research findings. The theoretical base of the model, the centrality of instructional dialogue, points toward a rich research agenda encompassing many points of view: pedagogical, psychological and economic.

To conclude, we return to our starting point—'students' approaches to study'. This area of inquiry may be enriched by the vantage point afforded by the theoretical framework. For example, students' adoption of deep- or surface-level approaches may be investigated as a function of the structural resources available in an instructional system. Certain structural resources may enhance the use of deep-level approaches by students. For example, Gibbs (1992) developed instructional strategies for doing so, while Garrison and Anderson (2003) suggested that the use of asynchronous discussion groups had the same effect for many distance education students. More precise relations between students' approaches to study, on the one hand, and the structural resources and the subsequent dialogue types engaged in by students, on the other, could be investigated.

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