DOCUMENT RESUME

ED 389 287 IR 017 500

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TITLE Mediated Collaborative Learning - How CSILE Supports a Shift from Knowledge in the Head to Knowledge in the World. Draft.

PUB DATE Apr 95

NOTE 39p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 18-22, 1995).

PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.

DESCRIPTORS Cognitive Processes; *Computer Assisted Instruction; *Computer Mediated Communication; *Cooperative Learning; Databases; Elementary School Students; Foreign Countries; Grade 5; Grade 6; Intermediate Grades; Learning Activities; *Problem Solving

IDENTIFIERS *Learning Environment

ABSTRACT

In Computer-Supported Intentional Learning Environments (CSILE), students use a computer-database system as a tool to store and organize their curriculum-related knowledge as a means of sharing information and thoughts with peers, supporting both individual and collaborative learning. This study contrasts two conditions: face-to-face collaboration and CSILE mediated collaboration where the students can pursue individual learning and collaborative learning flexibly through both oral and written discourse. The subjects were 30 students from a grade five/six elementary classroom. Students worked in groups of 3 for a total of 10 groups; the topic was "Gravity and the Solar System." The study then focused on the roles of three students and how they used oral discourse in the face-to-face and CSILE sessions. Results indicated that in the face-to-face condition, oral discourse is mainly a tool for pursuing or supporting others' individual learning goals, as opposed to constructing and pursuing collaborative ones. In the CSILE condition, students, through oral discourse, construct a joint problem-space, resulting in individual learning that is both a contribution to their own learning and the group's learning. A trace of each individual's process of learning and knowledge is recorded in the database, making it available for inspection, evaluation, and for building on and integrating by themselves or others. (AEF)

Mediated collaborative learning -

How CSILE supports a shift from knowledge in the head to knowledge in the world

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Cohen, A. (April 1995). Mediated collaborative learning - How CSILE supports a shift from knowledge in the head to knowledge in the world. In Marlene Scardamalia (Chair), Collaborative Knowledge Building on a Computer Network. American Educational Research Association (AERA). San Francisco.

Introduction and Background

"Computer-Supported Intentional Learning Environments (CSILE)" is a computer mediated environment developed to support a problem based curriculum and foster intentional learning and progressive discourse. In CSILE, students use a computer-database system as a tool to store and organize their curriculum-related knowledge as a means of sharing information and thoughts with peers (Scardamalia, Bereiter, Brett, Burtis, Calhoun, & Smith-Lea, 1992; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). CSILE gives every student more chances to participate in classroom learning and to reflect intentionally on their own student activity in CSILE (Lamon, 1992). Both individual and collaborative learning are supported by CSILE and need to be examined. Norman (Norman, in press) suggests that how a tool is used depends on how the user perceives accomplishing the task through use of the tool. To create a more successful environment for students' authentic learning, we must understand what function students perceive CSILE can perform as a tool to support their learning.

As a tool which mediates learning activity, CSILE can be understood by appealing to both Leontiev's notion of "three strata of human activity" (Leontiev, 1981) and Engeström's "triangular model of activity" (Engeström, 1987) Both Leontiev and Engeström seek to develop a framework for the analysis of activity mediated by cultural tools. Although they do not describe the same aspects of human activity, both theories can be considered together to create a more comprehensive theory of human activity (Wells, 1994, April). Using Leontiev and Engeström's work we can carefully examine the relationship between individual and joint work in CSILE. Examining joint work under computer mediated and face-to-face collaboration will allow us to understand how students' cognitive activity changes when using CSILE, and how that affects learning. This study looks specifically at differing types of oral discourse in both conditions paying particular attention to metacognitive or executive type of discourse. To this end, this research examines a group of three students' activity in two different conditions, face-to-face collaboration and computer-mediated collaboration using CSILE. I then generalize the findings to a larger population.

Computer-Supported Intentional Learning Environments (CSILE)

Scardamalia & Bereiter have developed a strategy for the restructuring of schools and the tools which afford this (Scardamalia & Bereiter, 1991; Scardamalia & Bereiter, 1992). At the center of the restructuring is a knowledge building environment where students create a sociocultural environment typical of expert communities. Here the learners continually raise the standards of understanding. Each contribution becomes an achievement which others strive to meet and understand. Children become actively engaged in the construction of knowledge through progressive problem solving which raises understanding to higher and higher levels. The tool, CSILE, is a collaborative database system which helps to create the knowledge building community described above by allowing students to externalize their ideas in the database. Students accomplish this using a network of microcomputers in their classroom. They can create graphic or text notes, develop joint discussions, comment on the work of others and link together complexes of notes in order to further develop their knowledge.

CSILE supports reflective thinking by providing the students with tools to manipulate their externalized ideas and information on a curriculum topic (Lamon, 1992). In CSILE students can store and organize their information and ideas in the database; they are encouraged to report their information and thoughts as notes in the form of texts and charts in the database. Each note can have several keywords, a title, and a thinking type. They can select keywords for their own notes from the list of words which is determined by a teacher beforehand, and they can create new keywords for their notes. Notes are titled so that students' can identify notes in organizing their thoughts and accessing pertinent information. Furthermore, students are instructed to label their notes with a "thinking type" which helps them regulate their leaning, expressing the status of their note. Examples of thinking types are: (1) What I already know, (2) I need to understand, (3) High-level questions, (4) New learning, (5) Plan, (6) My Theory, (7) New Experiment, (8) Conclusions, (9) Synthesis. Often the teacher and students decide to limit the number of thinking types to a subset of the above for any given classroom unit. Research indicates that students can reflect metacognitively on their previous thoughts and information, based on the thinking types indicated in their notes.

Second, as a communal database, CSILE allows all students to access and comment on others' thoughts in building their interpersonal knowledge. Students can search other students' notes by using the search function in CSILE. If they want to add some suggestions or ideas on others' notes, they can open a "comment note" window and type their comment in it. The comment is automatically linked to the target note so that the author of the target note can easily access the comment. Others can also access the target note from the comment and vice versa. Thus, CSILE supports students' asynchronous cooperation in addition to their natural cooperation in the classroom.

While using CSILE the learning context in the classroom is altered so that students pursue their knowledge through peer collaboration, with their teacher as a learning expert who coaches them to become expert learners. In a CSILE classroom, where students contribute to each other's knowledge building, learning takes place on both the group and solo planes. On the solo plane the students pursue their own questions in a self-regulated manner. On the group plane, the goal is to be engaged as part of a group collaboration in knowledge building activities.

A CSILE classroom from the perspective of Activity Theory

Much of the research with CSILE has given the impression that all the CSILE activity goes on in writing activities in the database. However, observation of the classroom process reveals that this is not entirely true. This research has its origins in the fact that a significant amount of student time in a CSILE culture is spent discussing orally what information is where, what should be done next and what a particular idea means. Therefore we must study both students' use of CSILE and the process around students use of CSILE. Here Leontiev's and Engeström's theory of activity are useful as a framework for analyzing cognitive activity.

Leontiev (Leontiev, 1981), proposed three strata of human activity, 'activity' which refers to the "motive" of social action; 'action', which refers to the intentional "goals" of actors within an activity setting; and 'operation', which refers to the "conditions" or real behaviors of actors in the carrying out of actions within an activity. Engeström's "triangular model of activity" (Engeström, 1987) lays out a framework for the analysis of human activity by expanding the activity system to account for the cultural context. Engeström's activity system incorporates "the tool as mediational means" but expands the notion to relate the individual to a larger culture or institution (see figure 1).

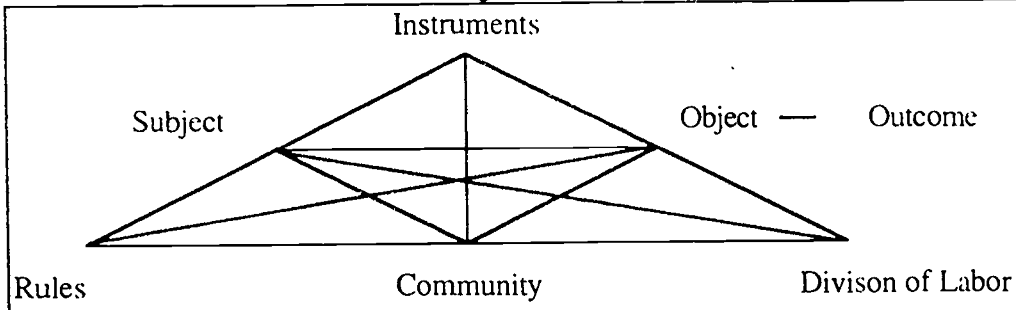


Figure 1: Engestrom's expanded notion of activity systems

A major advantage of Engeström's approach (Engeström, 1990; Engeström, 1991) is the ability to compare systems of learning which are very different. In this case, a face-to-face collaboration is compared to students' collaboration using CSILE, a different context, with different task structures and tools. Here, I compare the same students' learning activity within the group, in the two different conditions. It is useful to consider not only what was learned by each student but also what activities each student was engaged in both individually and as a member of the group over the course of the curriculum unit. It is useful to consider how, from each subject's point of view, the goals of activity change in the two conditions.

Using Engeström's expanded model, we can specify the components of the triangle (see figure 2): the instrument is CSILE; the subject refers to the one member of the group whose perspective we are considering. The community refers to all three members of the group as they all share the common problem-space. The division of labor refers to both the division of tasks and the division of power and status. When CSILE is added to the set of tools available, the division of labor changes. In the face-to-face condition, the division of labor involves deciding who writes the ideas in the proforma, who controls the simulation, and, as only one idea may be followed at any given time, which member of the groups actions are to be carried out. In the CSILE condition, each member of the group has his (her) own 'idea space" as each can run their own simulations and enter their ideas into their personal entry in the common discussion. Learning is divided up at the level of goals rather than tasks.

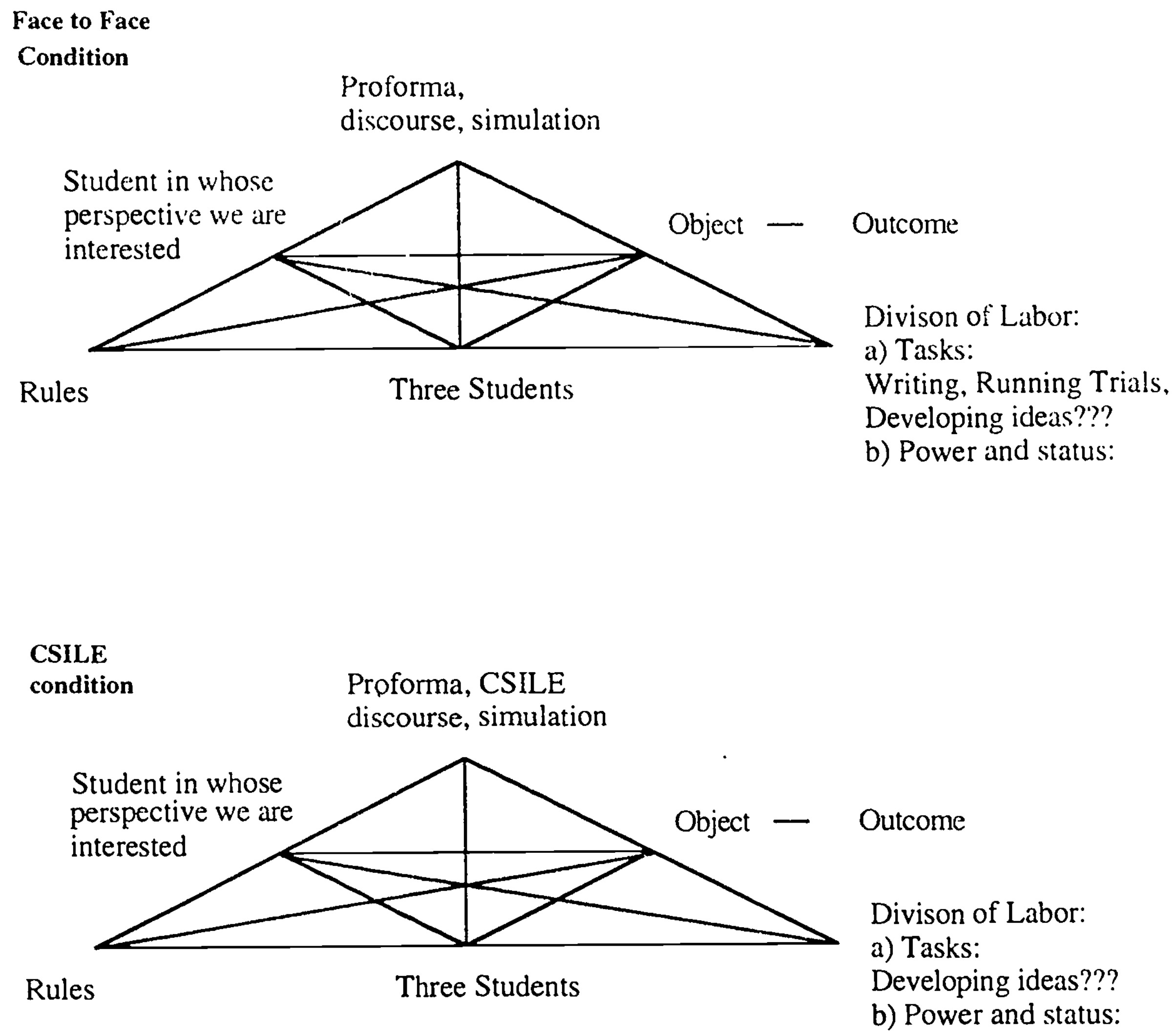


Figure 2: Expanded activity diagrams for the face to face and CSILE conditions

This study is specifically concerned with whether CSILE promotes the type of intentional learning as originally designed in the work around CSILE, and whether through using CSILE students who have a difficult time contributing in face-to-face settings can pursue intentional learning using CSILE as a tool to facilitate their work. How CSILE supports access to knowledge, making their own and others referent and high level problem-centered knowledge visible such that students can effectively monitor each other and make effective use of their distributed abilities are explored and analyzed. Activity theory is used as a framework within which we can understand how the introduction of new tools mediates new goals not previously possible.

This study contrasts two realistic conditions: face-to-face collaboration and CSILE mediated collaboration where the students can pursue individual learning and collaborative learning flexibly through both oral and written discourse. In the CSILE condition, students could pursue their own experiments and make their own judgments and explanations. They could talk orally as much as they liked. They were required to collaboratively form High Level goals and conclusions. Thus, they could pursue individual work and collaborative work in the same setting.

In both conditions, oral discourse mediates the group interactions. In the CSILE condition, written discourse is an operation that can also mediate the group interactions. Students can move freely between collaborative and individual work. They have their own space in which to work and CSILE makes that process permanently visible.

These two conditions were picked because they were realistic conditions; the proforma and the type of experiment had a somewhat contained task structure; they were part of an ongoing classroom topic; and with the students generating data on their own, they were immediately generating the points for discussion and learning. As the primary interest was in how the students could intentionally regulate their own individual and collaborative learning, this was a rich context for study. Returning to the area I am examining, the type of contribution to high level knowledge and executive types of activities, two specific hypothesis are proposed (See Table 1)

Table 1

	Meta cognitive
I.1	Students when collaborating via CSILE and orally will exhibit more metacognitive oral discourse than the same students when collaborating face-to-face.
I.2	Further investigation of what types of metacognitive moves are made should show that when using CSILE as compared to Face-to-face collaboration, students monitor others knowledge and actions significantly more, in addition to reflecting on the past knowledge and monitoring their own knowledge.

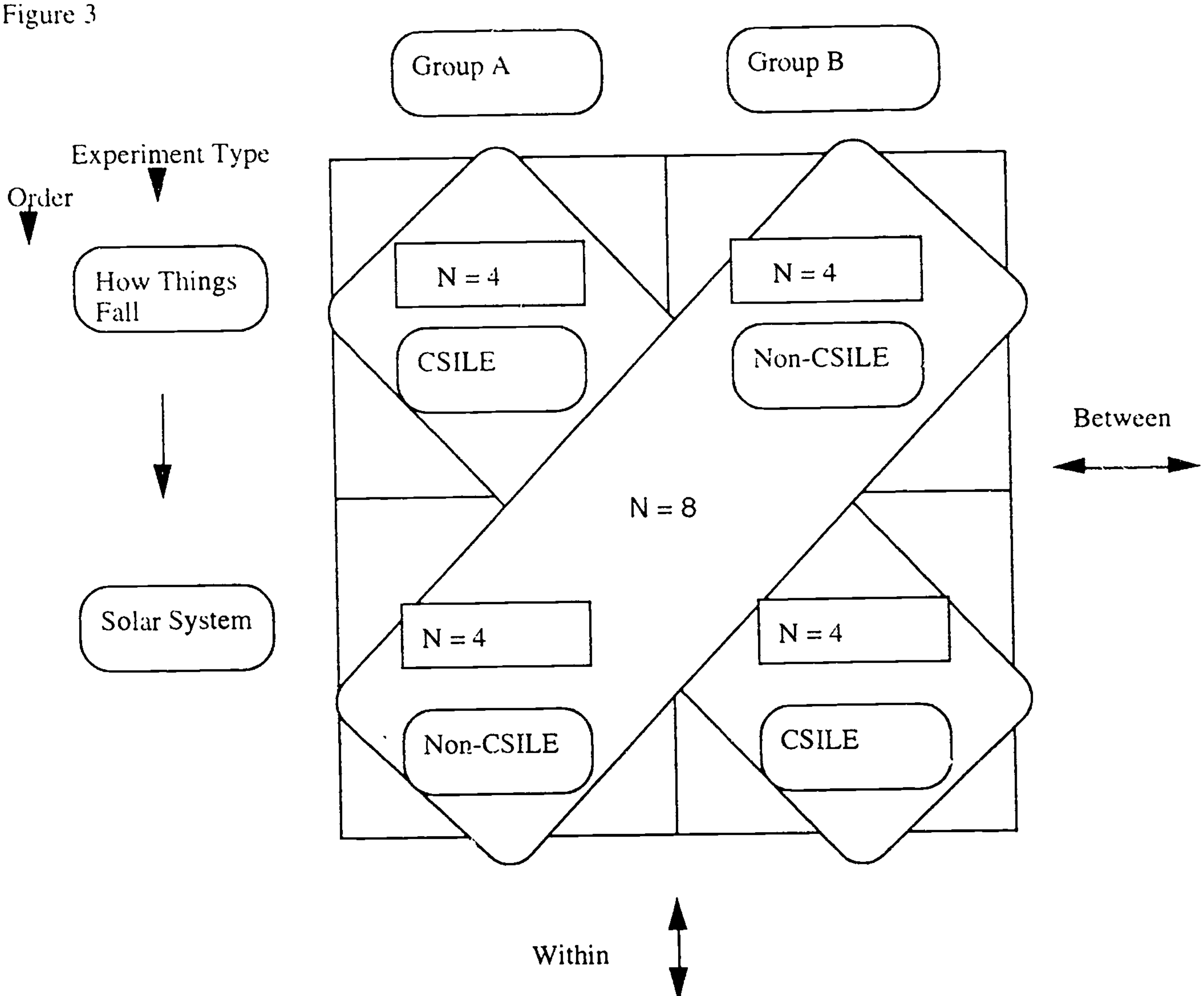
The structure of CSILE and the types of collaboration and cognitive activity actually occurring in the process of using CSILE are postulated as accounting for the phenomena

Method

Design

The design of this study (see figure 3) is a comparison of two realistic classroom conditions, CSILE and face-to-face collaboration. The design was limited by the fact that it was an in classroom study and part of an ongoing curriculum unit. It is an incomplete between/within design with two factors, CSILE and experiment type, though we are only interested in one, CSILE. This study was designed to interfere with the classroom process as little as possible. I wish to understand structures and processes relevant to the research hypothesis in as ecologically valid a situation as possible.

Figure 3



<u>Subjects</u>

The subjects were thirty students from a single grade five/six elementary classroom The class was an experimental class, part of the ongoing CSILE research program. The students worked in groups of three for a total of ten groups. The students self selected their own groups with help from their teacher. The Canadian Test of Basic Skills (CTBS) scores averages across the groups were used to categorize the top four, the middle two, and the bottom four groups. Fifty percent of each level, top, medium, and bottom will be assigned to one of two conditions, CSILE and Face-to-face collaboration. By the end of the intervention, two of the ten groups had lost one member each (both students left due to families moving to other cities). Both groups were dropped from the analysis, leaving a total of eight groups.

Two different contexts - Face-to-face and CSILE

Face-to-fsce

In the face-to-face condition, students worked in triads over three sessions. Initially, they formulated a theory of how the system worked. At the beginning of each session students developed "high-Level goals", then they carried out the following actions: planning experiments, making predictions, executing experiments and explaining what they learned. Each session ended with students developing a consensual conclusion. After all three sessions they wrote a consensual synthesis of what they had learned. They had a folder with copies of a proforma which was used both to help the students structure and keep track of their work. Experiments were executed using a physics simulation package, which enables them to develop and run experiments about gravity ("How things fall") or Satellites and Comets ("What affects the orbit/path of the Satellite/Comet"), depending on the curriculum unit. They could run as many trials as they wished, but they had to run them sequentially as they only had one computer to use.

CSILE

In the CSILE condition, students also worked in triads over three sessions. Each student had their own Macintosh computer with CSILE and the physics-simulation package running. Students did all their work by opening a discussion note in the discourse facility available in CSILE. In this format, all the students have a copy of the SAME discussion note open on their computer. Each student can add an entry to the discussion. The new entries can be viewed by all, but edited only by the author. The students were seated next to each other and engaged in both solo and collaborative work. They collaborated both orally and with written notes and they were able to work alone. Initially they formulated a theory of how the system worked. At the beginning of each session students collaboratively developed high-Level goals. Subsequently they each planed, made predictions, executed experiments and 'explained what they learned'. They were allowed to do this any way they felt was productive, i.e. they could work alone or collaboratively. Finally each session ended with students developing one consensual conclusion. When they did trials, students used a special experiment entry in the discussion note (Schauble, 1990). The entry was an electronic copy of the above proforma, with additional facilities for scrolling through a table of experiments

Materials

Students worked on the topic "Gravity and the Solar system" They did experiments on "What affects how things fall" and "What affects the path of satellites". A basic template for experiments was provided in the simulation package Interactive physics^{TM}. Students could change objects to run trials on and change the values of variables (Figure 4 & 5), and run trials of the experiment as often as they wished. In the face-to-face condition students had a folder of proformas to record their results (pencil and paper). There was one folder per group, and the group had one copy of the simulation running on a single Macintosh computer. In the CSILE condition each student had their own machine. The proforma was on CSILE in the discussion note format and the students did all their written work and experiments on their own computer while using CSILE. The simulation software was available on each machine.

Figure 4 "How things Fall

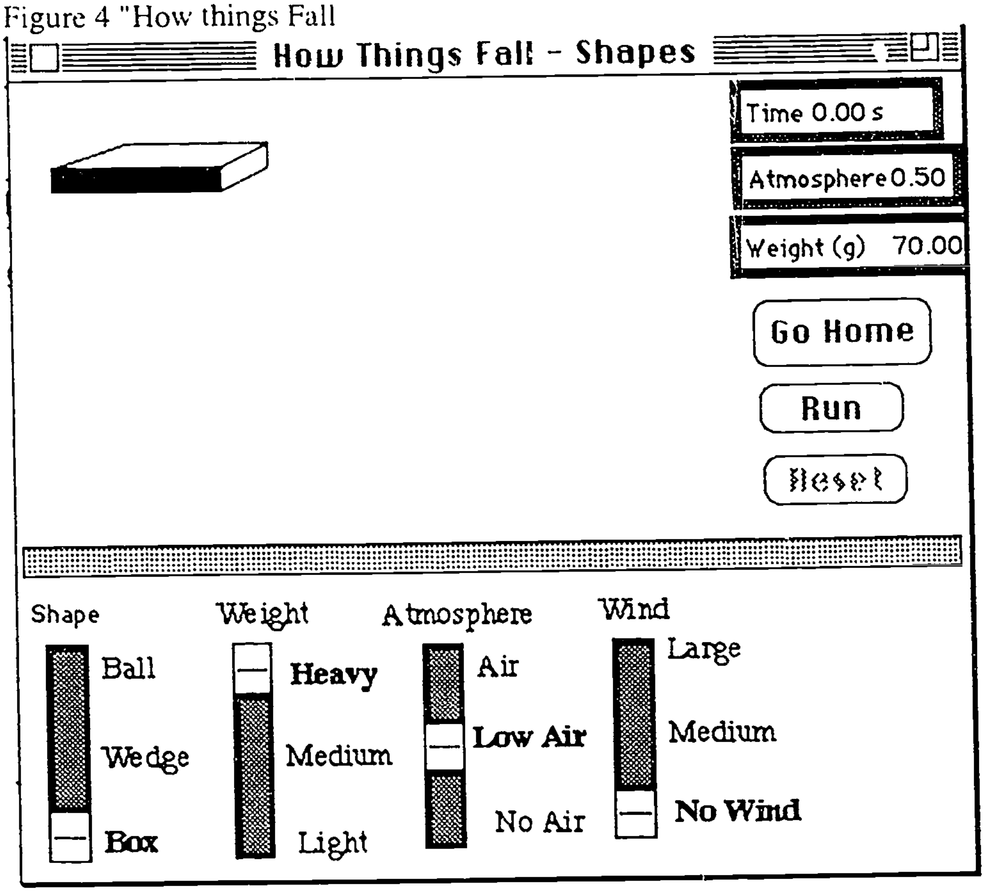


Figure 4: In this simulation the shape ca.. be changed from a box to a wedge to a ball. Also independently the weight, the amount of air, and the wind can be changed. Selecting "run" runs the simulation and the time is recorded and stops when the object reaches the ground

Figure 5 "What affects the path of the Satellite

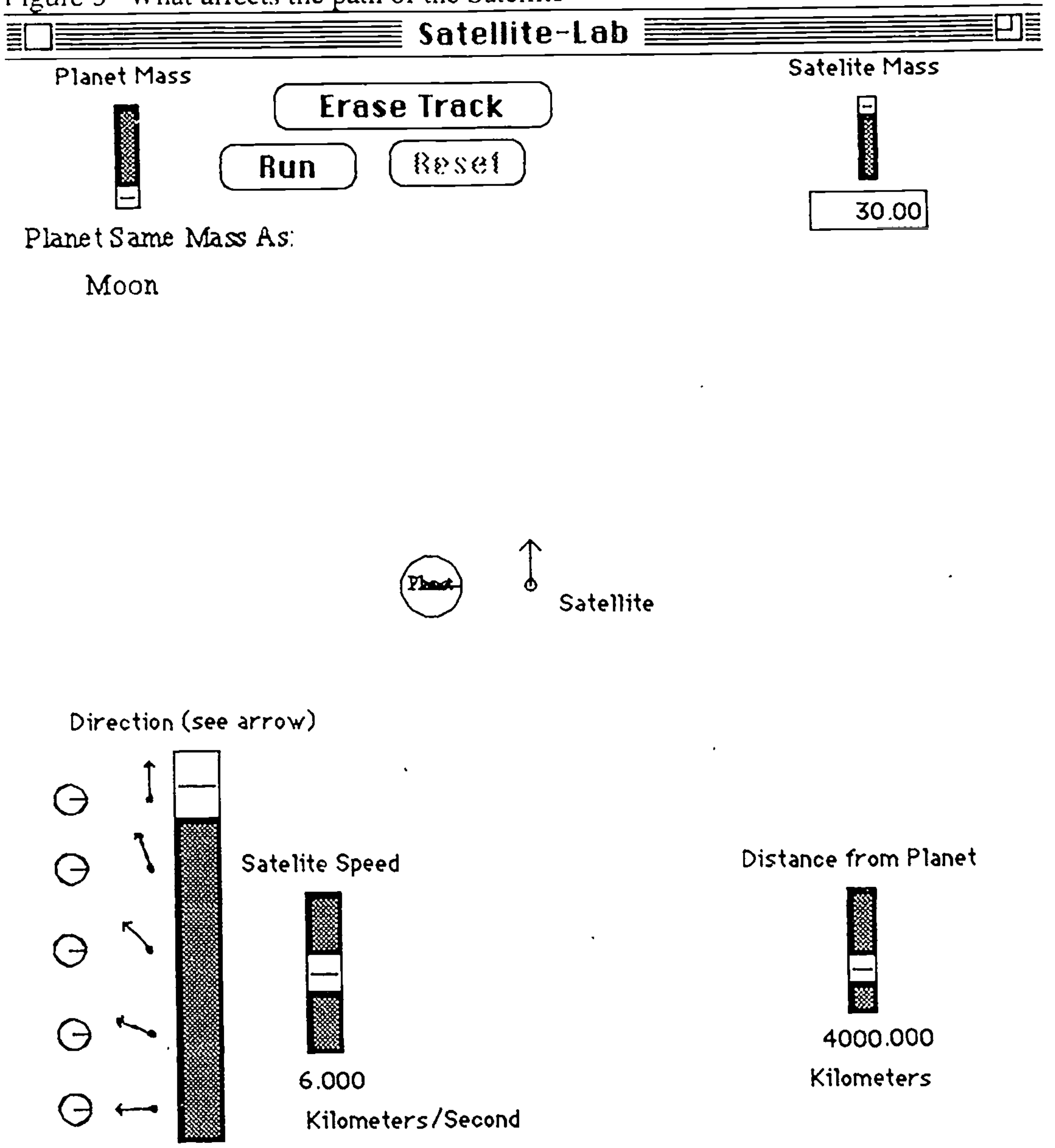


Figure 5: In this simulation the direction, the mass of the planet and satellite, the speed of the satellite and the distance from the planet can be changed. Selecting "run" runs the simulation. The path is traced and the type of path must be judged by the student

Procedure.

The students used either the proforma or CSILE (depending on their condition) to record, store and retrieve all work. All students could use Interactive physicsTM to run trials to test their hypotheses. In the CSILE condition, students articulated (and entered into CSILE) what they were trying to find out, their plan and then prediction. After running the experiment they individually entered what they had learned into a joint discussion note. They did this on their own computer, but sitting near their collaborators. Oral exchanges were frequent and central to completing the problem. In the face-to-face condition, the students jointly (using one computer) entered the above information into one proforma. Each session lasted no longer than 45 minutes, and no less than 35 minutes. All sessions were both video and audio taped

Data.

The second session in which students considered each of the above questions was transcribed. All the written work in CSILE including the work before the students began their experimenting and the proforma from CSILE and the written proforma from the face-to-face condition were used in the data analysis

Analyzing the Oral Discourse.

The primary concern was the type of contribution to knowledge participants had in oral discourse, in particular, the amount of metacognitive discourse or executive control each experimental condition exhibited. Accordingly, Each exchange were coded into one of four types: (1) no direction to knowledge or knowledge content (e.g. reading from the proforma, simple request for more information, affirmations or negations, or repetitions); (2) referent-centered orientation (e.g. factual statements, outcome directed, requests for information, or clarifying procedure or facts); (3) problem-centered orientation (e.g. theory, Explanation with data, relating theory to data, questions relating to data/ theory, or clarification - about data/theory); (4) metacognitive- orientation (e.g. monitoring - checking & evaluation one's or groups' behavior, looking at others work with evaluation, statements about learning or thinking, or noticing similarities or irregularities or anomalies). The exchanges which were scored as metacognitive were further broken down into three categories: monitoring knowledge and monitoring past work (self or group as opposed to others knowledge), coordinating others (actions or knowledge [looking forward]) monitoring others (actions or knowledge)

A case study of the Cognitive Activity of students using CSILE vs. face-to-face collaboration.

In this section, the process of learning science is examined through a case study. The purpose of this case study is to examine in detail an example of two different forms of collaboration, face-to-face and CSILE and how those forms of collaborations both provide evidence for the main hypothesis of this research. This case examines the roles of these three students and how they use oral discourse in very different ways in the face-to-face and CSILE sections. The data is examined paying attention to the executive or metacognitive processes in the two conditions.

Case Study

In the following, one face-to-face section and one CSILE session of the same group are presented. This was a particularly interesting group as they exemplified all the hypothesis in this study. First, I present two sections of each condition of the discourse, with annotations discussing who participated and in what way (see appendix A for a more full example). This is followed by a graphical representation of this progress. Finally a general discussion of the activity of each of the three students is given.

Oral discourse from face-to-face condition

In this example the three students are beginning a new trial for the experiment. C uses the proforma questions to structure the discussion. B responds with a problem-centered comment specifying the causal variable, shape that they are going to test. The parts of discourse which are in bold represent questions/prompts asked which are nearly or exactly the same as the prompts on the proforma, "What are we trying to find out?", "Explain what you think will happen", and "What have you learned?" The parts of the oral discourse in italic represent the first appearance of responses which later appear in writing

Sequence - O.3

1	C	OK. Let me try to find it. OK. **What are we trying to find out?**
2	B	**What are we trying to find out?** We are trying to find out if the ...
3	B	*The shape affects the speed that it has.*
4	B	..If the speed affects it
5	B	We are trying to find out if the shape affects the speed of the object.

{Entry into the proforma: If the shape affects the speed of the object}

In this example , they are making a prediction for the trial of the experiment. C again starts with a question directly from the proforma (1). B responds with a referent-centered reply (4), followed by two problem-centered explanations (6 & 8).

Sequence - O.4

1	C	OK. **Explain what you think will happen.**
2	C	Same?
3	B	Even though ...
4	B	*I think ... it will probably go a bit faster.*
5	A	OK.
6	B	Because the mass doesn't look as big.
7	A	I don't know.
8	B	So it looks like its the mass. Because the box is taking more area.
9	C	Oh, yes.

{Entry into the proforma: It will go a bit faster then the other experiment}

These are interesting passages because they illustrate the use of different genres or structural features of language in the process of accomplishing goals. In neither sequences student A or C uses the proforma (which has the prompts on it "What have you learned from this experiment?", "What are we trying to find out?", "Explain what you think will happen") to initiate or structure the sequence. The response to the prompts often involve a statement of factual knowledge followed by an explanation. The proforma mediates the structure of the discourse. There is no high level discussion between either B or C and A, while B attempts to construct explanations.

Note that almost all the reasoning and explaining moves are made by B. And that B is generally the one who moves discussion toward a problem-centered structure. A interacts little or not al all with B or C. While the students do monitor their past work and knowledge, it is generally only at the level of reflecting on what they have done in the past. The never consider each other others ideas as separate ideas to build together and collaborate on.

Students' use of oral discourse and CSILE

In this example, A is pursuing his individual learning. A has done three trials, controlling mass then controlling speed. Upon reporting his results, that the mass does not matter, B responds that the results were different on the two trials of the experiment. Further B leads A first through his operations (did you control variables?). When A reports that he changed the speed, B responds by explaining that you must control all the variables but one, or else "it will be a completely different effect" This in turn directly leads to a new judgment opposite to the one A initially had. This is a critical passage. It is here where the movement between individual learning and joint learning becomes important in CSILE. As each of the members of the groups work is visible to the others, a trace of the path of the individual work is left for the other's to see, and potentially examine. These students use their joint plane of learning to collaborate on their individual learning. Their joint plane is constructed by B monitoring A's progress. A few moments later, B, after looking through A's experiments, explains to A that he did change the Mass and therefore the mass matters. So we can say that B's monitoring of A lead A to change his judgment and enter a more correct one into CSILE.

Sequence - C.6

1	A	It's not the mass, really.
2	B	But it collided the first time, and the second time it went right around.
3	A	That might have been just because of something else I did.
4	B	What did you do?
5	B	Did you change anything in the second time except the mass?
6	A	Okay, this is what we can do. Same thing for distance.
7	B	Yes.
8	A	Same thing for ... oh, speed.
9	A	It could be the speed does affect it.
10	B	Did you change the speed?
11	A	Yes.
12	B	You shouldn't have done that. You should have kept them the same all through the experiments except for the mass. Because it will be a completely different effect.
13	B	You definitely changed the mass. I think the mass affects it
14	A	Yah
15	B	a lot.
16	A	Yes, if it is the planet.
17	B	Yes, I don't know yet. I will have to try it one more time.
18	A	Because the moon pulls it in really easily but ...
19	B	So that definitely affects it.
20	A	Yes.

This is another example of B monitoring another students learning. This time B is monitoring C's progress. B has noticed that they have done the same experiment, however that they have recorded different results. He can only know this because he is reading the trace of student C from the database. His response is to note how that can't be and that they should figure that out. (It turns out that student C was not keeping track of the experiment variable levels on the experiment and recording those properly in CSILE). This problem was quickly rectified, but again this is a critical joint interaction which can only come about because there is a trace of their learning which allows one student to monitor others learning moving from individual learning to joint learning about their individual learning.

Sequence - C.11

1	B	Oh, hold on.
2	B	Who did 40?
3	A	What?
4	B	You did?
5	A	Who did?
6	B	Come here? This is really weird.
7	C	What happened?
8	B	Because we have the same thing, okay? But yours went into space and my orbit was circular.
9	C	There?
10	B	What was the planet mass?
11	C	while I put ...
12	B	Or was it Earth?
13	C	How about what is the name of the planet?
14	B	Okay, Danny 40, into space. 41, orbit, circular.
15	B	Hold on let me have a look ...
16	B	Okay, Danny ... Planet Earth.. .. Planet mass, Earth. Okay.
17	??	[inaudible]
18	B	Results, into space. That is so weird.

In the CSILE examples the structure is quite different. First of all, in the examples B is either monitoring others oral and written discourse and commenting on their individual learning. In CSILE students can pursue individual learning leaving a trace of that process. Learning is visible to the other members of the group. Students can benefit from having other students monitor their learning behavior. The first example is a particularly good example of this. Student A has actually done controlled experimentation, both on speed and mass, however, it is difficult for him to interpret the data. When making a claim which is incorrect, B, can view A's trace of learning and can help him walk through the interpretation.

Differences between individual and joint activity in CSILE and face-to-face

The above example illustrates the function of oral discourse in the face-to-face and the CSILE conditions. In the face-to-face condition, B dominates the discussion, making all the problem-centered moves from proposing the control of variables scheme to proposing the explanations about causal variables. C only occasionally contributes and A contributes little or no problem-centered work. The situation of the three students does not allow for individual thinking or learning to be constructed or built upon. In the CSILE session, we see that the oral discourse has a different function. The students use oral discourse to set up their space for individual learning and to discuss others path of learning, while they use their CSILE space to pursue their individual learning.

Cognitive actions of the CSILE vs. the face-to-face groups

In the following, I attempt to build an abstract framework for the cognitive actions afforded by the movement between individual learning and joint learning as opposed to joint learning alone. Above, I have presented data on one group (this will be generalized to the whole dataset below). Students' individual work leaves a trace of what the students were doing. The trace of work allows students' to monitor other students progress. The process becomes visible and allows others to interact with it.

In the following I attempt to represent the data graphically, indicating only the metacognitive interaction between students (see figures 7 and 8). In the graphic representations, each row of boxes represents an exchange, with the shading of the box representing the role of that particular student (see figure 6). In the left column the seq. # represents the sequence in the initial examples that set of exchanges represents. Written discourse (the work put into the proforma) is represented in the larger boxes, with the box crossing all three students in the face-to-face session (representing joint contribution) and in the CSILE session the box is in the place of the student who made the entry. The arrows represent monitoring. An arrow pointed at ones own role means reflecting on ones own knowledge orally, an arrow pointing back (up) represents monitoring past work, a solid arrow pointing across the columns represents monitoring others actions or knowledge, and a dashed arrow pointing across the columns represents coordinating others actions or knowledge.

Figure 6

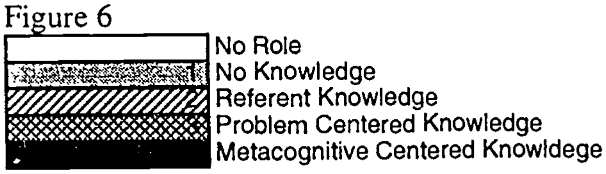
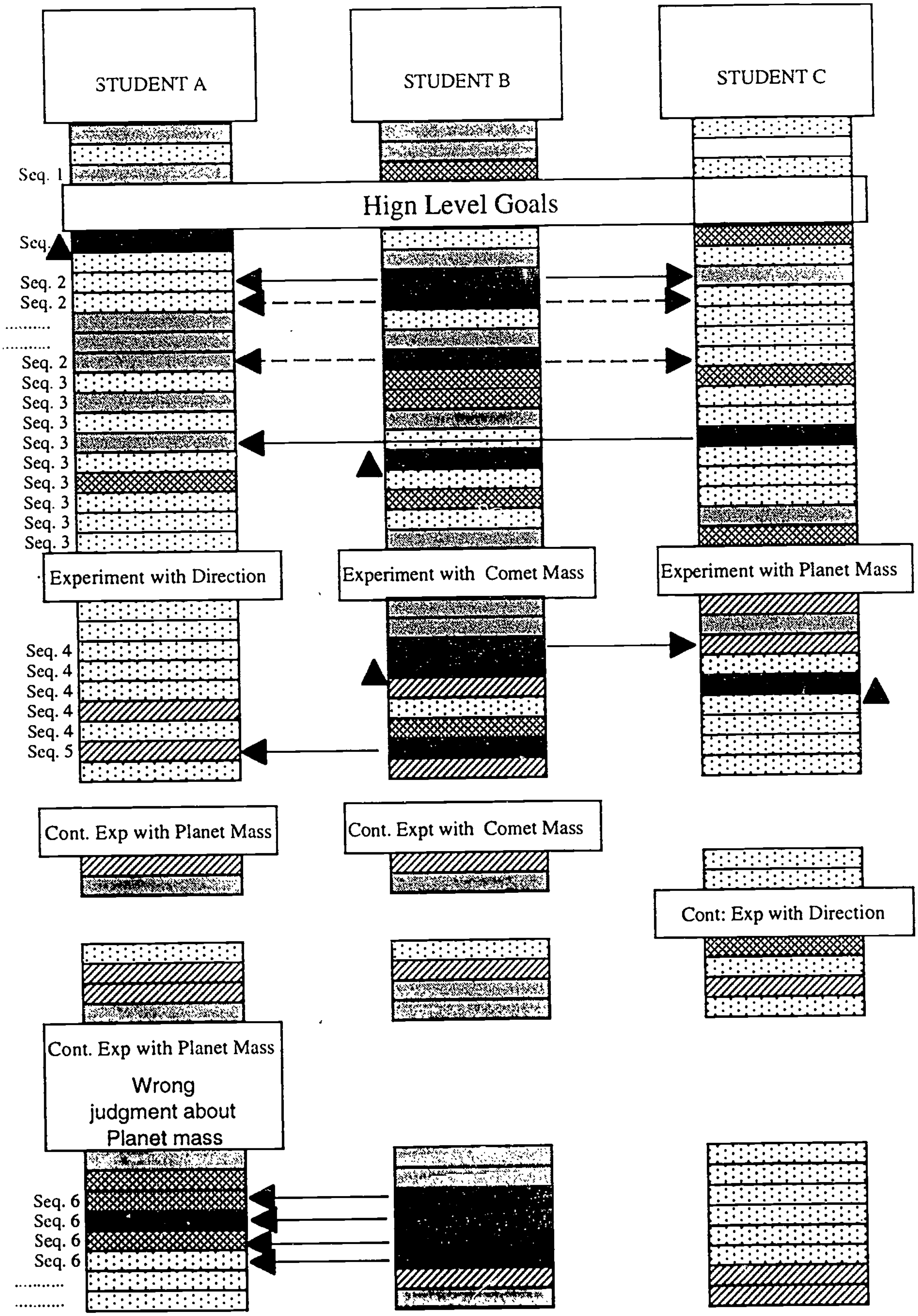


Figure 6: The shading of the boxes represent a role in an exchange directed at a particular type of knowledge.


STUDENT A
STUDENT B
STUDENT C
Seq. 1
Hign Level Goals
Seq.
Seq. 2
Seq. 2
Seq. 2
Seq. 3
Seq. 3
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Experiment with Direction
Experiment with Comet Mass
Experiment with Planet Mass
Seq. 4
Seq. 4
Seq. 4
Seq. 4
Seq. 4
Seq. 5
Cont. Exp with Planet Mass
Cont. Expt with Comet Mass
Cont: Exp with Direction
Cont. Exp with Planet Mass
Wrong
judgment about
Planet mass
Seq. 6
Seq. 6
Seq. 6
Seq. 6

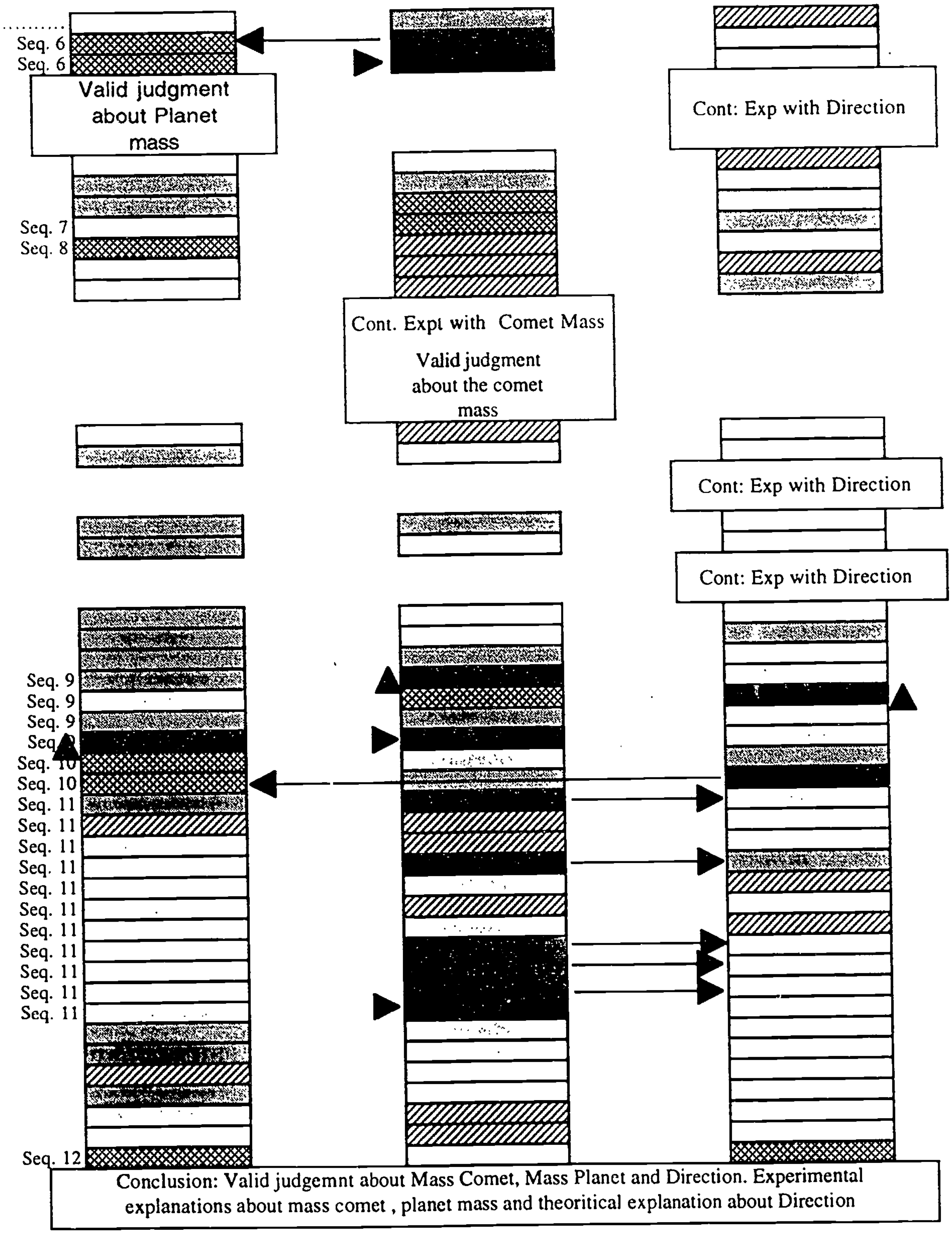
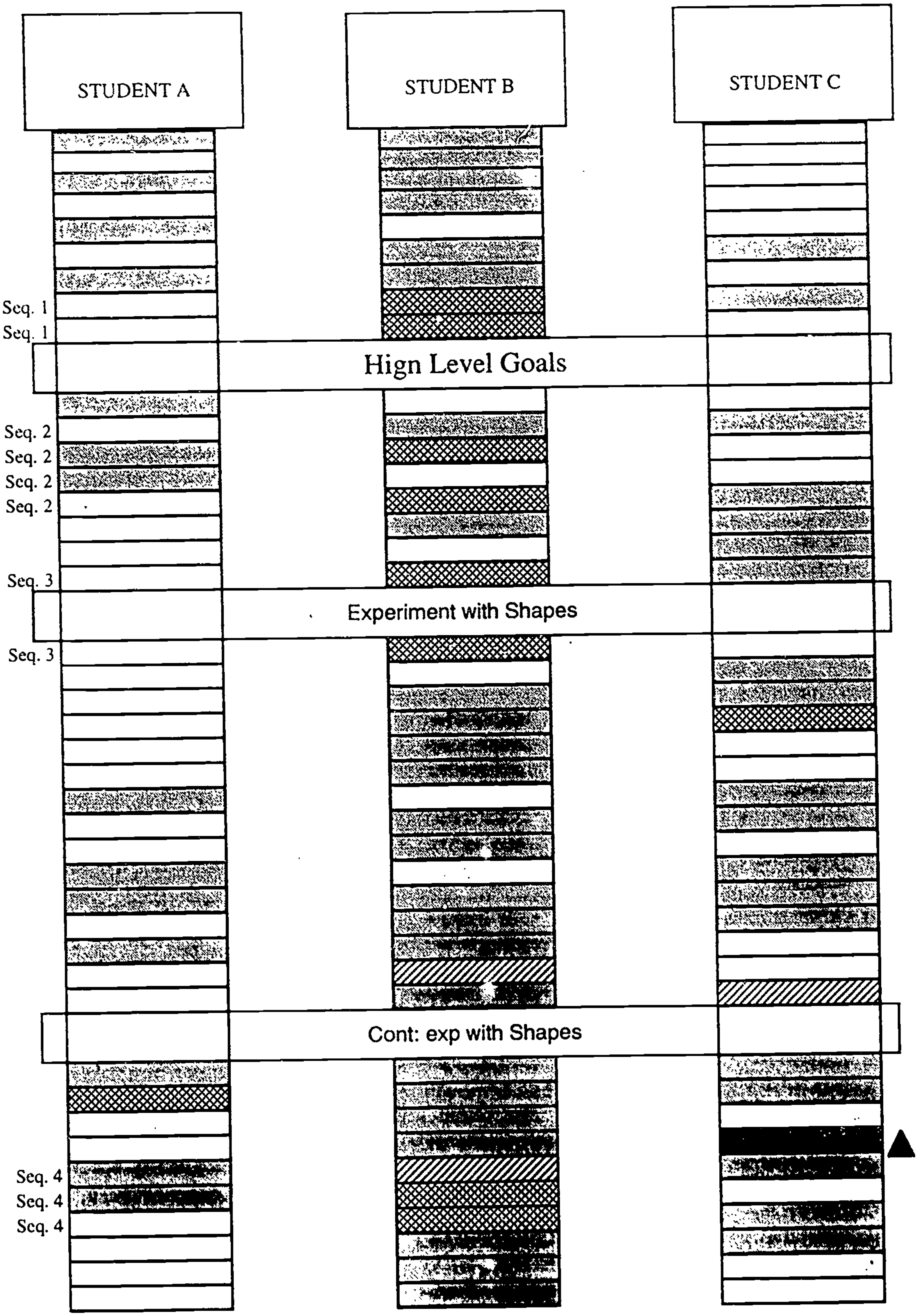
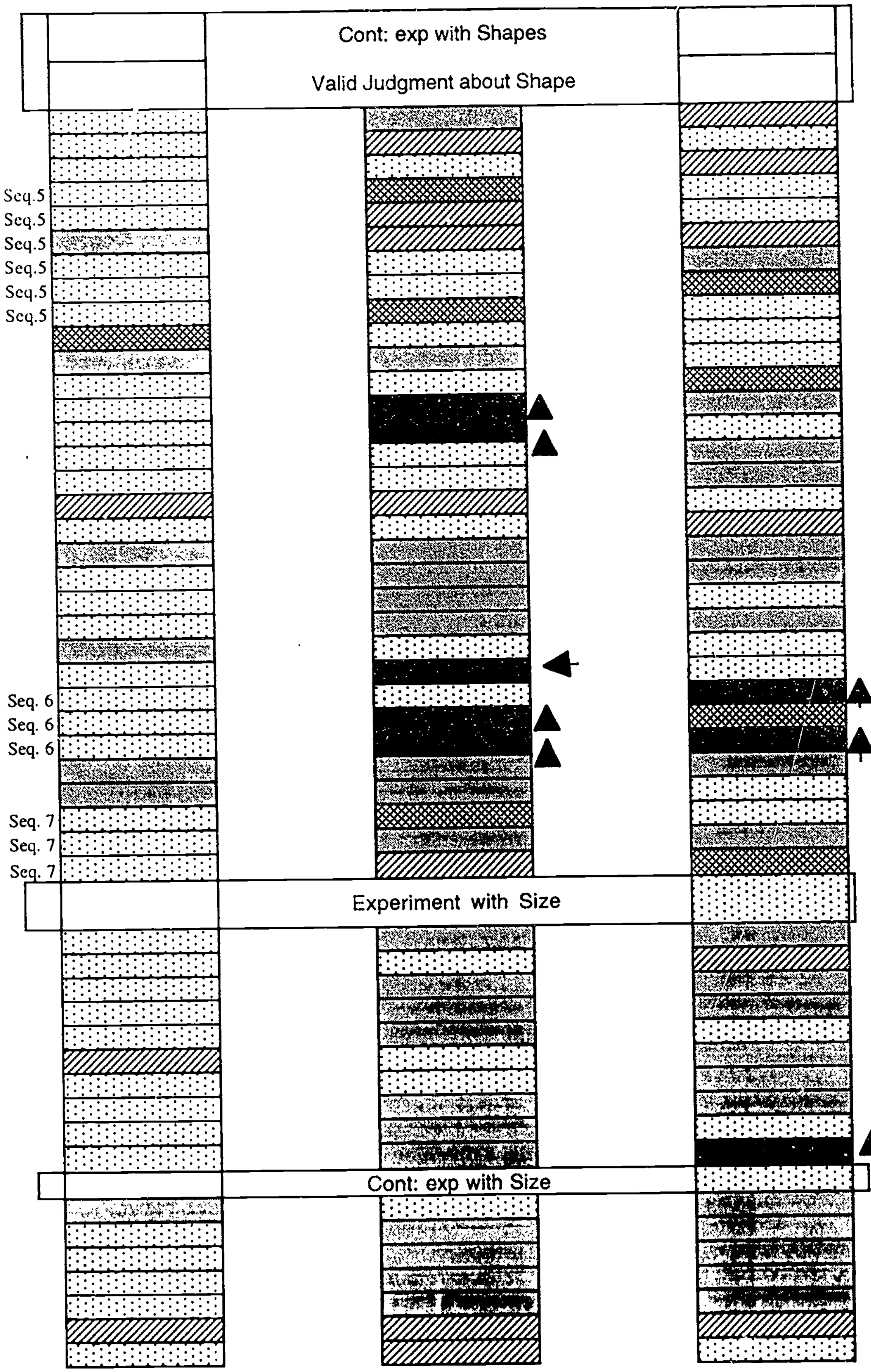
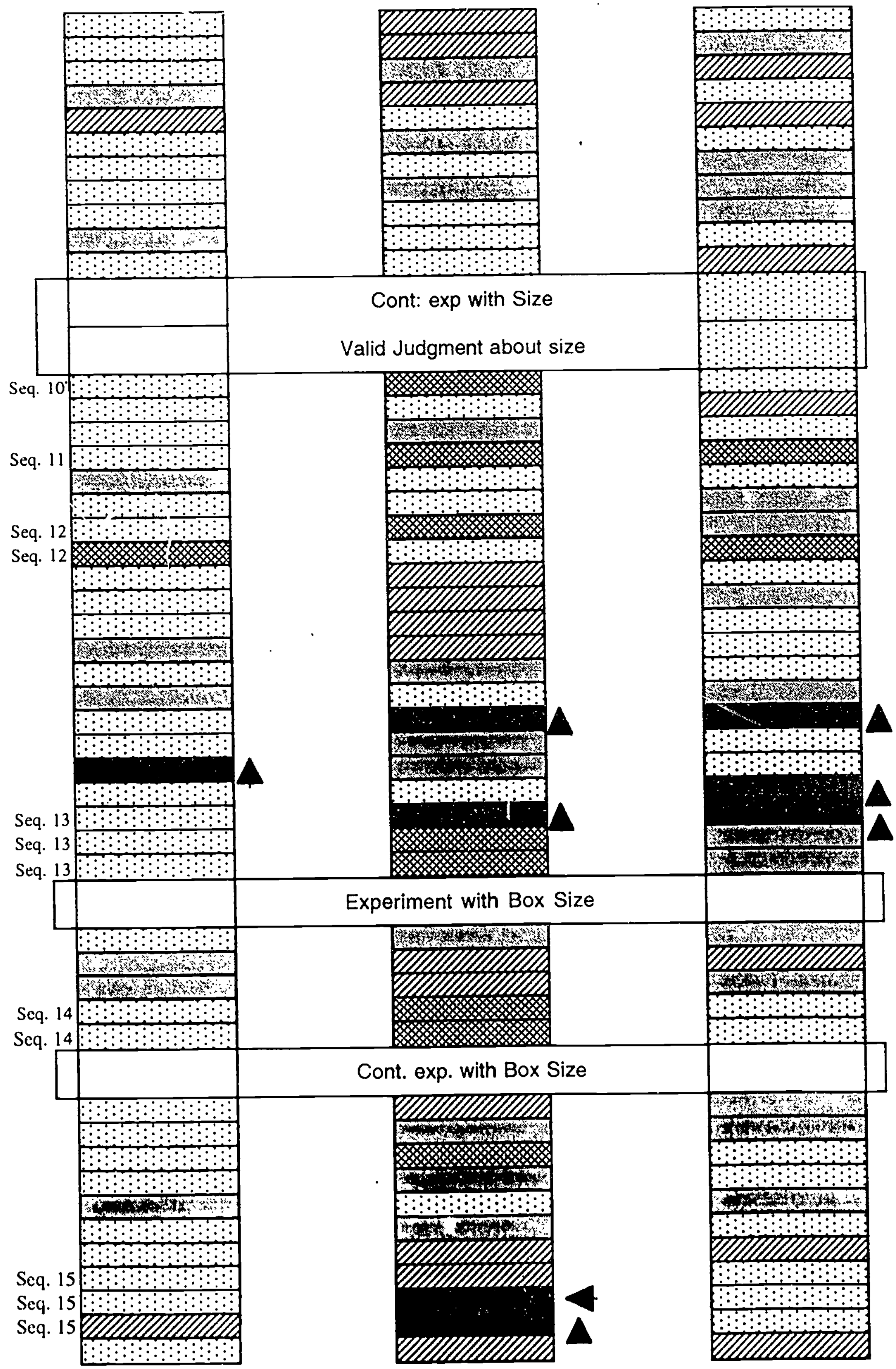


Figure 7: Individual types of contribution to knowledge and metacognitive framework by a group of student using CSILE plus oral discourse.


STUDENT A
STUDENT B
STUDENT C
Seq. 1
Seq. 1
Hign Level Goals
Seq. 2
Seq. 2
Seq. 2
Seq. 2
Seq. 3
Experiment with Shapes
Seq. 3
Cont: exp with Shapes
Seq. 4
Seq. 4
Seq. 4


Cont: exp with Shapes
Valid Judgment about Shape
Seq.5
Seq.5
Seq.5
Seq.5
Seq.5
Seq.5
Seq. 6
Seq. 6
Seq. 6
Seq. 7
Seq. 7
Seq. 7
Experiment with Size
Cont: exp with Size


Cont: exp with Size
Valid Judgment about size
Seq. 10
Seq. 11
Seq. 12
Seq. 12
Seq. 13
Seq. 13
Seq. 13
Experiment with Box Size
Seq. 14
Seq. 14
Cont. exp. with Box Size
Seq. 15
Seq. 15
Seq. 15

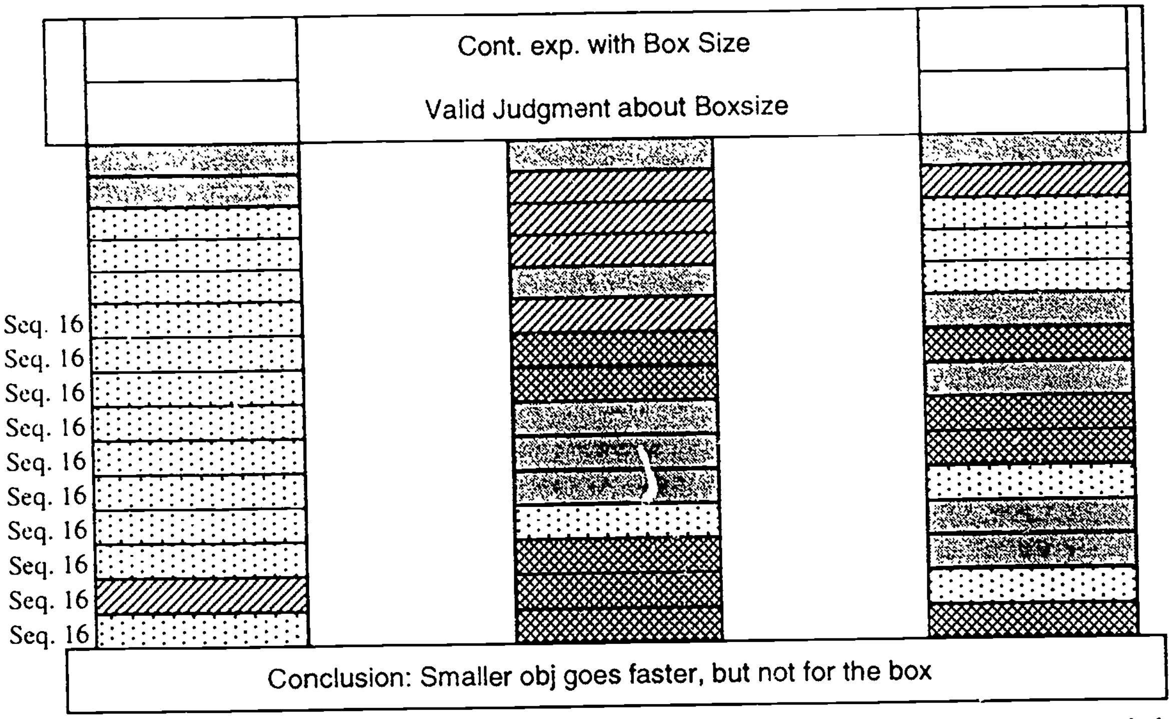


Figure 8: Individual types of contribution to knowledge and metacognitive framework by a group of student in the Face-to-face condition.

In these two graphic representations I attempt to represent three cognitive activities; (1) the relative types of contributions directed toward knowledge in oral discourse by the different individual members of this group. (2) the relative contribution to knowledge in written discourse, individually in the CSILE condition and by group in the face-to-face condition; and (3) most importantly, the amount and type of metacognitive discourse in the oral discourse by and between the students in this group. Here I will focus only on (3).

In (3), I ha e represented the metacognitive activity of the students in the two groups. The arrows only indicate metacognitive activity. First, in the face-to-face group, we can see for student A, there is only one arrow (reflecting back). We can conclude that student A does not monitor his thinking or the groups' work at all. For student B, there are several metacognitive events. Most of them are reflecting back, but others are directed at his own knowledge. Here I conclude that B is monitoring both others' past work and his own knowledge, but not others actions or knowledge. For student C we see a series of events reflecting back on past behavior, but no monitoring of his own knowledge. For all three students combined, we see many metacognitive events monitoring their past behavior (e.g. checking their past experiments and results and checking what they have previously learned). Student B and C do considerably more reflecting on their past behavior than student A. What is missing from this group interaction is any differentiation between each others knowledge, either referent- or problem- centered. Bereiter's argument concerning moving schooling toward Popper's World Three (Bereiter, 1994) emphasizes that the focus of schooling should stress improving collective knowledge through the production of immaterial things such as explanations, theories solutions and algorithms. The important point is that the students' focus should be out toward these objects, not in toward what's in their heads The data above from the face-to-face condition indicate that students can monitor what they have done in the past, but only as a single entity. There is no differentiation, evaluation, or comparison between differing ideas or paths of knowledge. The focus is on their own learning and of their past learning. Student B produces knowledge objects, but objects that only are evaluated by himself.

In the CSILE session the interaction at the metacognitive level is very different. For student A, again we see little metacognitive activity done by himself. The only two events are reflecting back on past work. For student C, there are two types of events. Reflecting back and monitoring student A . However for student B, the activity has changed dramatically. Throughout the entire session, B acts to monitor others' knowledge and actions, both through commenting orally on others' oral discourse and by monitoring others' entries into their CSILE discussion note. This is rather striking behavior. In the example above, student B monitors the judgment of student A. By walking A thorough the series of trials it first becomes clear that this student was not *intending* to control variables (in fact he did control variables, though is seems clear that this was not his intention): That prompts an explanation from student B concerning the importance of holding all variables constant or else the effect will be completely different. Immediately following that episode, B (I assume he reads through A's data) reports to A that he [A] did change the mass and that mass does matter. As A had in fact run three trials, the second changing only the mass and the third varying both the speed and the mass, but in such a way as to control the speed between the first and the third trials. This leads A to change his judgment from mass does not matter to mass does matter. In example above, B is reading the trials from C and himself. He notices that there are two trials with the same variables, but with different results. Through discussion with student C, they realize that there has been a reporting error, one of the variables was set wrong. While this episode does not result in a change in judgment or conception, it represents B's understanding that these data and judgments are objects which can be tested and need to be explained. B's interactions with both the other two students from the perspective of knowledge involves testing their knowledge against his understanding. B's focus is outward toward others knowledge. This is a indication that pursuing individual knowledge in a joint environment allows students to interact with their own and others knowledge as objects which can be evaluated and tested. This provides evidence that CSILE helps the students interact with knowledge moving toward Popper's World Three.

This qualitative analysis allows us to understand and presents evidence for one group supporting both hypothesis. (1) The proportion of metacognitive work these students did in oral discourse increased dramatically in the CSILE condition; and (2) The increase in the metacognitive oral discourse came through an increase in the monitoring and coordinating of others knowledge. This indicates a shift from thinking of knowledge in the head to using ones' own knowledge to relate it to others' knowledge, or knowledge as objects to evaluate, integrate or build on.

Quantitative findings

The above findings can be generalized to all groups participating in this study. Each exchange were coded into one of four types (see method section for more detail): (1) No direction to knowledge or knowledge content; (2) Referent-centered orientation; (3) Problem-centered orientation; (4) Metacognitive- orientation. For the proportion of metacognitive discourse in the CSILE condition compared to the face-to-face condition, the oral discourse was separately scored in the knowledge plane - discourse directed toward metacognitive processes when the group was working on their knowledge, and the operation plane - discourse directed toward metacognition when they were working on experimental design, and set-up. Simple comparison of means via t tests revealed that the differences were significant for the operations plane (t=2.36, p. < 0.03) and for the knowledge plane (t=2.36, p. < 0.00) (see figure 9)

Figure 9

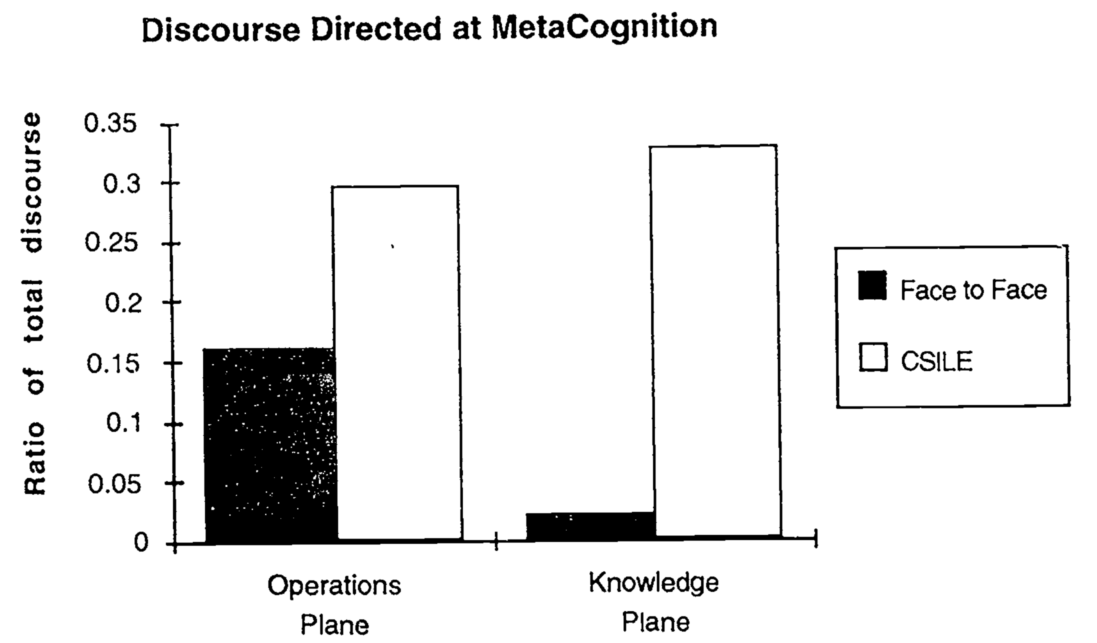


Figure 9: The ratio of oral discourse directed at metacognition in the operations plane and the knowledge plane

Collapsing both the operations plane and the knowledge plane and separating the types of metacognitive discourse events into three categories (see method section for more detail), monitoring knowledge and monitoring past work, (MK), coordinating others, (CO), and monitoring others, (MO), we can see that while there are similar amounts of monitoring knowledge (that is reflecting back or monitoring self knowledge), there is little coordinating others in either condition. However, there were significantly more events where one member of the group monitored another's knowledge or actions (monitoring others MO) (F = 77.2, p. < 0.00) (see figure 10).

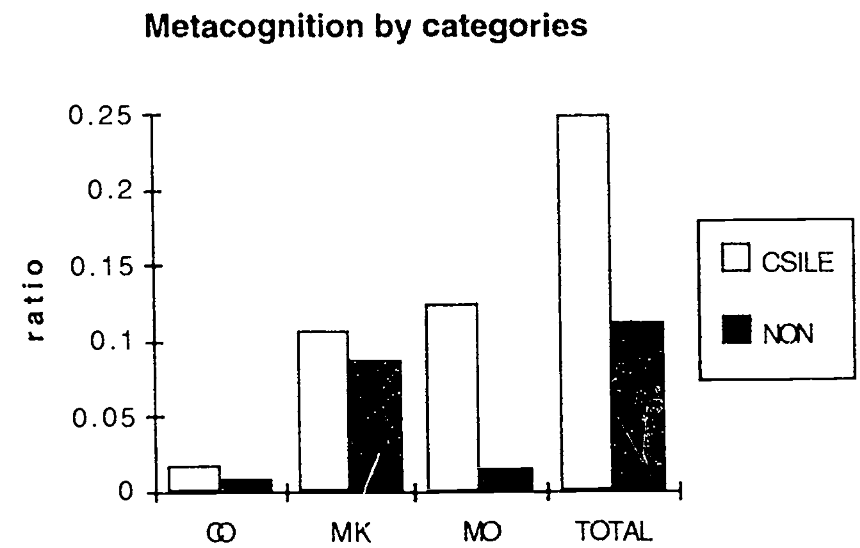


Figure 10: The ratio of oral discourse directed at metacognition collapsed over the operations and knowledge plane by category

Summary

To summarize, this research considered the following hypotheses: (1) that the proportion of metacognitive work these students do in oral discourse will be greater in the CSILE condition as compared to the face-to-face condition; (2) that the increase in the metacognitive oral discourse comes through a significant increase in the monitoring of others' knowledge. The data presented support both hypotheses by presenting a detailed description of the evidence in the qualitative study, which is generalized through a quantitative analysis of a larger population.

The relationship between CSILE and the activities described by the data can be interpreted by considering Engeström's framework once again. In the face-to-face condition, oral discourse is mainly a tool for pursuing or supporting others individual learning goals, as opposed to constructing and pursuing collaborative ones. The results of those individual learning goals make their way into the proforma and become a tool only for memory and recording progress. Similarly the proforma is used as a tool for structuring students' discourse and structuring their experiment process insofar as it requires them to plan, predict and record their results. The outcome of use of oral discourse and the proforma only is that there is a record of their work. Other than occasional referral to the proforma to check if they have completed a particular experiment, the record in the proforma does not facilitate other interaction with the knowledge. In the CSILE condition, CSILE and oral discourse are more closely connected. Students, through oral discourse, construct a joint problem-space. Students can then work on CSILE. The students have a space for individual learning, and the individual learning is both a contribution to their own learning and to the group's learning. The result of the individual contribution is that there is a trace of each individual's process of learning and knowledge in the database. This trace or record of each individuals learning process or knowledge is available for inspection, evaluation and for building on and integrating by themselves by others. This is the main finding of this research. CSILE provides a space for individual learning in the midst of collaboration. That individual learning becomes an object for discourse about the process of learning and the knowledge itself. That evaluation of the learning in turn has the effect of providing a basis for the reevaluation of what an individual has learned.

CSILE as a tool to realize educational goals has provided the means for restructuring educational process away from knowledge in the head of the learner, and toward individuals as producers, integrators and evaluators of knowledge in the world. CSILE helps shift the focus of education from inward toward the self to outward toward the world.

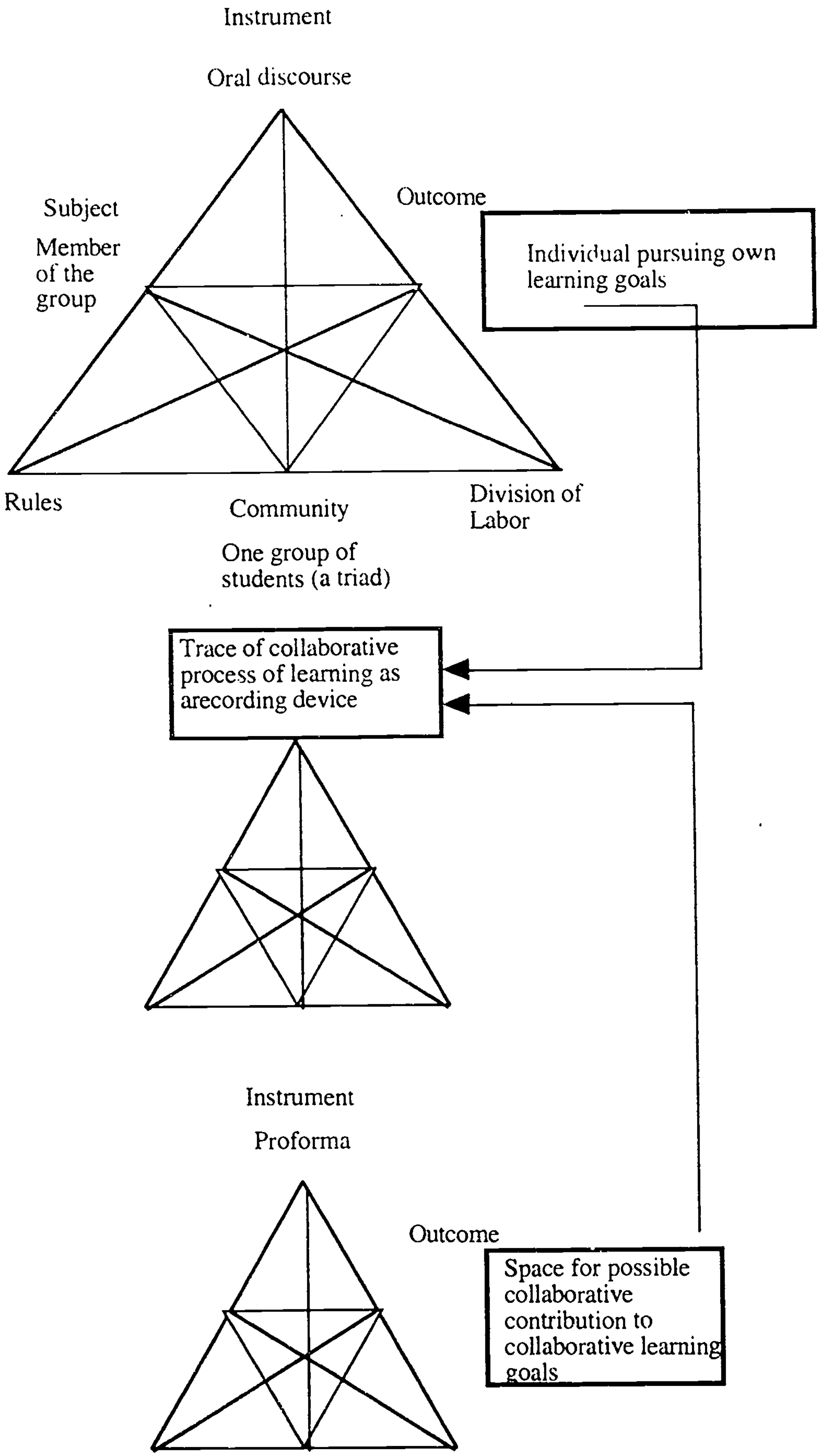


Figure 11: Students activity in the face to face condition

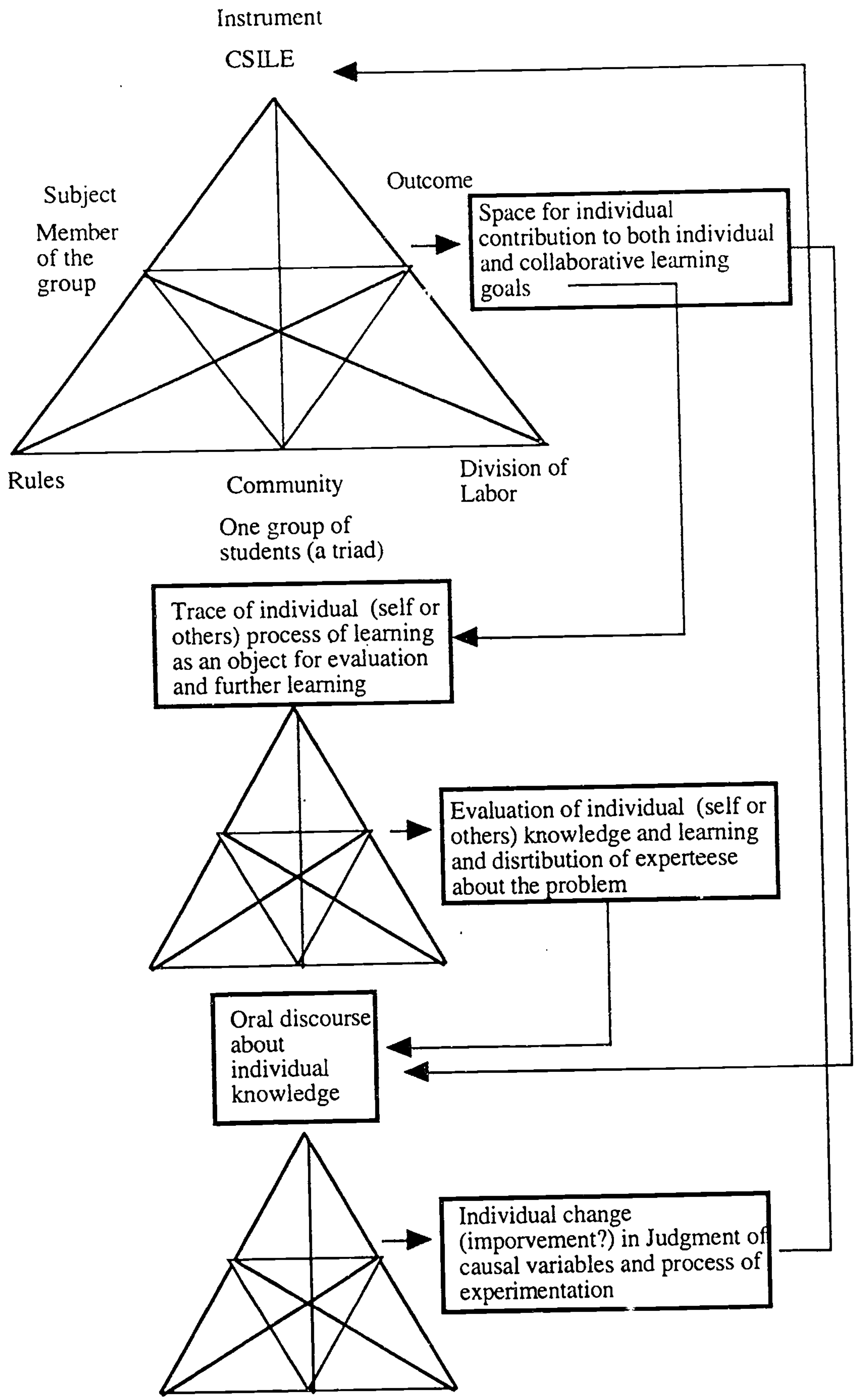


Figure 12: Students activity in the CSILE condition

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Appendix A

Case Study

In the following, one face-to-face section and one CSILE session of the same group are presented. This was a particularly interesting group as they exemplified all the hypothesis in this study. First, I present sections of the discourse, with annotations discussing who participated and in what way. This is followed by the frequencies for contribution in oral and written discourse and then a graphical representation of this progress. Finally a general discussion of the activity of each of the three students is given. The parts of discourse which are in bold represent questions/prompts asked which are nearly or exactly the same as the prompts on the proforma, "What are we trying to find out?", "Explain what you think will happen", and "What have you learned?" The parts of the oral discourse in italic represent the first appearance of responses which later appear in writing

Oral discourse from face-to-face condition

This first section is their joint effort, lead by B to construct their high level goal.

Sequence - O.1

1	B	Shape. See if the shape affects it .
2	C	Shape, shape shape shape
3	C	[inaudible]
4	B	so does the shape affect the speed?

In the second sequence, B is dictating the groups process of experimentation. In line number 4 he indicates that they must control variables and in line 6 he specifies exactly what the variables will be. There is no discussion of the process of experimentation. A and C offer no ideas, they only go along with B

Sequence - O.2

1	B	A ball a wedge or a box
2	C	Yes.
3	A	[inaudible] [Reads something]
4	B	OK all we have to do is ... keep everything like that for all the experiments.
5	A	Wait,
6	B	Daniel. These are going to be the weight, atmosphere and wind for all experiments.
7	C	OK,
8	C	just give. OK. Does the ...
9	B	[inaudible] ... or even heavy, heavy large Heavy ... [inaudible]. large

In the third example the three students are beginning a new trial for the experiment. C uses the proforma questions to structure the discussion. B responds with a problem-centered comment specifying the causal variable, shape that they are going to test.

Sequence - O.3

1	C	OK. Let me try to find it. OK. What are we trying to find out?
2	B	What are we trying to find out? We are trying to find out if the ...
3	B	The shape affects the speed that it has.
4	B	..If the speed affects it
5	B	We are trying to find out if the shape affects the speed of the object.

{Entry into the proforma: If the shape affects the speed of the object}

In the fourth example , they are making a prediction for the trial of the experiment. C again starts with a question directly from the proforma (1). B responds with a referent-centered reply (4), followed by two problem-centered explanations (6 & 8).

Sequence - O.4

1	C	OK. Explain what you think will happen.
2	C	Same?
3	B	Even though ...
4	B	I think ... it will probably go a bit faster.
5	A	OK.
6	B	Because the mass doesn't look as big.
7	A	I don't know.
8	B	So it looks like its the mass. Because the box is taking more area.
9	C	Oh, yes.

{Entry into the proforma: It will go a bit faster then the other experiment}

In the fifth example , they are finishing up a trial and going on to another trial for the experiment. B proposes that mass is the causal variable (1). In the second and third exchanges, B reports the result, factual, referent knowledge. In the last exchange, C begins again with a proforma statement (7). He follows it up by jointly constructing a problem-centered explanation (8 & 9) with B. This a rare example of joint interaction where both persons are making a problem-centered contribution to the problem. It is interesting to note that B is able to both report referent knowledge, then re conceptualize the knowledge as fitting into problem-centered knowledge.

Sequence - O.5

1	B	You know it is the mass that is affecting.
2	B	0.42.
3	C	Oh, 0.42?
4	B	0.43
5	A	0.43, that is what I meant.
6	C	0.43
7	C	What have you learned from this experiment? ..
8	C	... Or the mass affects ... the mass. The slower ... the faster it goes.
9	B	Mass is smaller the ... the smaller the object is ...

{Entry into the proforma: The smaller the object the faster it goes}

In the sixth example, C suggests a new experiment with Ball size. Notice that the criteria C uses is only whether they have done an experiment with Ball size before. C does not try to relate it to their high level goals, or provide a theoretical basis for doing this experiment. B monitors their past experiments using information from the proforma.

Sequence - O.6

1	C	Have we done an experiment with ball size?
2	C	Do you want to do experiments with the ball size?
3	C	[inaudible].
4	B	We never did it with ball size.
5	C	Like what about ball size. We have never done ball size.
6	B	Ball size?
7	C	Yes, we have never done that one.
8	B	No, we never done it.

In the seventh example B redefines their plan as not doing an experiment with Ball size, but as whether the size effects it. B takes "doing another experiment with Ball size", (example 6 line 1) and redefines this as directed at solving a problem "does the size affect it" (1). B suggests that this should be another high level goal, however C ties it to their High level goal by suggesting that size is shape.

Sequence - O.7

1	B	does the size affect it?
2	B	Yes, but no ...
3	C	Yes, does the size affect it?
4	B	OK,
5	B	that should be another high level goal, right?
6	B	Yes. [inaudible]
7	C	No, no it shouldn't because the shape is size.
8	A	[inaudible]

The eighth example is similar to the fourth except that now A is using the proforma to structure their discourse, while B first offers a referent-centered (fact), following it up with a problem-centered explanation (4)

Sequence - O.8

1	A	What do you think ... what do you think will happen?
2	B	It will go faster.
3	A	Oh, geez.
4	B	The smaller the ball is the faster it will go. Because the less mass then ...
5	A	Faster than what?

As in the second example, here B proposes a control of variables strategy.

Sequence - O.9

1	B	OK, need more experiments.
2	B	Then everything is the same except for that is ... it will be the second ball is medium.
3	C	OK.

In the tenth-twelfth examples, B and C jointly attempt to construct the explanation that the smaller the ball the faster it will go. B uses an analogy to balloons (this was a reference to an in class experiment they did at the beginning of the unit). Here we can see B proposing explanations of the problem, the interaction between mass and size. He is reaching to develop a strategy to explain why smaller size goes faster.

Sequence - O.10-12

1	B	But the mass, because a balloon goes up ... it was ... the smaller the balloon ...

1	C	I guess that the smaller the ball ...
2	B	Yes, the faster it will be.

1	B	But that says another thing with the mass, because it is ... if the bigger the ball, it will ... the bigger the balloon ... the longer time it will stay up.
2	C	Oh yes.
3	C	Bigger ball ...
4	.C	The object.
5	B	The bigger ball.
6	A	The bigger the object ...
7	C	The longer.

In the thirteenth and fourteenth example C is monitoring that they only did one experiment with box size, there fore they should do boxsize next. B questions whether they need to do box size comparing it to finding the mass. In the next sequence B continues on to give an explanation as to why the boxes are so slow. B again moves a suggestion of something they need to do into a problem-centered frame, mainly that understanding box size is like the mass and that explaining the causal status of box size might take the place of running experiments on box size.

Sequence - O.13-14

1	B	We haven't talked about it.
2	C	... we only did one experiment with box size. We can do box next.
3	A	[inaudible]
4	C	No, we haven't
5	B	No we haven't.
6	A	[inaudible].
7	B	Well, what are we going to do with box sizes?
8	C	oh, oh
9	B	Like, it was just finding the mass.
10	C	Yes.
11	B	OK.

1	B	All of them are going to be really slow. Because it is taking up ... it is deplacing a lot of air.
2	C	[inaudible]
3	B	You see, when I move my hand it deplacing air. So .its like when you go in the bathtub,. It is like when you go in the bathtub. It is like when you go in the bath, if you have water that much, and you go in and the water can go up that much.

In the fifteenth and sixteenth example B realizes that all the boxes are going the same speed (same surface and different widths same mass). His explanation above, regarding air displacement combined with the results from the ball and box lead to the last sequence, their conclusion. Note that both C and B push the causal explanation along. Also B offers explanations while C offers only statements about the causal variable, but no explaining.

Sequence - O.15-16

1	B	It is going faster he?
2	B	This is really weird because with the small ball it was going faster than the other ones.
3	C	But this is a very thick ...
4	B	What was that ... their time?
5	A	81 seconds.

1	B	So ...
2	C	The box size ... [inaudible]
3	B	The box size shouldn't affect .
4	C	the shape
5	B	.. the box size did not affect .but the shape..
6	C	No.
7	B	So our conclusion was ...
8	C	The smaller object, the faster it goes.
9	B	Yes.
10	C	So the conclusion is the smaller the object the faster it goes.
11	B	Conclusions.
12	C	The smaller the object the faster it goes.
13	B	Yes. Smaller ...
14	B	[inaudible] Why does it go faster?
15	B	Because there is not as much mass.
16	C	Yes.
17	B	No, because there is not as much deplacement.
18	A	Yes. air deplacement.
19	A	[inaudible].
20	B	Yes. OK, and ... but this does not affect ..
21	B	no.
22	C	Does not affect the box.

These are interesting passages because they illustrate the use of different genres [Did this term appear before?] or structural features of language in the process of accomplishing goals. In many of the sequences student A or C uses the proforma (which has the prompts on it "What have you learned from this experiment?", "What are we trying to find out?", "Explain what you think will happen") to initiate or structure the sequence. The response to the prompts often involve a statement of factual knowledge followed by an explanation of factual knowledge. In other words, the proforma helps structure a response. There is no discussion between either B or C and A, while B and C attempt to construct explanations together several times. For a significant proportion of the discourse, the proforma has the effect of affording a genre of discourse

Note that almost all the reasoning and explaining moves are made by B. And that B is generally the one who moves discussion toward a problem-centered structure. A interacts little or not al all with B or C. While the students do monitor their past work and knowledge, it is generally only at the level of reflecting on what they have done in the past. The never consider each other others ideas as separate ideas to build together and collaborate on.

<u>Students' use of oral discourse and CSILE</u>

In this first example the students are jointly constructing their high level goal.

Sequence - C.1

1	B	What causes the satellite to crash into the planet?
2	A	Yes.
3	C	Well, that is like, what affects the path of the satellite?
4	A	We did that last time.

{Entry into the proforma: What causes the Satellite to Crash into the planet}

In this second example student B is monitoring what the others are trying to so, and attempting to monitor whether a particular type of experimentation is going to go on.

Sequence - C.2

1	B	So what are you guys trying to do?
2	C	What?
3	B	Are we all going to be doing the same experiments?
4	B	Are we all going to be doing the same experiments? Or ...
5	A	We are not going to do the exact same.

In the third example the three students are trying to coordinate their experiment space. In particular student B takes the lead in monitoring that they are not duplicating any past work, and that they all take a separate piece of their overall goal. Their joint learning is used to set up a space for individual learning.

Sequence - C.3

1	B	C, why don't you try to find out if the speed causes the satellite to go into the planet. And A try ...
2	C	Direction. I will try direction.
3	B	Direction.
4	B	And what should I try? Mass? I will try mass.
5	A	Okay.
6	B	Mass of the satellite.
7	A	Okay, then I have to change the direction. I will just leave it always at north.
8	C	No, I am doing the direction.
9	A	I know. (separated)
10	B	Actually A, we know that if the direction ...
11	C	Yes ...
12	B	We know the speed and direction so I will have to try mass and ...
13	A	I will do mass of the planet.
14	B	I will do mass of the satellite.
15	C	Then what do I do?
16	C	I will do the direction.
17	B	Direction? Okay.

{At this point student A goes on to do a series of experiments on the planet mass, B goes on to do a series of experiments on the mass of the comet, and C goes on to do a series of experiments on direction}

In the next two sequences they are in the middle of experimentation. All of the students have run at least one trial and are in the process of trying to figure out what results are. Student B is monitoring student Cs experimentation and interpretation. Additionally Student B is relating student C's results to his past results (with some surprise). Finally student B puts forth a hypothesis for why the satellite actually will not go around. Student B is monitoring others individual learning (in this case student C), as opposed to paying attention to only his own learning.

Sequence - C.4-5

1	B	Oh you got the north to go around? {B LOOKING AT A'S SIMULATION}
2	C	I don't know how. I haven't done a full orbit yet.
3	B	Because that is so weird. When I tried it with a lot speed ...
4	C	I don't ... I couldn't get it to do it before.
5	B	It went like this.
6	A	I know, it went like ... [sound effect]. Weird.
7	B	I think the speed causes it to go so fast that it doesn't have time to react ... to go around. To rotate around the Earth.

1	B	What did it ... you tried the mass of the ... What did you try?
2	A	Yes. I put it that it would do a circular orbit and then it hit the planet.

In the sixth example, A is pursuing his individual learning. A has done three trials, controlling mass then controlling speed. Upon reporting his results, that the mass does not matter, B responds that the results were different on the two trials of the experiment. Further B leads A first through his operations (did you control variables?), and when A reports that he changed the speed, B responds by explaining that you must control all the variables but one, or else "it will be a completely different effect" This in turn directly leads to a new judgment opposite to the one A initially had. This is a critical passage. It is here where the movement between individual learning and joint plain becomes important in CSILE. As each of the members of the groups work is visible to the others, a trace of the path of the individual work is left for the other's to see, and potentially examine. These students use their joint plane of learning to collaborate on their individual learning. Their joint plane is constructed by B monitoring A's progress. A few moments later B after looking through A's experiments explains to A that he did change the Mass and therefore the mass matters. So we can say that B's monitoring of A lead A to change his judgment and enter a more correct one into CSILE.

Sequence - C.6

1	A	It's not the mass, really.
2	B	But it collided the first time, and the second time it went right around.
3	A	That might have been just because of something else I did.
4	B	What did you do?
5	B	Did you change anything in the second time except the mass?
6	A	Okay, this is what we can do. Same thing for distance.
7	B	Yes.
8	A	Same thing for ... oh, speed.
9	A	It could be the speed does affect it.
10	B	Did you change the speed?
11	A	Yes.
12	B	You shouldn't have done that. You should have kept them the same all through the experiments except for the mass. Because it will be a completely different effect.
13	B	You definitely changed the mass. I think the mass affects it
14	A	Yah
15	B	a lot.
16	A	Yes, if it is the planet.
17	B	Yes, I don't know yet. I will have to try it one more time.
18	A	Because the moon pulls it in really easily but ...
19	B	So that definitely affects it.
20	A	Yes.

In the seventh example, B reports results

Sequence - C.7

1	B	Sorry guys. Satellite mass does not affect ... cause collision or go off into space.
2	C	Cool
3	B	CoolEH?

{B's Entry into CSILE: "I have learned that the mass of the satellite does not cause it to go into space or crash into the planet because the satellite orbit was circular on every experiment" }

In the eighth example, A reports individual work to B and seeks help interpreting the results. Here you can see B's problem-centered work directed at A's learning as opposed to his own learning.

Sequence - C.=8

1	A	What should I put for the thing. Because one crashed. One did an ellipse, and then one went into space. And the one that did an ellipse was when I did the moon.
2	B	Say that the ... "our experiment .. my experiments showed that that the mass of a planet definitely affects "

{A's entry into CSILE: "My experiments have shown that the mass of the planet affects a lot" }

In the ninth example. B is monitoring their group progress. He monitors the goals and what they are doing (if it will answer the question) and what they do not yet know.

Sequence - C.9

1	B	But our question is completely different.
2	A	What?
3	B	How do satellites orbit the Earth?
4	C	No, we changed it.
5	B	No.
6	B	How do satellites orbit the Earth? {POINTING TO THE SCREEN}
7	A	I know.
8	A	The satellite's size, how does it affect the orbit?
9	B	Yes, I guess so. But we still don't know what makes it go around.
10	A	Yes, but there is no questions from this.
11	B	Yes, I guess not.

In the tenth example, C is monitoring the learning of other students. The interesting this here is that the focus is on what others learned. Until now C had been only concerned with what C learned, however here C is concerned with another individual learning.

Sequence - C.10

1	C	The planet is going to ... what have you learned from this experiment?
2	A	It is just gravity. It is gravitational pull.
3	C	Can't do gravitational pull.
4	A	I know, but that is what keeps it orbiting.
5	B	Probably.

{A's Entry into CSILE: "My Theory: My Theory in that the earth's gravitational pull holds the satellite in place, but if the satellites goes too far the earth's gravitational pull can't reach the satellite so the satellite drifts of into space" }

The eleventh example, is another example of B monitoring another students learning. This time B is monitoring A's progress. B has noticed that they have done the same experiment, however that they have recorded different results. He can only know this because he is reading the trace of student C from the Database. His response is to note how that can't be and that they should figure that out. (It turns out that student A was not keeping track of the experiment variable levels on the experiment and recording those properly in CSILE). This problem was quickly rectified, but again this is a critical joint interaction which can only come about because there is a trace of their learning which allows one student to monitor others learning moving from individual learning to joint learning about their individual learning.

Sequence - C.11

1	B	Oh, hold on.
2	B	Who did 40?
3	A	What?
4	B	You did?
5	A	Who did?
6	B	Come here? This is really weird.
7	C	What happened?
8	B	Because we have the same thing. okay? But yours went into space and my orbit was circular.
9	C	There?
10	B	What was the planet mass?
11	C	while I put ...
12	B	Or was it Earth?
13	C	How about what is the name of the planet?
14	B	Okay, Danny 40, into space. 41, orbit, circular.
15	B	Hold on let me have a look ...
16	B	Okay, Danny ... Planet Earth.. .. Planet mass, Earth. Okay.
17	??	[inaudible]
18	B	Results, into space. That is so weird.

Finally during part of the conclusion student C indicates that the direction does matter, contributing his individual learning to the joint conclusion.

Sequence - C.12

1	A	Now what did you ... Dan, what did you guys ... distance from the planet?
2	A	Does it?
3	C	Yes, the farther ...
4	C	The direction does

{A's Entry into CSILE: "In these sets of experiments "we have learned that the mass of the planet affects the orbit of a satellite. The satellite does not affect the orbit at all, the direction affects the course of the satellites }

In the CSILE examples the structure is quite different. First of all, in example C.6, C.7, C.9 and C.12, B is either monitoring others oral and written discourse and commenting on their individual learning, or in C.12 reading over the trace in CSILE of others individual learning and commenting on their process of learning. In CSILE students can pursue individual learning leaving a trace of that process. Learning is visible to the other members of the group. Students can benefit from having other students monitor their learning behavior. Example C.6 is a particularly good example of this. Student A has actually done controlled experimentation, both on speed and mass, however, it is difficult for him to interpret the data. When making a claim which is incorrect, B, can view A trace of learning and can help him walk through the interpretation.