Learning from Lectures for Comprehension

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Abstract: This study reports a method of helping college students acquire skills to comprehend and learn from lectures. The method utilizes a commentable bulletin board with lecture video clips, which students reflect upon for knowledge integration. Learning from lectures has to be an active process, where learners need to decompose the linear input into components, to identify their roles, select parts important to the topic and to each learner's concern, and to integrate selected parts to form a coherent comprehension. This is comparable to but more demanding than learning from texts because learners have to engage in this decomposition and reconstruction "on line," without records. To make this situation more learnable, we provided sophomore students with a bulletin board on which sequences of 5 to 15 minute clips covering each lecture are placed for comment. Using this support tool, three 90-minute classes were devoted to guiding the students in decomposing and restructuring one of the lectures. Students were required to integrate selected parts of the lecture during this intervention. Sixty-one percent of the students successfully identified the structural connection of one episode at the beginning of the lecture to its main theme, compared to 7% who had succeeded without support prior to such an intervention. Some students commented that this was a new experience for them and gave them a new perspective to take lectures. On a transfer lecture, we found an increase from 5 out of 66 (7.6%) to 26 out of 62 (41%) in the number of students who could give more meaningful comments at the end of the lecture. The results show that the intervention was within reach for the middle-range students, with some potential for the acquired skills to stay on.

Learning from Lectures

Among diverse methods of teaching, lectures can be an effective way, at least time-wise, and still prevails from elementary schools up to colleges and universities, and to work places. It may be assumed that quietly listening students are actively learning, yet there has been little work on what is involved in learning from lectures. Schwartz *et al.* reported once that a lecture given at a right time, i.e., after having students engage in active groping of data to raise their intellectual motivation, yielded better understanding than both lecture alone or groping alone (Schwartz & Bransford, 1998). This is an informative research, but does not tell us much about how to construct a lecture itself, or how to scaffold students, who have needs to cope with lectures without much time allowed to raise their motivation and/or groping with data.

The Process and Difficulties

In our undergraduate course of cognitive science, we have a lecture series where each member of our nine faculties takes turns to lecture on her/his research. This provides us with an interesting case to observe how well students learn from lectures, given in different styles. As preparatory work we have been collecting and analyzing notes written by the students at the lecture ends, on which they are asked to write a summary of the lecture, with comments and questions. The overall pattern shows that the students are in one sense quite good at this—at capturing some key phrases spoken by a lecturer like, "Let me conclude what I've said so far…" and "So this slide summarizes my findings…." and focus their summary, comments and questions on utterances and slides around them. These summaries, comments and questions are not off the point, but often direct copies of what the lecturer said, or just lists of key terms, without any evaluative phrases. They bare signs of shallow understanding, listening to lectures without much comprehension.

We have also observed some students watching video-taped lectures in quasi-experimental situations, where they are asked to take notes to write a summary and answer comprehension questions at the end. We have also observed students using a tool for video clipping and commenting on recorded lecture videos for securing their understandings so that they could explain the contents to other students. Under these clear demands, the participants did engage in active learning, by re-viewing the videos several times. This process often took three to four more times of the length of the original videos. Learning from lectures, without records, for comprehension could be a highly demanding task.

We have also observed that the process of learning from lectures is comparable to those of learning from texts. They both require students to engage in an active set of knowledge integration. The process involves following activities.

1) Decompose a text/lecture into elementary components,
2) Identify roles of each component,
3) Select components relevant to the topic and to the receiver's concerns,
4) Connect and integrate selected components into a coherent comprehension, and
5) Take care of remaining comments and questions.

Though most of the steps should be obvious, the second step might need some explanation. The roles of components can be identified by answering questions why the components are sequenced as they are in the text/lecture and then connecting them. This step helps reveal the structure of the text/lecture. As texts are externalized, tangible objects, readers can mark their components and leave memos of their roles, for future reflection and reconstruction. Because lectures do not share these characteristics, it is no surprise that learning from lectures is harder than learning from texts.

Possible Suggestions (Hypotheses) for Support for Learning from a Lecture

If the process of learning from lectures is comparable to those of reading, we could take hints from reading research on how to support learning from lectures. In our studies on college level reading, we have found that poorer readers are not aware of steps mentioned above, and often read through the material once by picking up key phrases identified by key terms, and list them to make a summary. The summaries thus created are often quite readable to experts, probably because they know the content well enough to fill between the lines. The problem with these summaries is the students who produced them do not feel they understood the material, nor were they able to answer conceptual questions correctly. This one-shot reading style of poor readers has also been identified by other researchers (Bransford & Stein, 1984). Among the steps identified above, one-shot reading involves mainly 1), with sporadic 2) and 3), but not 4) and 5) which are essential for learner's own knowledge construction. By making all the steps available to the students, we have shown that it is possible for helping them to learn better from texts. Compared against reading, learning from lectures is inevitably one-shot, unless some recording is made available. The situation itself forces listeners to act as a "poor reader," who has no easy access to steps 4) and 5).

This analysis suggests two specific types of support for learning from lectures. For one, it would be beneficial to provide students with tangible access to records of lectures. It would be better if the records can be commentable so that students could compare their understandings and connections with others for reflection. This should support steps of decomposition and role identification, mainly steps 1), 2) and 3) in the above list. Steps 4) and 5) are more advanced skills requiring a separate set of more explicit activity support. Students would need guided activities to go through all the steps, particularly steps 4) and 5), which could be developed on segmented records of a lecture video. We implemented these two kinds of support in an undergraduate cognitive science curriculum. In the remaining part of this paper we describe the learning context, details of the support tool and the activities, and the results, with some discussion on integrating lectures with more collaborative type of classes.

Learning Context

Background

The context for this study is a curriculum set to teach introductory cognitive science to sophomores, at a Japanese university. It is embedded in larger curricula for undergraduates in a department of cognitive science, which cover two semesters per year, taking four years to complete (Miyake, et al. 2003; Shirouzu & Miyake, 2003). In the first year, hands-on experiences of simple cognitive tasks are emphasized and analyzed, first individually and then collectively, across the class, so that the students could extract cognitive "rules of thumb." These experience-based techniques are gradually meshed into reading activities of technical materials, to help students gain a deeper comprehension as well as to grasp the breadth of research. In the third to fourth year they are encouraged to engage in more inquiry-oriented, project-based learning, leading them to graduation research. The basic form of their learning activities is collaborative, where students are encouraged to engage in collaborative reflection for their own knowledge building. Throughout the curricula, we use the jigsaw method extensively, where each member of a group is assigned a part to master and then exchange that information to create a whole understanding. This produces a natural setting to explain what one understands to others, often motivating them for further learning. The students are gradually introduced to the simple jigsaw of two to three parts, to a more complicated and dynamic jigsaw to cover thirty to forty research pieces, by expanding each member's understanding of her/his own interests. These classes are organized and taught mainly by the authors.

The Target Class for This Study

Surrounding these collaborative, student-centered classes, there are more traditional lectures and lab classes in the curricula. This study focuses on a bridging two-semester course, consisting of both collaborative activities and lectures, organized and taught by the authors but involves all the other faculty members of our department. The aim of the class is to cover the scope of cognitive science research, both at large as well as at home, i.e., the research scope of the faculty members of our department. To fulfill this latter purpose, each of the nine faculty members contributes a lecture once at some point of the course. The classes in the last year's course were taught once a week, the first half starting from April 8 to end on July 8, 2003, while the second half spans from September 24 to December 17, 2003. Each class lasts for 90 minutes. The topics covered are listed in Table 1. In Table 1, nine lectures are shown in broad letters.

Table 1. Topics in "The Scope of Cognitive Science" course, 2003.

The Scope of Cognitive Science I		The Scope of Cognitive Science II	
April 8	Guidance: Orientation to some classical materials to be covered in this class.	September 24	***Learning how to learn from lecture (1) :Identifying "facts" and "relations"***
April 15	Concept mapping of research figures covered in the first year.	October 1	***Learning how to learn from lecture (2) :Recreating relations.***
May 6	Decomposition and integration of the classical materials of April 8.	October 8	***Learning how to learn from lecture (3) :Sharing relations for reflection.***
May 13	Jigsaw on the classical materials.	October 15	**Lecture by faculty member 4**
May 20	Introduction of the CogSci Hexagon.	October 22	**Lecture by faculty member 5** **
May 27	Jigsaw and expansion of concept maps.	October 29	**Lecture by faculty member 6**
June 3	**Lecture by faculty member 1**	November 5	Reflection on lectures 4, 5, and 6.
June 10	**Lecture by faculty member 2**	November 12	**Lecture by faculty member 7**
June 17	**Lecture by faculty member 3** *	November 19	**Lecture by faculty member 8**
June 24	Reflection on Lectures 1, 2, and 3.	November 26	**Lecture by faculty member 9**
July 1	Concept mapping of lecture video clips.	December 3	Reflection on Lectures 7, 8, and 9.
July 8	Integration of concept maps.	December 10	Placing lectures onto a broader scope.
		December 17	Summary concept mapping.

NB: * The target lecture for intervention; ** The lecture for testing transfer.

At the end of each lecture, the students were required to write down the main point of the lecture, and the comments and questions they might have. They were given 5 to 10 minutes to do this. These notes served as a target for evaluation of how well the students comprehended the lectures.

Two Kinds of Support

In order to support students to understand the art of learning from lectures and to gain concrete skills to do so, we have provided two kinds of support. One is a technical tool, which keeps records of lectures and makes them accessible by the students to work upon. A part of it was introduced on June 24, and was fully put in use from October 1 on, covering all the lectures as they were delivered. The other is a set of activities to explicitly guide the students through steps explained in the first section, from decomposition of the lecture into components, identification of their roles, selection of relevant components, to connecting and integrating them to form a coherent comprehension. These intervention classes took place at the beginning of the second half of the class, on Sept. 24, Oct. 1 and 8, as shown in italics in Table 1. For this intervention, the third lecture delivered by faculty member 3, the first author, was used as the target (noted by * in the table).

Technological Support

In order to help students work on lectures, we need their tangible records. We implemented this on a system called Commentable Movie Sheet, which lets clipping and commenting on videos, with the capability of publishing those clips with comments on the web, for further comments and responses. For this study, the lectures contributed by the faculty members were pre-cut by the authors and put on a bulletin board accessible on the web, to solicit comments and responses. Each 90-minute lecture was cut into 13 to 17 segments, of 7 to 16 minute long. Fig. 1 shows some screens of the bulletin board, showing a column of small video clips and rows of comments, in separate windows. Clicking a video clip opens up a new window to show the segment of the video. We abbreviate this as CMSonBB, the Commentable Movie Sheet on Bulletin Board, in this report.

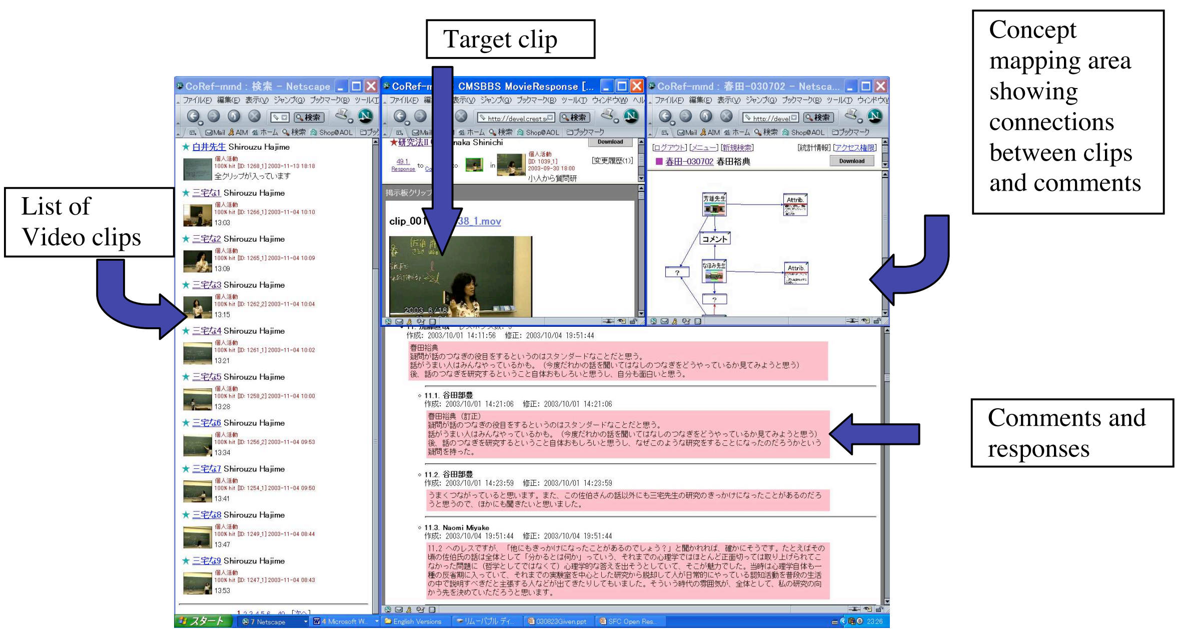

Figure 1. Some screens of the Commentable Movie Sheet on Bulletin Board.

Classroom Activity Support

In order to help students acquire the skills to learn from lectures, we used "Lecture 3" delivered by the first author to introduce all the steps necessary for comprehension. The activities were designed to guide them through explicit relation-making among some pre-selected components. As mentioned above, three classes were devoted for this at the beginning of the latter half of the course, as shown in italics in Table 1. Lecture 3 was cut into components to be used in the three classes.

Structural Components of "Lecture 3"

Lecture 3, an 80-minute lecture, was divided into 17 components in total. Table 2 summarizes the components, with Number, Name, Content and Length of each component in columns from left to right. Eight of them dealt with experimental facts (shown as Fact A, B, C, D, E, F, G and H in Table 2), while the other nine contained the theme (shown as Theme in Table 2), with seven relations between the facts (shown as Relation A, B, C, D, E, F and G in Table 2), and the conclusion (shown as Conclusion in Table 2). The Facts were "Demonstrations of human visional attention (Facts A and B)," "An episode from a problem solving research of simple physics (Fact C)," "Experimental results of the lecturer's previous studies on question asking (Fact D; Miyake & Norman, 1979)" and "Constructive interaction (from Fact E to Fact H; Miyake, 1986)." The lecture's main theme was on constructive collaboration for learning.

Table 2. Components of Lecture 3.

Number	Name	Content	Length
1	Theme	Constructive collaboration for learning	5:38
2	Fact A	Demonstration of a blind spot	3:08
3	Relation A	Importance of seeing things by both eyes	1:00
4	Fact B	Demonstration of "Change Blindness"	3:29
5	Relation B	Difficulty of meta-cognition of what is not seen	0:30
6	Fact C	A way to understand physics through meta-cognitive points-of-view shifts	6:45
7	Relation C	Difficulty of meta-cognition of what is not understood	3:19
8	Fact D	Question-asking from Miyake & Norman (1979)	7:35
9	Relation D	Amount of knowledge enough to ask a question	4:27
10	Fact E	Iterative process of understanding of physical device from Miyake (1986)	7:36
11	Relation E	Levels of understanding enough to notice non-understanding	6:00
12	Fact F	Shift of conceptual points-of-view from Miyake (1986)	9:48
13	Relation F	Coincidence of POV-shifts and feeling of non-understanding	8:55
14	Fact G	The role of monitor for topic-divergent suggestion from Miyake (1986)	4:17
15	Relation G	Importance of divergent points-of-view	1:00
16	Fact H	Individual process of understanding from Miyake (1986)	0:30
17	Conclusion	Importance of learning through the diversity in collaboration	4:00

NB. Grey cells represent the contents that were provided in a hand-out for intervention (see Figure 2).

The first class on September 24

Utilizing the components in Table 2, the students were guided through the following activities in the three classes. The activities were mainly of two types: "watching" video clips and "relation-making" with paper and pencil or on CMSonBBS.

1) ***Watching Theme & Conclusion to grasp the whole lecture:*** They watched a 6-minute video that integrated the first (Theme) and the last component (Conclusion) to reflect upon what kinds of components they usually try to gather from a lecture. They were then asked whether these components were enough to grasp the lecture, to what extent they felt they comprehended by just watching this.
2) ***Watching Fact A to relate it to Theme & Conclusion:*** They watched a 3-minute video of Fact A to confirm what it was and to think about its relation to the contents of the first video. They were explicitly encouraged to think about how Fact A was related either to the theme and/or the conclusion of the lecture.
3) ***Relation-making through Fact C to Fact H:*** They were given a handout of 25 cm x 36 cm shown in Fig. 2, which carries thumbnails representing Fact-components in the leftmost side. Thumbnails show materials used for demonstration or experiments, and figures and tables of experimental results. Texts in the square boxes in the center part show the summaries of Fact-components provided by the

lecturer. The five boxes on the upper right corner represent Theme, Relation A and Relation B, which were also provided by the lecturer. The box on the bottom right represents Conclusion. These texts provided by the lecturer correspond to the cells shaded gray in Table 2. This scaffold aimed at helping students to learn how to grasp points of each research and to relate them. The students were divided into groups of two to three and asked to think about on this sheet how each of the eight factual components were sequenced in the order given in the lecture, as from Fact A to B, B to C, and so on down to G to H. They were then asked to write down such relations in the space provided. There were six potential opportunities, i.e., Relation C to G, to relate each set of two research facts on the left side and to work out some abstract explanations connecting those two.

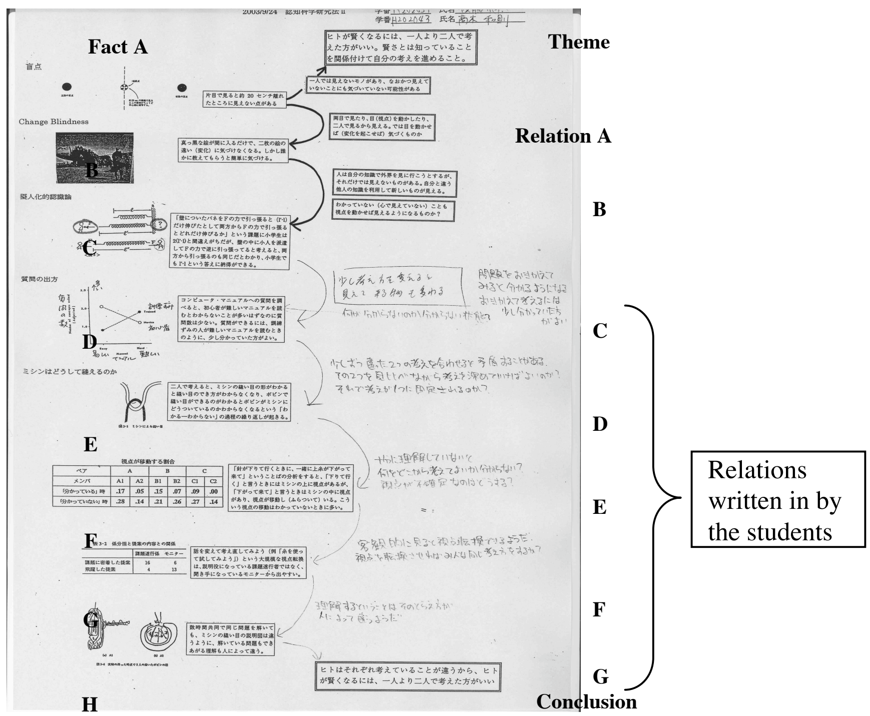

Figure 2. The handout to help identify roles and connections between factual components of Lecture 3.

The Second Class on October 1.

1) ***Relation-making between Fact C and Fact D:*** In the first class, most of the students made some relations between Facts C and D. They created Relation C by themselves. In this class the students were encouraged to rethink the relation they had made and expect what they would see in the video showing Relation C.

2) ***Watching Relation C:*** They collaboratively watched a 3.5-minute video Relation C, at their own pace using CMS, to confirm how the lecturer had related Facts C and D. They were research findings with no apparent relations, which were made significant only through the lecturer's research aims. This activity was, in that sense, a type of problem solving, representing the importance of active search for connecting components in order to form a coherent comprehension.

The Third Class on October 8.

1) ***Watching Fact E &Relation E:*** The students collaboratively watched a 4-minute video of a brief summary of Fact E and Relation E, at their own pace using CMS, to confirm the facts and how the lecturer had related them.

2) ***Relation-making between Fact E & Relation E and Fact C & Fact D:*** They were then encouraged to think about the relations between this video and Fact C or Fact D, or both, which were by then the most familiar two facts for them. Finally, all the students wrote comments on CMSonBB and responded to others' comments for shared reflection. They were encouraged to continue doing this at their leisure, outside of the class.

Results

Could the students follow the intervention?

During the first class on Sept. 24, almost all groups could write down at least one relation. Compared against what they did after the lecture given on June 17 (Lecture 3), where only three students wrote anything relating its subcomponents, this was a conspicuous sign of students' learning occurring during this intervention. At the end of the third intervention on Oct. 8, out of 66 attendances, 18 students made two-component relations (from Fact E to Facts C and D), and additional 35 made one-component relations (From Fact E to Fact C or Fact D, but not to both). This amounts to 53. Forty out of 66 (61%) were of substantial contents. Compared to 3 out of 70 (4%) who did this at the end of Lecture 3 on June 17, this is a clear increase. Some wrote on the handouts that they felt they understood the lecture for the first time, only after making connections among parts by themselves. On CMSonBB, they produced 105 comments and responses in about 10 days. Some commented that this activity was new to them, that it helped them realize the need for active relation-making to understand the lecturer's intent. Twenty-eight percent of the comments were questions, more relevant to the lecture content than the ones noted at the end of the lecture (on June 17). Seventeen percent contained criticisms about the lecture structure (e.g., "You mentioned the research question first and then its motivation, but this was confusing, because it is different from what is common in lectures."), and some gave suggestions for a better structure ("You could have mentioned at this point how you would develop this theme later."). Overall their performance level during the intervention period was high, revealing their enjoyment of these activities.

Could the students transfer their acquired skills to other lectures?

In order to see whether the students could transfer the skills they seemingly acquired through the intervention for other lectures, we compared the quality of the end-of-lecture notes from two lectures, Lecture 3 and Lecture 5. Lecture 3 was the target for the intervention, delivered by a senior, experienced faculty member who was also an active researcher in the field of learning sciences. Lecture 5 was given by a younger faculty, who also was active in the field of natural language processing and emotion studies in AI. Both of them structured their lecture by first looking back on some pieces of their previous work, explaining why they did them and what remained as further topics of research. Both lecturers asked the students not to just passively listen to the lectures, but to identify attractive parts and relate them, among themselves as well as to the students' own concerns and interests. The notes were categorized according to four quality levels. Level 1 notes were of the lowest in quality, only containing key words or short phrases. Level 2 notes pick out plural components but not fully connect them, while Level 3 notes contain clear expressions of connections. Notes of Level 4 go beyond simple relation making; some relate more than two subparts to give a better gist, some others develop their own perspectives beyond the lecture content. Examples are shown in Table 3. Table 4 shows the numbers of notes in each category for Lectures 3 and 5. The students who wrote Level 4 notes increased from 5 out of 66 (7.6%) to 26 out of 62 (41%), demonstrating a clear increase, a sign of carry-over from the intervention. Note that during this lecture, they were not using the tool, nor guided through the steps. The higher levels of summaries, questions, and comments could mean they were ready to take fuller advantage of such scaffolds like lecture videos and the CMS.

Table 3. Examples of end-of-lecture notes by quality categories.

Level	Explanation	Example notes of Lecture 3
1	Key words or phrases only	"Points-of-view shift"
2	Juxtaposing components, no explicit connections	"When one does not understand, their conceptual points-of view shift (Fact E). At the end of constructive interaction, the two participants may still hold different perspectives (Fact F)."
3	Expressing connections	"As one realizes non-understanding, her points-of-view starts shifting (Fact F). Could this happen because one looks for evidences for her own non-understanding? (Fact F to Fact D)"
4	Broader connections in better expressions	"Questions are asked by people who have some level of understanding to gain more understanding (Fact D). By relating this to the sewing machine results (Facts F and H), we could say when you do not understand the problem you could try deliberately changing your points-of-view, possibly taking hints from others (new conclusion)."

Table 5 itemizes the number of students who made shifts or no shift from Lecture 3 to 5 (the number of the students in each class is smaller on this table because of the absentees). Thirty-one out of fifty-two students, or 55% of the entire class, shifted upwards. Many students who were at Level 2 jumped up to Level 4 (14 out of 33, or 42% of Level 2; or 14 out of 56, or 25% in total), indicating that the skills we focused on in the intervention were in fact within reach of the middle to lower range students, which did not just raise their immediate performance but had a potential to stayed on.

Table 4. The number of notes per levels.

Levels of notes	After Lecture 3 on June 17	After Lecture 5
1	14	9
2	39	20
3	7	7
4	5	26

Table 5. Shift of the number of students from Lecture 3 to Lecture 5.

		To Lecture 5			
		Level 1	Level 2	Level 3	Level 4
From Lecture 3	Level 1	2	6	1	2
	Level 2	5	10	4	14
	Level 3	1	2	0	4
	Level 4	0	1	0	4

NB. Grey cells show no shift.

Discussion

The results positively show that an activity set with the scaffolding tool devised here are promising to help students acquire the difficult skills of comprehending and learning from lectures. Through this intervention, the students could have gained a new strategy as we hypothesized, or they could have been, as an alternative explanation, just responding to the demands set by the authors. The reason for the results remains to be further clarified. From the learner's viewpoint, we believe what is important is that they are responding to lectures differently, of which we could take advantage to help them advance their skills. Because lectures would not disappear easily even after the denser introduction of wired communication, it would be handy to have skills to take advantage of them. The steps we identified in this paper may serve for a broader purpose, not just learning from lectures and texts, but also learning from a group of people with different backgrounds, with different thinking styles. Yet, the current set of skills needs to be refined, to reach the students who did not benefit from our intervention. The tool should also be shaped to let students connect their commented video clips more easily, for clearer collective reflection. More thorough analyses of the students' notes both during and at the end of classes are planned, to extract hints for lecturers to prepare better lectures. This study, though small in scale, is one of the efforts we are experimenting with to introduce benefits of learning science research for wider audience, including lecturers who believe their students naturally understand their lectures, without much effort both by the lecturer and the students.

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