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Peer Lecturing as Project-Based Learning: Blending Socio-Affective Influences with Self-Regulated Learning

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Abstract

As a contribution to the efforts to understand the influence of peer presence on self-regulated learning, this paper studies students' reaction to a project-based activity, the final product of which was a scientific communication to peers. In this activity, *peer lecturing*, the students formulate a question on a topic linked to the course, search scientific information in order to answer the question, and teach the result of their investigations to their class in the form of a whole-class communication. The paper draws on the qualitative analysis of 23 interviews of first-year student teachers involved in *peer lecturing* in the framework of an introductory zoology course. In this study, the expressed gains in self-regulated learning described by the students are compared to the gains reported in the literature in other project-based methods and in peer teaching. Original gains in motivation (*social goals*), cognitive processes and self-regulation, are highlighted, while stressing differences between student types. Further development of the method is suggested.

Keywords: self-regulated learning, social goals, project-based learning, peer teaching, qualitative methodology

1. Introduction

1.1 General Purpose

One of the important factors influencing learning outcomes is learners' ability to conduct self-regulated learning (SRL), i.e. to be "metacognitively, motivationally, and behaviorally active participants in their own learning process" (Zimmerman, 1986). Most models of SRL are not restricted to cognitive aspects, but also tackle environmental influences (Puustinen & Pulkkinen, 2001). One of these influences is the presence of other learners in the framework of the studies, not only as collaborating partners, but also simply as stakeholders undergoing a similar process with whom there are random direct and indirect interactions. Reflecting upon the benefits of peer presence in the learning process takes on an even more important meaning in a time when classroom lessons are replaced more and more by on-line instruction. As a contribution to this line of research, we present here the analysis of students' reactions to an activity fostering self-regulation and in which peer presence was deeply embedded. In this activity, which we call *peer lecturing*, the students formulate a question on a topic linked to the course, search scientific information in order to answer the question, and teach the result of their investigations to their class in the form of a whole-class communication.

1.2 Overview of Research Focusing on the Influence of Peer Presence on Learning

The presence of peers in learning settings not only influences learning through organised interactions, like peer collaboration, peer tutoring and peer assessment. It also influences students' learning through more informal and unorganised aspects like informal talks, peer interventions during course meetings, unplanned help providing, or the mere consciousness that one is not alone in class. In this paper, we shall call these aspects *peer presence*.

The influence of *peer presence* on the motivation to learn has been described in the framework of several theories in education (Martin & Dowson, 2009).

In *achievement goal theory*, the initial dichotomy (Elliott & Dweck, 1988) between *mastery goals* (or *task goals*, i.e. learners' concern for developing competence) and *performance goals* (learners' concern for demonstrating ability), was enriched by later researchers with the concept of *social goals* (Urdan & Maehr, 1995). *Social goals*

depend on various social influences in and outside the learning context, one of them being *peer presence*. *Social goals* may be divided into different types (Wentzel, 1989): *social responsibility goals* (the responsibility on other members of the society) which usually lead the pupils to achieve high grades, and *social interaction goals* (the drive to interact with others), which can lead them away from the learning effort. The influence of *social goals* on learning depends on the context. For instance, in some tasks, helping a peer (as the result of the social responsibility goal) can improve achievement because it improves learning, and in others, it can decrease it because of the time lost. Likewise, approval seeking (as a result of *social interaction goals*) may or may not lead to an increased effort in learning, depending on peers' disposition towards learning.

In the realm of *self-directed learning theories*, Boekaerts and her coworkers (Boekaerts & Corno, 2005) distinguish between *growth goals* (students' willingness "to deepen their knowledge or increase their cognitive and social skills") and *well-being goals* (students' efforts to protect themselves). They focus mostly on self-regulation efforts which are necessary to overcome the excessive influence of *well-being* concerns.

The influence of *peer presence* on cognitive processes has been modeled in theories like *situated learning*, which describes how learners unintentionally gain knowledge and skills through participation in a "community of practice" (Lave & Wenger, 1990). Independently, the positive influence of *peer presence* on learning has been shown in researches describing students teaching whole-class lessons to peers (Renkl, 1995; Fiorella & Mayer, 2013) or to high-school pupils (Elmendorf, 2006) as a means of improving their knowledge. For instance, at college level, Fiorella and Mayer (2013) show a difference in knowledge retention between students learning alone, students preparing to teach and students actually teaching the subject they learn to a whole class.

1.3 Peer Lecturing as a Self-Regulated Process Loaded with Peer Presence

In this research, we chose to investigate the influence of *peer presence* in a context of project-based learning (PBL), because project-based learning, as other inquiry-based learning settings, induces a great deal of self-regulated learning in students (Dignath & Buttner, 2008; Loyens, Magda, & Rikers, 2008; Wiley et al., 2009): it places "responsibility on students to access information, to achieve goals, and to monitor understanding" (Sungur & Tekkaya, 2006) and give students "choice and control about what to work on, how to work, and what products to generate."(Paris & Paris, 2001).The different phases of project-based learning (project launch, guided inquiry and product creation, project conclusion) can even be seen as a parallel to the three phases of self-regulated learning described by Zimmerman (English & Kitsantas, 2013): forethought, volitional control, and self-reflection (Zimmerman, 2000).

Although *peer lecturing* does not include experimental inquiry, it fits the definition of project-based learning (Prince & Felder, 2007) as an "extended inquiry process structured around complex, authentic questions and carefully designed products and tasks" (Markham, Larmer, & Ravitz, 2003) and can be related to "literature or Internet-based inquiry" already described at college level (Sutcliffe, Cogdell, Hansell, & McAteer, 1999; Wiley et al., 2009).

Numerous research works describe the original contributions of PBL to learning. From a motivational viewpoint, PBL induces in learners a sense of control (Deci & Ryan, 1987), excitement from discovering new knowledge, and in some cases, authentic peer-reviewed scientific literature (Tribe & Cooper, 2008; Wiley et al., 2009). From a cognitive viewpoint, PBL activities have been shown to help students learn and retain the course's subject matter (Dochy, Segers, Van Den Bossche, & Gijbels, 2005), develop a deeper, wider and more flexible understanding of their discipline (Thomas, 2000), and improve critical-thinking skills (Narode, Heiman, Lochhead, & Slomianko, 1987) and scientific information handling skills (Elrod & Sommerville, 2007; Henderson & Buising, 2000; Hoskins, Lopatto, & Stevens, 2011).

Classroom-wide presentations are often used as the product of project-based learning, but their significance in this context in comparison to other types of products (written report, poster, movie, and artefact) has seldom been studied, nor has it been linked to self-regulation in learning. In order to estimate the benefits deriving from this aspect of *peer lecturing*, the literature on *peer teaching* or *peer learning* (Boud, Cohen, & Sampson, 2001) can be used. Reciprocal teaching activities have been found to be effective both for the learning and the teaching students (Topping, 2005), but since in our case *peer lecturing* involves whole-class lessons, it is clear that for the students receiving the instruction, it does not consist at all of a student-centred method and in comparison to regular lectures, it is not expected to provide significant improvement in self-regulation except in lowering stress (Goodlad & Hirst, 1989). But for students providing the instruction, *peer lecturing* is expected to contribute to SRL development as a peer teaching method (Paris & Paris, 2001). From an affective point of view, it should help the students to develop their sense of self-efficacy (individuals' beliefs about their capabilities; Bandura, 1977) (Griffin & Griffin, 1998) and their motivation to learn (Damon, 1984). From a cognitive point of view, it

should bring reinforcement in existing knowledge, emergence of a deeper understanding, expansion of knowledge (Goodlad & Hirst, 1989; Roscoe & Chi, 2007) and improvement in knowledge retention (Bargh & Schul, 1980). It should increase metacognitive activity and induce reflection on knowledge and on conceptual change, discovery of meaningful applications of the subject matter (Goodlad & Hirst, 1989) and promotion of the consciousness about the limits of one's knowledge (Cortese, 2005).

1.4 Purpose and Research Questions

In order for an activity to foster self-regulation development, adequate characteristics alone are not enough, and students' perception of the link between the activity and SRL is equally important. This claim holds for PBL (Dochy, Segers, Van Den Bossche, & Gijbels, 2005; van Grinsven and Tillema, 2006) as well as for *peer teaching* (Wittrock, 1989). Therefore, our research turned to students' conception of the activity they experienced. We assume that further comparison of their opinions with existing knowledge regarding the benefits of regular PBL would make it possible to pinpoint *peer lecturing's* specific contributions. And since we expected to uncover some new influences, we adopted a qualitative approach, like in other works which attempt to describe self-regulated processes (Deed, 2010).

The following questions were asked:

What did the students feel they gained in the different dimensions of self-regulation from *peer lecturing* as learners?

How did the students think that *peer lecturing* generated these gains?

2. Method

2.1 Participants

The participants in the activity were first-year preservice teachers specializing in science teaching (at elementary or junior high school level) at a small teachers' college in northern Israel. During the academic year, the students took several introductory courses in science and in education. Concurrently, together with non-science preservice teachers, they participated in a year-long 6-hour weekly workshop on general (not science) teaching methods, during which they began to train in microteaching sessions in the second semester, without a link with our activity.

Among the 30 students enrolled in introductory zoology, 23 participated in the research, mean age 23, 21 females and 2 males, 17 having learned in high-school in Hebrew, and 6 in Arabic.

The second researcher taught the zoology course, and the first one (participative observer) taught another year-long 60-hour introductory science course on a parallel track. The first researcher planned to mentor the students the following year in their first year of field work in application school. At the end of the first semester, both researchers had established a trusting and open relationship with all the students.

2.2 Format of the Activity

The *peer lecturing* activity was introduced to the students in the course "introductory zoology" as an opportunity to apply and expand their knowledge in zoology, to experience scientific literature inquiry and to improve learning strategies. The first semester of the course was devoted to learning basic knowledge in the framework of participative lectures, for a total of 30 hours. Indeed, we believe that in order to conduct an efficient inquiry, and to individually cope with new information, students should first acquire some literacy in the discipline (Kirschner, Sweller, & Clarke, 2006). At the beginning of the second semester, each student (or pair of students, as they preferred in half of the cases) was asked to choose a phenomenon linked to one of the chapters remaining on the syllabus, to formulate a research question expressing an issue which she would be interested to clarify about the phenomenon (e.g. "Why and how does the blow-fish inflate? " by Amal and Jasmine, or "Why and how does the chameleon change colour?" by Abigail and Deborah), to search for information which could answer the question, and to present her conclusions to the class in the form of a short communication in scientific style. Thus, during the second semester (30 hours), the zoology lessons were divided into regular professor's lectures, and students' enrichment communications on topics pertaining to the same chapter.

Because of time constraints, the inquiry work occurred outside the classroom and professor's monitoring was made in an asynchronous mode. But the status of the lectures as scientific briefings entailed several requirements which served as scaffolds for students' project-based learning (Barron et al., 1998; Hmelo-Silver, Golan Duncan, & Chinn, 2006). The consequences of these constraints on the three dimensions of self-regulation - motivation, metacognition and behaviour (Zimmerman, 2008) - are summarised in Table 1. *Peer lecturing* included three formative evaluation steps followed by professor's feedback, and two of them by peer feedback (each student

was required to provide an on-line evaluation of two summaries or two presentations), with the same assessment grid for professor's and students' evaluations. Counselling from the professor was obtained by electronic mail and by individual talks before course meetings, in a way which encouraged metacognitive thinking and self-directedness. During the students' lectures, the professor rarely interrupted, but she asked some questions afterwards and added further information on the topic. Peer assessment as organised in the activity is a part of *peer presence*, but its products will not be considered here since it was uniformly reported and enacted by the students as lacking objectivity owing to interpersonal sensitivity issues (Liu & Carless, 2006).

At the end of the year, the students took a written examination including a 23 multiple-choice and 21 true/false questions on the topics of the first semester, as well as three essay questions which had to be picked out of 21 possible options, each of them matching one of the students' lectures in the second semester, and each written by the student(s) who gave the corresponding lecture. The final grades of the students in the course were an average between the lecture and the examination grades.

Table 1. Requirements of *peer lecturing* and their influence on students' self-regulated learning in the motivational, cognitive and behavioural domains

The Requirement in *Peer Lecturing*	Motivation	Cognition	Behaviour
Forethought Phase			
Students' free choice of the topic of their presentation	Enhanced motivation by learning a topic of personal value and working autonomously	Developing a general view of the content of each chapter	
Restriction of the lectures to ten minutes and ten slides			Focussing on a limited topic
Planning/Implementing Phase			
Inclusion of material from peer lectures in the scope of the examination	Activation of performance goals and social goals	Investing a genuine effort in explanations	
Restriction of the information sources to academic sources only		Training to search and read academic literature	
Deadline			Monitoring time and effort
Reflection phase			
Publication of lecture topic in the course forum at the beginning of the semester	Feeling peers' interest in the topic of the lesson	Checking with professor the relevancy of the topic to the course. Clearly define the topic.	
Publication of lecture abstract in the course forum one month before lecture	Motivation by *social responsibility*	Explicitly formulating the explanations to be presented in class	
Sending the presentation to the professor		Checking with professor the accuracy of explanations	

2.3 Data Collection

Presentation files, students' summaries of the lectures, written comments in the courses' forum, interviews and final examination forms were analysed for each of the 23 students. A 30-minute semi-structured interview was performed with each student a few days after her lecture, and not after the final examination. The interviews, which were conducted during day breaks in an office next to the science classrooms, were introduced to the students as both their contribution to the research and their first guided reflective talk as science teachers. During the talk, the students were given warm feedback and were granted the freedom to speak spontaneously (Spradley, 1979), after receiving the instruction to tell what they did, what they liked, what was difficult, and what they learned in each part of the activity. The interview prompts, which were written according to current knowledge about the benefits of PBL, peer teaching and SRL, were used to jump-start the talk, and to check no topic was omitted. The final interviews did not yield new ideas. 4 months after the examination, several short talks were made with one representative of each type of students.

3. Results

3.1 Interviews' Content Analysis

In order to avoid misinterpretation or omission of data due to prior conceptions, the interviews were analysed according to a procedure derived from the "grounded theory" methodology (Charmaz, 2006; Shkedy, 2003). As a first step, all interviews were transcribed, and their content underwent open coding into primitive three-level categories: dimension of the activity–aspect–student's report on the topic (for instance: "information search"–"searching strategy"–"from the general to the particular"). In a second step, the categories which were similar among students were given identical names.

In the interviews, the students expressed a variety of thoughts about peer lecturing: they described gains as learners, gains as prospective teachers, difficulties, and even feedback. Yet this research work focuses only on the influence of peer lecturing on learning and on students' gains as individual learners. Therefore, in a third step, the categories which did not belong to the scope of the research were discarded. A careful study of the 43 remaining categories revealed the hypothesis that the original gains resulting from the addition of lectures to PBL were mostly socially-born gains in the different dimensions of learning. This study also allowed us to discard other hypotheses, as, for instance, the hypothesis that lectures increased dysfunction in the activity, and the null hypothesis. In a fourth step, the primary categories were rearranged into new categories reflecting this principal finding, for instance, "Lecture structure based on effort to help peers understand" was transferred from the primary category " Lecture structure", into the category "cognitive gains from the combination of PBL and peer teaching", which contained other cognitive gains like some categories belonging to "searching strategies". The presentation files and the audio records of students' communications were used to confirm or refute the conclusions drawn from the interviews.

The categories emerging from content analysis of students' discourse were grouped according to the three principal domains of learning already presented (Zimmerman, 2008), and in relation to the two basic activities from which *peer lecturing* draws its inspiration (basic components): inquiry learning and peer teaching. It appeared that, along with the benefits already reported in the literature from PBL and peer teaching, the students also reported original gains which did not exist in the primary methods, and which stemmed from "crossed" influences of one component upon the others.

3.2 Student Types

Similarities emerged in the answers of students according to their general achievement level in science (as assessed by mean grade in first semester examination in an introductory science course). Therefore we grouped the students into three categories. **A students** (9 students with grade over 85) expressed both a high competitiveness as well as a high level of interest in the activity (Harackiewicz, Barron, Elliot, Carter, & Lehto, 1997). **B students** (10 students with grade between 70 and 84) displayed a willingness to do a good job and to enjoy the activity, but for several reasons not to be discussed in this paper, without the same tension as A students**. C students** (4 students with grade below 70) displayed interest in the activity but did not show as strong an effort as the others. The unequal distribution of the students in the three types in respect to ethnicity and gender was not representative of the composition of the classes in our college, and therefore, it will not be discussed. In particular, the sample included several Arabic-speaking students who, for various reasons, chose to learn in a Hebrew-speaking college in spite of their extremely low proficiency in the Hebrew language, and whose academic development probably slowed down at this stage owing to their struggle with language difficulties.

The students' initial grades and final performance in the lectures were unknown to the relevant researcher at the time of the interviews.

3.3 Affective Gains

In the affective domain, the students expressed that the activity helped them develop **self-concept as learners** as a result of increased self-regulation (Thomas, 2000):

> '… I learned by myself, no-one taught me. It gives me self-confidence and the passion to read more.' (Jasmine, C).

As expected, the inquiry component of the activity offered **sources of intrinsic motivation to learn** (sources of sheer interest for the activity; Deci & Ryan, 1985), such as interest for one's lesson topic or enthusiasm from discovering professional literature).

At the same time, the peer teaching component of the activity implied several **sources of extrinsic motivation** (the motivation to perform the activity in order to achieve a different outcome) linked to socio-affective

processes (Goodlad & Hirst, 1989; Lawson, 1989): these were *social responsibility goals* (Wentzel, 1989), such as the desire to enhance peers' knowledge, and *social interaction goals*, such as the fear of their negative judgment, taking into account not only the phenomenon of social comparison (Darnon, Dompnier, Gillieron, & Butera, 2010), but also the fear that the audience's reaction might influence the professor while grading the lessons:

> 'If you want to present a topic to students, you have to know the material at an outstanding level, truly, you have to know everything about it. You cannot come to the class with questions remaining in your head. When they told you to teach something, it turned out to be such a responsibility that you wonder: what if they ask a question and I don't know?' (Rachel, A).

The centrality of *peer presence* as a motivation source for lecturing students was confirmed conversely by the comment of C students who claimed that they chose to lecture at the end of the semester, in order to lecture in front of the professor alone, and explained that, because the audience was less relevant socially, they hardly made any effort at all to build a good presentation.

The students also expressed reasons which drove them to attend peers' lessons as an audience: interest for some of the topics, curiosity to see how fellow students would manage in their lesson, and feelings of solidarity. But these reasons were not sufficient to insure the presence of all the students at all the lectures in this class.

Additionally, along with enhancing the motivation to learn only the material to be taught, the environment in *peer lecturing* created **original sources of motivation to inquire about original information**. Students expressed a **feeling of responsibility for others' learning**,

> '[Interviewer] Where did you do a deeper information search, in high-school inquiry work or in this lecture? – In my lecture! - Because you have to introduce it to an audience? – You don't have only to introduce it, you ought to understand it too. In high-school biology, it is simply nice to submit an assignment to somebody whose mind-set is known to you.' (Maria, B)

or the **willingness to enrich the culture of peers or to impress them,**

> 'I wanted them to leave our ten-minute lecture with knowledge, with something useful. […] our goal was for them to say: hey, what is that? This is new! [enthusiastic tone]. – That they were satisfied with the lecture? – Yes.' (Amal, B)

Several A and B students describe their **desire to instil ideological values**:

> 'I wanted them to think twice before they kill an ant.' (Osnath, A).

In general, these sources of motivation are found neither in regular inquiry learning, nor in peer teaching and can be seen as an original contribution of *peer lecturing*.

3.4 Cognitive Gains

The cognitive gains reported by the students from *peer lecturing*, belonged to the domains of information processing, knowledge assimilation and epistemological thinking.

Most students expressed that the activity helped them to reinforce and better remember their basic knowledge in zoology, to deepen it beyond what they knew, and to enlarge it to new topics (Boaler, 2002):

> 'In other courses I did not reach that level, because I learned what they sent to us and I just searched a little bit beyond if I have some questions.' (Deborah, B)

In the epistemological domain (Hofer, 2004; Wiley et al., 2009), some A and B students reported their new insights about semantic issues or about ways of coping with multiple explanations for the same phenomenon.

All these gains were mostly attributed by the students to the inquiry component of the activity (Strobel & van Barneveld, 2009), but also in some cases to its peer teaching component (Fiorella & Mayer, 2013).

As expected from their high initial level, most A students did not report gains in knowledge reinforcement and retention. But only some A and B and one C student described knowledge deepening and enlargement.

According to students' reports, the similarity in scientific literacy between lecturers and audience resulted in specific cognitive requirements to *peer lecturing* as compared to other lessons which the students taught in the same semester to non-scientific audiences as teaching exercises in general methods courses. On one hand, some students expressed the feeling that the scientific literacy of the audience in *peer lecturing* raised the probability of critics, and therefore required a more rigorous preparation of the lecture. But on the other hand, others claimed that the literacy of the audience reduced the efforts to explain basic concepts in zoology in a thoughtful manner.

Finally, the combination of peer teaching with inquiry acted as an original **scaffold in the information search,** since many students were guided in their decisions regarding what information to include in their search, by the rationale of trying to explain their topic to other people:

> '… There is a lot of information, so if someone does not know the topic, you cannot explain C without explaining first A and B. So I recalled this [A and B topics] briefly, and I deepened only what I had to deepen. But it is complicated.' (Rebecca, A).

The combination of peer teaching with inquiry also yielded **original products** due to pedagogical concerns. When they did not agree with professor's pedagogical choices, instead of bargaining to lower the activity's requirements like more performance-oriented students (e. g. Rachel, A) (Blumenfeld et al., 1991; Harackiewicz et al., 1997), some A students found a compromise by enhancing their cognitive effort:

> '[Interviewer] Did the summary spoil the surprise of the lecture? – Not at all, because we did not write in the summary what we were talking about. We only explained what camouflage is, and which types of camouflage exist. We did not reveal the chameleon. – Did the fact that this document gave only a general background and not a real summary, fit the intent of the professor? – After the lecture, we issued a real summary. - What? One more document? – Yes. – Was this final summary more difficult to write? -No, the background document was more difficult.' (Deborah, B).

Students' progresses in zoology could somehow be supported by the higher grades observed in the zoology examination in comparison to preceding years or to other disciplines, despite obvious reliability problems (Metz, 2009). But a comparison of the grades in the final zoology examination to the grades in the final examination of the first semester introductory science course as an indicator of students' initial level (Figure 1.), showed that *peer lecturing* did not enable a breakthrough in grade performance for less achieving students. The same was true for the grades in the lectures.

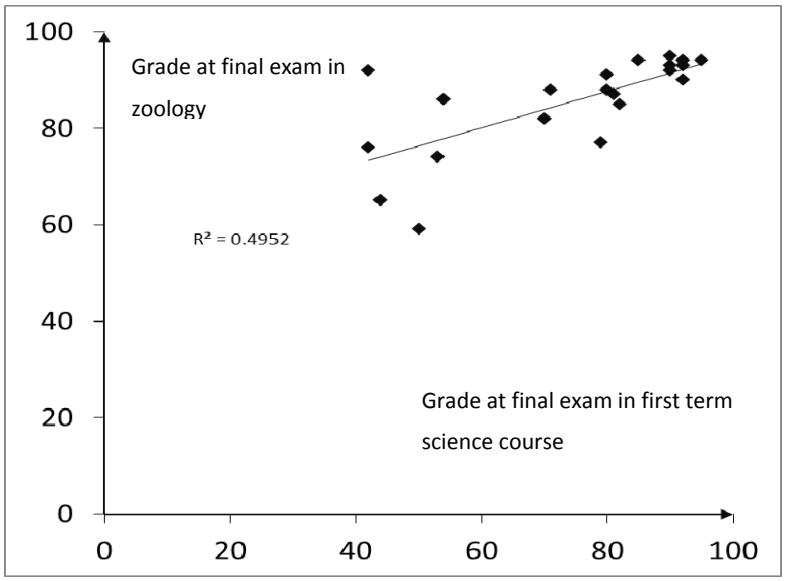

Figure 1. Grades in final zoology examination vs. grades in first-term general science examination

A special finding regarding deep knowledge acquisition was the fact that in the open-ended part of the examination, half of the students (mostly A) did not choose to answer the essay question about the topic of their own lecture and preferred to write about somebody else's lecture. The explanation of Batsheba (A) reflects the opinion of most students:

'The instructions in the examination were to explain the topic in a few lines, and I know so much now on the topic I lectured about, that it would be difficult for me to summarise it in just a few lines!'

Thus it seems that in what concerned the topic which students lectured about, even if they did not yet reach full mastery, they evolved from a simplistic understanding towards expert knowledge.

3.5 Behavioral Gains

A and B students' thorough description of their information-processing work showed a progress **as well in their learning skills as in metacognitive ability** (Palincsar & Magnusson, 2001):

> 'I only had ten minutes [to teach], so I had to focus a lot. I began [my information search] with [the topic] "navigation" and I found the Sahara desert ant, then it became my focus, and then I searched more about it, and one thing kept leading to another.' (Osnath, A)**.**
>
> 'The information search was a bit complicated, until Rebecca brought us a book about Amotz Zehavi with all the theory of courtship. And then we settled down. From then on, we knew what to search for, and suddenly we found material, we found an article on the site X, on the site Y. – Did you gain insight from this experience for the next information search? – Definitely. I see it now when I write an assignment in special education.' (Hannah, A).

To varying extents according to their achievement level, all students showed that during the activity, they analysed their process in order to monitor it. In the interviews, they manipulate a variety of forms of metacognitive thinking: about knowledge, about their own inquiry procedures (such as the "meta-strategic knowledge" described by Ben-David & Zohar, 2008) and about the instructional procedures they experience as students (such as the "instructional metacognitive knowledge" of Elen & Lowyck, 1998).

> 'We searched for pictures twice. Because the scientific level of the presentation we originally made was not so high, we understood that it wasn't right. So we changed everything.' (Abigail, A).

Several students reported how they set up **personal guidelines** during the activity regarding **how and when to use non-academic information sources.**

Although C students were genuinely enthusiastic about discovering knowledge, they hardly ever analysed their information-processing strategies, and their presentations (when they were not paired with more expert students) showed that they stayed at a shallow level in handling knowledge. The number of information sources used in the project decreased from A to C students, while some low achievers based their lecture on one single publication, even if they formally added some other references in their report.

Finally, the combination of inquiry and peer teaching promoted the students **to develop several new ideas**. All the students reported how their efforts to improve teaching (see Authors, to be published) in fact also indirectly improved learning (Vermunt & Verloop, 1999). Many students considered assessing the quality of inquiry though the actual reaction of the audience. Some students refined their conceptions about being a student: the reaction of peers to lecture yielded **insights about the desired behaviour of the audience in lectures** (Maman, 2004):

> 'Now I see how it undermines the confidence of the lecturer when someone claims in the middle of the lecture that she does not understand… and all the small-talk in-between. I shall talk with the students who did that and make sure they don't do it anymore.' (Batshebah, A)

Zimmerman and his colleagues describe self-regulation processes at three levels: self-observation, self-judgement, and self-reaction (Schunk & Zimmerman, 1997). They state that self-judgement always involves the comparison between the product of the activity and a reference state: an external standard, an internal goal, a person taken as a model, or peers. Indeed all the reflective processes reported in *peer lecturing* relied on such comparisons (Table 2, columns 1, 2 and 3).

Table 2. Types of metacognitive thinking emerging in students' analysis of *peer lecturing*, according to the situation to be evaluated, the reference situation to which it was compared and the affect motivating the comparison

Situation to be evaluated	Reference situation to which it was compared	Metacognitive thinking	Affect which motivated the comparison
Self as learner	Professor as a scholar	Sticking to high level material	Self-image
Self as learner	Self as teacher	Guiding the inquiry with teaching concerns	Responsibility for others
Self as an audience	Self as a teacher	Internalising appropriate behaviour as a student participating in a lecture	Self-advocacy
Self as teacher	Peer as teacher Professor as teacher	Improving information search	Identification, social comparison
Self as teacher	Self as audience	Evaluating the relevancy of one's explanations	Self-advocacy
Self as teacher	Peer as learner		Empathy

Self as teacher	Peer as learner	Adapting to students' differences as a teacher	Empathy
Professor as teacher	Self as teacher	Understanding professor's teaching choices	Self-advocacy
Professor as teacher	Self as learner	Understanding the format of the activity	Self-advocacy

4. Discussion

4.1 Limitations of This Research

The conclusions drawn from our study are obviously limited for various reasons. First, the group of students who participated in the study was certainly not an average group of students in general or in our college (regarding characteristics such as age, gender, ethnicity and the links between them). In particular, one should check whether the teaching aspect of the activity would have the same effect on students who are not prospective teachers.

Second, the restricted effectiveness and reliability of the interviews as a research tool should be borne in mind. Certainly, the students were accustomed to speak rather freely with the researcher about many topics and indeed, in the interviews, they did not seem to hesitate to criticise some features of the activity. Yet they sometimes seemed to express viewpoints which were biased by the desire to appear successful, or by the context (Hadwin, Winne, Stockley, Nesbit, & Woszczyna, 2001): C students probably overrated their effort, and A students their enthusiasm (Darnon, Dompnier, Delmas, Pulfrey, & Butera, 2009). The fact that the first researcher taught the students during the first semester, probably influenced the data analysis.

Third, there seemed to be domains in which most students had a warped awareness of their progress: for instance in what concerned critical thinking, most students did not explicitly agree they made precise gains, but all of them described processes which showed that they actually progressed. The fact that the students did not express (and were perhaps not aware of) all their feelings in the interviews, could be acknowledged when they formulate new opinions during free talks several months after the activity, while being exposed to activities similar to *peer lecturing* in other contexts where they had an interest in expressing more opinions.

For all these reasons, we do not consider the research data as being quantitatively representative or exhaustive. But still, the group of students we present did include relevant examples of different known student types, the opinions they expressed were shared by several others in the group, and therefore the collected data can be used to reveal possible states of mind about *peer lecturing* as is to be expected from qualitative research.

4.2 Peer Lecturing As Multiple Affective and Cognitive Opportunities to Improve Learning

The study of students' evaluation of *peer lecturing* shows that the addition of the *peer teaching* component to the inquiry activity brings several original benefits, all of them linked to social interactions: original *social responsibility goals* and *social interaction goals* enhancing motivation, a supporting cognitive framework for information search and processing, additional products, an intense metacognitive activity and new conceptions about learning. It also shows that the students were well aware of the factors which influenced them.

The original benefits of *peer lecturing* can be explained by the multiple situations in which it places the students.

In the motivational domain, the presence of peers promoted a variety of interactions yielding original sources of motivation from diverse *social goals*.

In the cognitive domain, the structure of *peer lecturing* offered the students at least two fruitful opportunities to reconstruct and apply their knowledge in the discipline: firstly when the students gathered, analysed and combined knowledge from different sources in order to obtain a personal understanding of their lecture topic (Bell, 2010), and secondly, when they clarified and reshaped their knowledge to enable other people to learn it (King, 2002; Ploetzner, Dillenbourg, Praier, & Traum, 1999; Roscoe & Chi, 2008).

In the regulative domain, the multiple roles that the activity allowed the students to adopt in the teaching-learning context, served as multiple frameworks to reflect on their learning process: in this activity, the students switched roles from audience in the professor's lecture, to learners, to teachers, to audience in peer lectures and even to professor's assessors, and in each role, they developed new insights (Table 2.).

What deserves to be noticed is that, even in the cognitive and regulative domains, the specific benefits of *peer lecturing* stemmed not only from cognitive factors but also mostly from socio-affective factors, such as self-advocacy feelings, the need for the professor's esteem, empathy for peers, social pressure or social comparison (Table 2., column 4). For instance, if in *peer lecturing*, pedagogical logics helped in structuring the knowledge search, it was not only because of the cognitive proximity of the activities of learning and teaching, but also thanks to the affective proximity of all the stakeholders in the process, that is, the interplay between the

concern for others and for oneself in the context of the activity. In this respect, *peer lecturing* exemplifies the importance of *peer presence* in every dimension of learning.

The different types of students according to initial level in science did not report the same benefits from *peer lecturing*. Low achieving C students displayed fewer progresses than more successful peers in respect to complex cognitive skills and reflective thinking (Zohar & Dori, 2003) and focused more on strengthening basic knowledge and social aspects of the activity. We think that the progresses of low achievers could be enhanced by incorporating in the *peer lecturing* format more sophisticated scaffolds (Hoskins, Lopatto, & Stevens, 2011) or differential individual guidance (Ben-David & Zohar, 2008) which could help them overcome difficulties pertaining to professional language, scientific level, presentation techniques or information-seeking strategies, and allow them to concentrate on content and self-regulation. The enthusiasm of discovery and the positive feelings arising in peer interaction could be used to leverage less attractive aspects of the learning process and improve motivational self-regulation. This direction could inspire further development of the activity.

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