Developing metacognitive awareness
-a modified model of a PBL-tutorial

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Summary

In order for students to become good self-directed learners, an awareness of one's own learning process and studying strategies is essential. The aim of this paper is to describe a project –and the results of it - where a modified model of a problem-based learning (PBL) tutorial is used, a project launched to develop students' metacognitive awareness and improve the quality of their tutorials. Dental hygiene students and their tutors at the faculty of Odontology, Malmö University participated in the project which meant that the students worked independently during the first PBL-session with the tutor only paying a few short visits to the group. At these visits, the students presented their problems, hypotheses and objectives with the purpose to create an opportunity of primarily reviewing and reflecting but also getting feed-back from the tutor. The tutor was present throughout the second PBL-session. This model was alternated with and compared to the traditional "Malmö model" in which the tutor participates throughout both PBL-sessions. The project was evaluated through interviews. A Metacognitive Awareness Inventory (MAI) was filled in before and after the project. Results for the MAI show a significant increase in metacognitive awareness. In the interviews, students state that they participated in the PBL-session to a greater extent and had more spontaneous discussions without the tutor, but also that they felt a lack of security and sometimes interrupted by the visits from the tutor.

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Introduction

Learning is a process developed within the single individual throughout life. However, in order to be successful learners, reflection, feed-back and an awareness of our knowledge is essential. If one is not aware of, or understands one's learning process and studying strategies, it becomes difficult to handle and take control of one's learning. This awareness can be referred to as metacognition – a term coined by John Flavell in the 1970's - and is of great importance in an educational context (Flavell, 1979).

In a society filled with information and in a field where new scientific findings are frequently brought to daylight it is necessary to develop and use one's critical thinking and metacognitive awareness. This is also statutory by the Department of Education, and a part of the Educational plan for the Dental Hygienist Education. It states that a development is to be seen in the
- ability to make independent and critical judgements
- ability to independently distinguish, formulate and solve problems, and in the
- ability to meet changes made in working life

The students should also develop ability to
- search for and value knowledge at a scientific level
- follow the development of knowledge, and
- exchange knowledge also with people without special competencies within the field

Högskolelagen (SFS 1992:1434, 1 kap 8 §) Lag *(2006:173)*

A prior project at the faculty of Odontology deals with metacognitive awareness and problem-based learning (PBL), which is the pedagogical method used at the faculty (Schmidt, 1993). The focus was to enhance learning by the use of a series of metacognitive workshops, and the conclusion from the project was that boosting students' metacognitive awareness is desirable and also possible to do (Wretlind and Warfvinge, 2006). The project presented in this paper is another attempt to develop metacognitive awareness by trying out a modified model of a PBL tutorial. PBL is considered an overall successful concept, but it has been reported that a long-term use of PBL might get into a rut and show signs of wear. Examples of this; students adapt too much to the seven steps, self-study time drops and there is too much focus on the role of the tutor who might be subject-matter oriented instead of process-oriented (Moust et al, 1997). No matter the reason for wear, even PBL is a method in need of innovations. This is a project with the purpose of enhancing metacognitive thinking and improving tutorials. As well as discussing the project and the outcome of it, some central concepts and theoretical point of views will be explained. Finally, the project and the carrying through of it will be discussed, possibly arising new questions and ideas for further research.

Aim

The foundation of this paper is made up by a pedagogical project called "developing metacognitive awareness in a modified model of PBL tutorial". This model was constructed with the purpose of improving the quality of tutorials and learning but also with the hypothesis that the metacognitive awareness of the students would develop and when measured, increase. The aim of this paper is to
   a) briefly explain the concepts of metacognition and self-directed learning
   b) describe the project and the results of the project

Method

Participants

The dental hygienist education at the Faculty of Odontology at Malmö University is a campus-based, 2-year programme. The pedagogical model applied in the dental hygienist education is, and has been since the year 2000, Problem-Based Learning (PBL). The class of 2008 is the main subject of the project and has 19 female and 5 male students. All together, twenty-four dental hygiene students and three tutors participated in the project, which was carried through over a period of twelve weeks during the students' second semester at the Dental Hygiene program. Dental hygiene students at another university in Sweden were used as a control group for one of the measuring methods, but did apart from this not participate in the project. This group will be referred to as the "2nd University".

Measures

Primarily, the project was evaluated through qualitative interviews. The students' experiences of the two models were discussed in individual semi structured interviews (Trost, 2005; Kvale 1997), held with 50% (12 out of 24) of the students after the completion of the project. These students were randomly picked, but were made sure to represent all three study groups – in each of the three study groups four names were drawn out of the total eight. The students were all asked the same questions, with some students just answering the questions and some students being very elaborate. There was no pre-set time limit to prevent stress and the interviews lasted between 15-40 minutes. The interviews were initially recorded on a dictating machine and later transcribed. After transcription the twelve interviews –which ended up filling eight pages of text - were gone through question by question and the answers were summarized and accompanied with suitable quotations.

A Metacognitive Awareness Inventory, MAI, was used as a secondary measurement and was given to and answered by the students twice, used as a before (occasion 1) and after (occasion 2) comparison. Dental hygienist students at another university in Sweden were used as a control group. They were not given any information on the project or the concept of metacognition, just asked to complete the MAI.

The MAI was designed and tested by Schraw and Dennison in 1994 and is one of few surveys used in measuring metacognitive awareness (Schraw and Dennison, 1994). The MAI has 52 statements representing two component categories of metacognition; knowledge and regulation. Knowledge of metacognition can be divided into three groups: declarative knowledge (knowledge about self and strategies), procedural knowledge (knowledge about how to use strategies) and conditional knowledge (knowledge about when and why to use strategies). Regulation of metacognition covers five areas: planning (goal setting), information management (organizing), monitoring (assessment of one's learning and strategy), debugging (strategies used to correct errors) and evaluation (analysis of performance and strategy effectiveness after a learning episode). The statements are mixed and not divided into these different areas (Schraw, 1998; Kincannon et al, 1999)

The students stated their stance to each statement by marking a Visual Analogue Scale (VAS-scale), 100 mm. The marks were measured and put into a computer program as numbers ranging from 0-100. Numbers administered sums up to 4784. In Malmö, the MAI was initially answered by 23 students (18 female, 5 male) and secondly answered by 21 students (16 female, 5 male). The corresponding numbers for the 2nd University were 25 (23 female, 2 male) and 23 (21 female, 2 male). No individual results are presented – the students did not fill in their names, only their gender- and therefore the drop-out is not taken under consideration. The numbers for female and male students respectively have not been calculated. The forms were not coded and the results are presented as group results.

Outline

The purpose with this pedagogical project was to stimulate students to take more responsibility for the group-process and the tutorial session and to make them more self-confident in their work. In order to achieve this, a modified model for tutorial work was constructed by a workgroup consisting of faculty members involved in the Dental Hygiene program. The modified model meant that the students worked independently with the tutor only paying a few –often two, sometimes three- short visits to the group during the first PBL-session. At these visits, the students presented their problems, hypotheses and objectives with the purpose to create an opportunity of primarily reviewing and reflecting but also getting feed-back from the tutor– and therefore presumably develop their metacognitive awareness. The tutor was present throughout the second PBL-session. This model was compared to the traditional "Malmö model" (Rohlin et al, 1998) in which the tutor participates throughout both PBL-sessions.

Figure 1 shows the outlay of the project. The test model (shown here as a circle and referred to as intermittent tutoring) was alternated with the traditional model (shown here as a star) for a period of twelve weeks, starting with three weeks of using the new model followed by three weeks of using the traditional model. This was repeated twice. The models were alternated in this way because of two reasons, the first one being case-related (to avoid either model being used on same-subject cases) and the second one because of increased opportunities for reflection and improvement of the group-process.

Figure 1
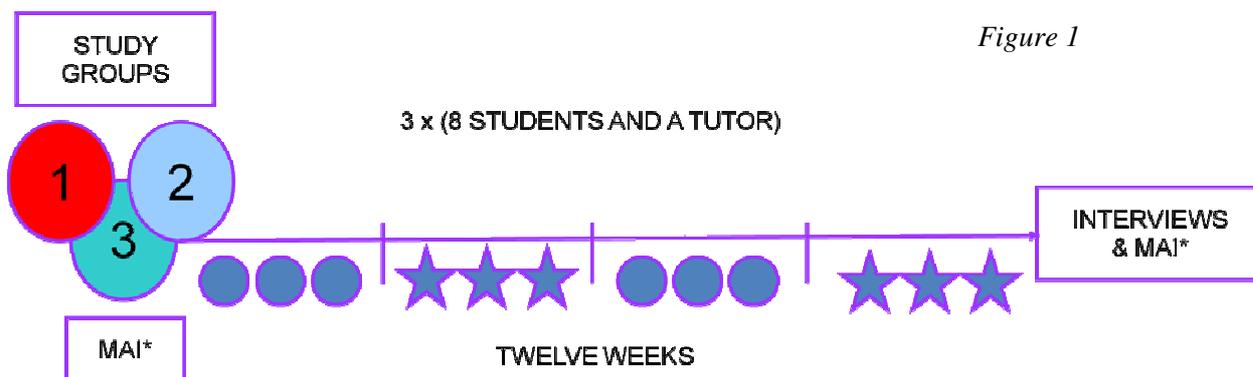
Intermittent tutoring – the test model

Traditional tutoring – the ordinary model

Central concepts

Metacognition

Metacognition was not known as metacognition until John Flavell, an American psychologist and researcher began using the term in the seventies. The concept has however been mentioned in literature and linked to an educational context since the Greek philosopher Socrates argued that you must "know thyself" to be wise. In the 17th century British philosopher John Locke ideas of reflection included something he referred to as "intuitive knowledge, little over two hundred years later the American philosopher John Dewey spoke of "reflective self-awareness". Today, the term metacognition is diligently used and is a concept that has been studied by researchers within educational psychology for over thirty years.

Metacognition can simply be explained by "thinking about thinking". A more detailed description is that metacognition is the awareness or understanding of one's acquired knowledge. This understanding can be expressed through actual use of this knowledge, or by the ability to verbally describe it. In other words, it is about being aware of your own thinking and what possibilities you see when solving problems, making decisions or interpret a text. It also means making intentional strategy-choices when facing problems, verifying the direction towards which you are heading and continuously supervising your course of action. It is about having an active, conscious and systematic attitude and being able to reflect upon your own learning (http://www.ne.se.support.mah.se/metakognition; http://www.gse.buffalo.edu/fas/shuell/CEP564/Metacog.htm)

Self-directed learning

Self-directed learning (SDL) might have been around since the wheel was invented, but the term was not properly defined until the 1970s. John Dewey, mentioned above, meant that "the most important attitude that can be formed is that of the desire to go on learning". This desire constitute the breeding ground for a process "... in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes." In 1975, self-directed learning was described in this way by Malcolm Knowles, born in Montana, USA in 1913 and one of the most important figures in American adult education (http://www.infed.org/biblio/b-selfdr.htm). Knowles was the one who made the concept of andragogy (adult learning) known to the English-speaking world, had it originally been formulated by Alexander Kapp, a German teacher, in 1833 (http://teach-usda.ahnrit.vt.edu/best _practice/ presentations/ pdfs/ Andragogy.pdf).
In the late 1970s, UNESCO (United Nations Educational, Scientific and Cultural Organization) suggested that lifelong learning should be the basis for the organization of the educational system, on all levels and different societies. We live in a society that is in constant change and education needs to be seen as a continuous, lifelong process. Self-directed learning is a method that focuses on the learner and his or hers ability to actively take charge of and create their own development (Pihl, Siöström, 2005).

Metacognition, self-directed learning and problem-based learning

Problem-based learning is student-centred in its nature, and one of the goals of PBL is to help students become lifelong learners. In order to achieve this goal, self-directed learning skills are a must. When working on becoming a self-directed learner, the use of metacognitive thinking and knowledge is essential. For example, in a self-directed learning setting, learners must first assess and value their own knowledge relative to the problems they face. Doing this involves metacognitive knowledge (Hmelo et al, 1997).

Prior research

Research findings on the Metacognitive Awareness Inventory or tutorless problem-based tutorials are very limited.
At UCLA, a study on tutorless groups and their ability to identify faculty objectives found that the lack of a tutor during the first session may have a slight negative impact on the overlap between faculty objectives and the learning issues generated by students for the purpose of self-study (Duek et al, 1996).
Woods et al studied tutored and tutorless groups and the processing issues both groups encountered. Without a tutor present, students find themselves having to master a large number of processing skills in order for the group to function. They encounter personal differences in learning, dominance/passiveness and the role of being a chairperson. Among dominant issues for tutorless groups were conflicts because all members were not seen as pulling their fair share of the work, attendance and trust and reliability (Woods et al, 1996).
At Florida State University the MAI was used as a measuring tool in a research which examined the effects of teaching metacognitive strategies to 60 students in a photography class. The results of the MAI showed an increase in the total mean score, from 65 to 68 out of

100. The MAI was answered before and after assignments with instructions and practice in reflection, planning and evaluation (Kincannon et al, 1999).

The MAI has been used at the faculty of Odontology in Malmö before, in a project focusing on students' proficiency to learn in a problem-based curriculum. Students took part in different workshops; they watched a tutorial play which was followed by discussions and worked in small groups designing cases. After the workshops the MAI-data from students taking part in the project was compared to data from other students, displaying significantly higher metacognitive awareness amongst students taking part in the project.

Results

Metacognitive Awareness Inventory

Table 1 shows the total mean score for both groups, first and second occasion.

Table 1- Changes in total mean score
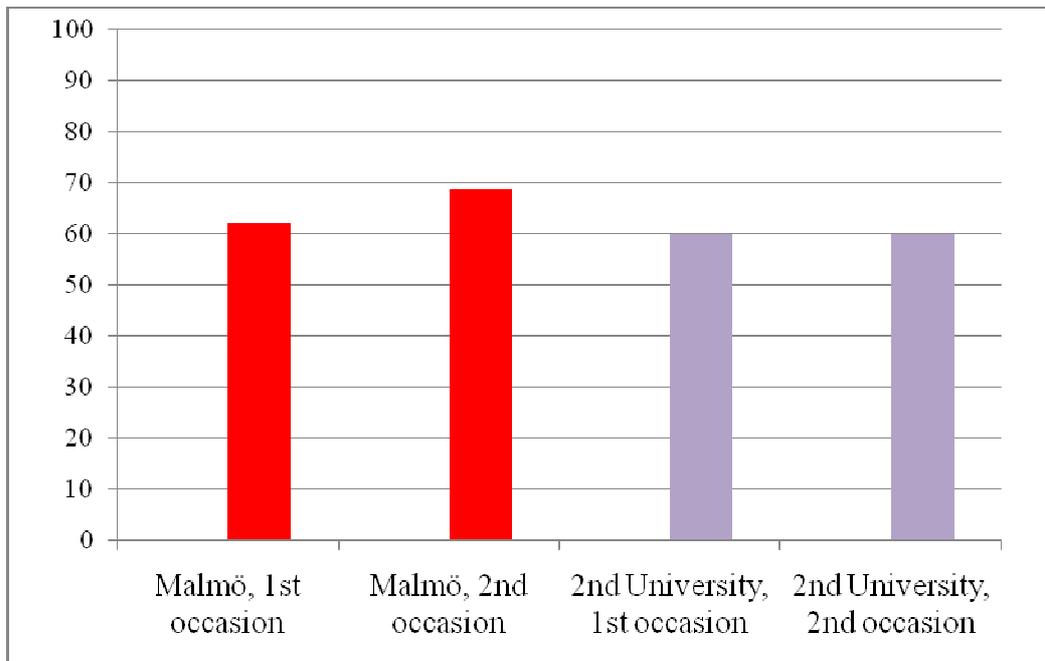
Group	Mean score, occasion 1	Mean score, occasion 2	Difference	Difference, %
Malmö	62,09	68,63	6,54	10,5 %
2nd University	59, 91	59, 94	0,03	0,05 %

For the Malmö-students, there was in increase on the mean total score from 62 to 68,5 out of 100. For the 2nd University-students, the increase was inconsiderable.

This result does not argue any statistical value, but has been calculated to be able to compare mean MAI scores from other studies.

Table 2 shows the mean difference between occasion 1 and occasion 2 for each of the subcomponents of regulation of metacognition and knowledge of metacognition for Malmö and the 2nd University respectively. Results analyzed with student's t-test.

Table 2- Changes and comparison of mean difference
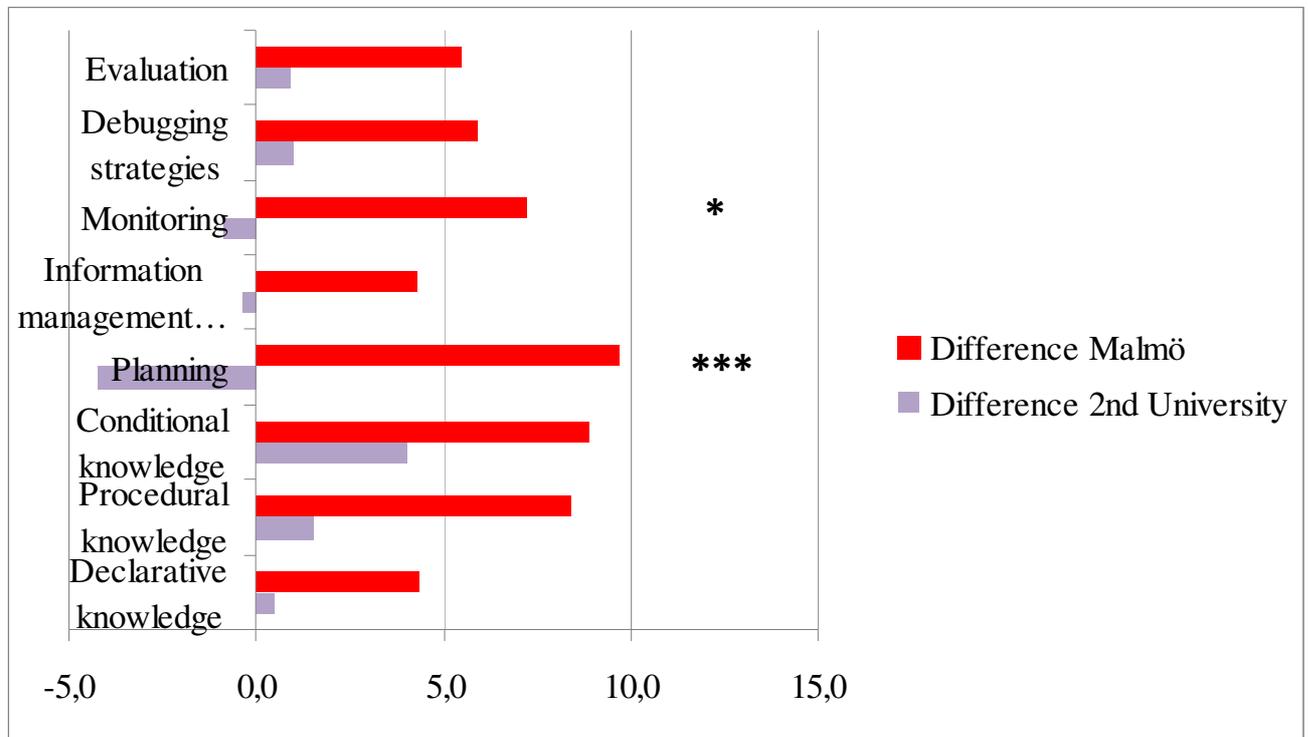
Subcomponent	Difference, Malmö	Difference, 2nd University	TTEST p-value	Statistically significant
Evaluation	5,5	0,9	0,1907	
Debugging strategies	5,9	1,0	0,2384	
Monitoring	7,2	-0,9	0,0335	*
Information management strategies	4,3	-0,4	0,0949	
Planning	9,7	-4,3	0,0009	***
Conditional knowledge	8,9	4,0	0,1159	
Procedural knowledge	8,4	1,5	0,1055	
Declarative knowledge	4,3	0,5	0,1523	

  * $p < 0,05$
 ** $p < 0,01$
***$p < 0,001$

The displayed results reveal that the Malmö-students show a significantly higher increase in metacognitive awareness in regard of monitoring and planning. In fact, students from the 2nd University show a decrease in the mean score for monitoring, information management strategies and planning.

Interviews

In the interviews, the following questions were asked:

1. What were your positive and negative experiences with the two tutoring models?
2. How would you describe the level (difference in width, depth, limitations) of the discussion when comparing the two tutoring models?
3. How would you describe the group constellation and roles (for example the role of the chairman) within the group when comparing the two tutoring models?
4. In what ways do you feel that the project affected your own learning development?
5. If you were to choose one of the two tutoring models, which one would you choose and why?

Results are here presented as a summary of answers followed by representative quotes.

1. What were your positive and negative experiences with the two tutoring models?

Intermittent tutoring, positive aspects:

• With this model the tutorial was more of a challenge; it put a greater demand on the students to function as a group. The work was more independent, there were more open discussions and it was easier to open up and talk.

"It's easier to say things that might be considered a bit foolish, but still might lead somewhere, and the creativity rises"

Intermittent tutoring, negative aspects:

• The students mention the process being interrupted by the visits from the tutor; a recap of the discussion was needed and this felt like a step back. Some felt that the tutor was missing out on important discussions that had occurred but hadn't been summarized on the white board. There was also at times a lack of security and questions about being on the right track or not.

Traditional tutoring, positive aspects:

• With the tutor present at all times the students found the tutorial more efficient. There were fewer walks down side-tracks, easier and more direct goal-access thanks to guidance from the tutor. A sense of security is greatly valued and the students felt more secure with the tutor present. They also feel that the need for quality checks is fulfilled with a tutor present. Something mentioned a lot is the importance of discussing the "right" things and finding the "right" objectives.

Traditional tutoring, negative aspects:

• No one brought up any specific negatives aspects of the tutor being present at all times. Some mentioned feeling more free when not having a tutor present, more on this under intermittent tutoring. One student saw it as a possibility that the tutor might control the group; the student had however not experienced this but reflected upon it.

2. How would you describe the level (difference in width, depth, limitations) of the discussion when comparing the two tutoring models?

When reflecting on the discussion, the students brought up the following differences:

- The discussions were more open, more fun, broader and livelier if the tutor wasn't present. Some students did bring up that it might have been *too* lively at times, but that the group as a whole took their responsibility and worked really well despite this fact. One student said that the discussion probably wasn't as efficient without a tutor.
- It was brought up by several students that they felt more at ease saying "dumb things" when the tutor wasn't present.
- All students but one did not feel that the depth or the quality of the discussion changed accordingly to the tutor being present or not. This seems instead to depend on the subject discussed. The one student mentioning a deeper discussion without a tutor present also believed that a sense of creativeness rose when the group worked independently.

3. How would you describe the group constellation and roles within the group when comparing the two tutoring models?

Reflections on this subject primarily involve the role of the chairman and the roles of the students divided into quieter or more talkative students.
- When not having a tutor present it took more work and energy being the chairman and there was a development of the chairman role.
- Both quiet students and more talkative ones talked more when not having a tutor present
- If a tutor wasn't present and the student being chairman had problems with this role, other students (referred to as stronger students or leader types) took over this role. Sometimes the group as a whole took over the role of the tutor.

"It was more of a challenge, demanding more from the group, that we pulled together and that the chairman took more control"

"Everyone in the group participated and contributed. I felt a bit more free, and I experienced my role as a group-member in a more positive way"

4. In what ways do you feel that the project affected your own learning development?

There were no direct answers to this apparently difficult question. The students all said they studied in the same way "as usual", regardless of the tutorial model. A common opinion however was that the project helped develop the role of the chairman, and that it helped the group become a better functioning group.

5. If you were to choose one of the two tutoring models, which one would you choose and why?

Whether answering one or the other, the common opinion among the students seemed to be that if the intermittent tutoring was to be used it would be necessary for the students to be

familiar with and comfortable in the PBL environment. That is, using the intermittent tutoring during the students first semester with PBL was not recommended by the students.

Seven out of twelve students said they prefer traditional tutoring. Reasons for this were

- need of security
- lack of direct feedback (intermittent tutoring)
- a disturbance of the process (intermittent tutoring)

Five out of twelve students said they prefer intermittent tutoring. Reason for this were

- more open discussions
- quieter students became more talkative

Discussion

This study aimed at enhancing metacognitive thinking, improving tutorials and giving the students tools to become better as self-directed learners. The thought is that tutorless sessions make the students take more responsibility for the group-process and ask themselves "why and what"-questions. By having the tutor paying short visits to the group the students have to be reflective when looking at their work, getting feedback and answering questions from the tutor.

The results from the MAI are positive and show that there was a significant increase in two out of eight subcomponents of metacognition. One cannot know for sure that it has anything to do with the project – all study groups were included in the study and so there was no control group continuing with traditional tutoring. This might be a good idea for further research, to have one group using a new tutorial model and one group continuing with traditional tutoring. By doing that the MAI could be used more as a reliable evaluation than it actually has in this project.

When interviewed, students did not state as many opinions on the traditional tutorial as on the test model, this might be because of the fact that the traditional model is the model they are used to and they are past the stage of questioning it.

When considering if and when to use tutorless sessions it is important to remember that students should feel comfortable in the PBL setting before alternating a tutorial, that is using intermittent tutoring on the students first semester might not be something to recommend.

In the interviews, many stated that most students to a greater extent participated in the session and found the discussions being more spontaneous without the tutor. This is worth for tutors to reflect upon – how can we maintain an open and permitting atmosphere even with us being present? And if using intermittent tutoring, how can we make the students feel positive about the visits from the tutor, and not report feeling interrupted and insecure about being on the right track or not? Perhaps more training in metacognitive thinking and a development of the chairman role could be included in future research projects.

When further developing this, a mix of different tutorials might be fruitful –as long as we find the right amount of the ingredients.

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