Promoting effective collaborative case-based learning at university: a metacognitive intervention

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The use of student-led collaborative learning activities at university level has increased dramatically in recent decades. However, whether such activities foster engagement in self-regulated, deep-learning practices remains contentious, with evidence that desirable learning outcomes are often not achieved. A metacognitive intervention was designed to induce groups of students to engage in productive learning from each other, while working on a clinical case-based group assignment. The intervention introduced students to a twofold metacognitive strategy aimed at enhancing learning through meaning making in group interactions and high-level questioning. The research involved a semi-experimental design, with a previous student cohort providing control data. Observation and self-report data converged to show that the intervention led to increased time spent on case content-discussion, but not at the desired deep level. The intervention’s positive impact was also evident in self-reports of personal goals, perceived difficulty of the assignment, group and task challenges, and evaluations of learning.

Keywords: deep-strategic learning; collaborative learning; high-level questioning; metacognitive strategy; metacognitive intervention

Introduction

Increasingly universities are under pressure to ensure that students develop skills for independent problem solving, critical thinking, teamwork and lifelong learning as part of their undergraduate study (Biggs and Tang 2007). However, recent research indicates that these desirable outcomes are not always achieved (Barrie 2007; Cranmer 2006), and particularly so in science education, where inquiry-based learning, collaborative support, problem solving and critical thinking are imperative for effective instruction (Schraw, Crippen, and Hartley 2006). They also argued that promoting students’ use of self-regulated learning would not only improve their content learning and achievement, but also provide valuable preparation for lifelong professional learning. Preparing students for future learning should include effective learning with and from peers, since workplace learning opportunities are predominately social in nature (Eraut 2007).

Implementing group learning activities at university is challenging (Blumenfeld et al. 1996), and evidence of their effectiveness in enhancing content understanding...
remains contentious (Hmelo-Silver, Duncan, and Chinn 2007; Kirschner, Sweller, and Clark 2006). In the field of health sciences, research has shown that students overwhelmingly prefer teacher-regulated and solo forms of learning to collaborative learning settings, and only a minority consider collaborative learning as effective in undergraduate study (Raidal and Volet 2009; Ryan et al. 2004; Thurman, Volet, and Bolton 2009). Furthermore, there is evidence that in student-led group learning activities a minimal amount of time is spent on high-level meaning making (Summers and Volet 2010). In other words, while the cognitive benefits of effective collaborative learning are well articulated in the literature (Ramsden 2003; Visschers-Pleijers et al. 2006), students may need instruction in the use of learning-enhancing strategies to optimise deep learning in collaborative activities. This article reports the findings of a metacognitive intervention aimed at promoting effective collaborative case-based learning at university.

The usefulness and benefits of collaborative learning among peers of the same level of understanding have attracted much research attention (Blumenfeld et al. 1996; Dillenbourg 1999; Hogan 1999; Terenzini et al. 2001; Van Boxtel, Van der Linden and Kanselaar 2000). Putting groups of students together and giving them group tasks does not, however, necessarily lead to collaborative learning (Summers and Volet 2010). Students who work on a group assignment individually, and then come together in a perfunctory fashion to collate individual research findings, cannot be said to have learned collaboratively, but rather to have cooperated to complete the task (Dillenbourg et al. 1996). The considerable learning benefits of discussing, explaining, elaborating and co-constructing conceptual knowledge at a deep level with peers are foregone, since genuine collaborative learning is achieved through interpretive, elaborative talk, rather than through collaboration itself (Teasley 1995).

The potential of collaborative learning to promote deep learning (Visschers-Pleijers et al. 2006) and knowledge retention (Ramsden 2003) is highlighted in the literature. In clinically orientated courses (e.g. medicine, veterinary medicine) a deep approach is essential to understanding the complex chain of concepts that link symptoms to theoretical knowledge, and as a basis for future professional learning (Newble and Entwistle 1986). It involves a search for understanding, relating ideas to previous knowledge and experience, looking for patterns and underlying principles, checking evidence and relating it to conclusions. These features are clearly aligned to meet the requirements of clinical undergraduate courses, where learning requires in-depth understanding of basic biological concepts that can be built upon as the content becomes more complex.

The stringent requirements and assessment procedures of most medicine and veterinary medicine courses often do not allow sufficient time for consistent engagement in deep learning (Blumberg 2005; May 2008; Newble and Entwistle 1986). As a result, students adopt a strategic approach, where effective management of time and effort becomes their main study tool. According to Entwistle and Peterson (2004), effective strategic learning is based on an acute awareness of learning in context and alertness to assessment requirements, leading to monitoring efficiency of study methods, but also responsibility to oneself and others for consistently achieving. While a strategic approach may be sufficient for passing tests successfully, it is not sufficient for achieving the depth of understanding required for clinical application. This implies that undergraduates need instruction and guidance in strategic learning.

The value of a hybrid deep-strategic approach to university study was posited years ago by Biggs (1987). More recently, Lonka, Olkinuora, and Mäkinen (2004) argued that a deep approach is a necessary but not sufficient condition for productive study. They
claimed that a strategic approach is also necessary on the ground that persistence is what sustains deep-orientated students towards graduation. There is empirical evidence suggesting that neither the deep nor the strategic, self-regulated approaches of learning are ideal on their own to achieve the desirable learning outcomes expected in higher education. Beishuizen, Stoutjesdijk, and Van Putten (1994) and Lindblom-Ylänne and Lonka’s (1999) research, with psychology and medical students respectively, revealed that the most successful students indeed used a deep-strategic, self-regulated approach to learning. In the context of veterinary medicine, Ryan et al. (2004) found that deep learners displayed ‘an awareness of the course objectives and a consciousness of their own ability to achieve them’ (248), making the strategic, self-regulated approach a crucial part of effective deep learning. All these studies point to the potential benefits of promoting strategies to monitor the process of deep learning, instigating the idea that a metacognitive strategy may help in this process.

Several intervention studies have attempted to induce students’ use of metacognitive strategies to enhance deep learning, but few are found outside the disciplines of education or psychology. Volet and colleagues (Volet 1991; Volet and Lund 1994) were successful in inducing undergraduate computer science students to use contextualised metacognitive strategies, but a follow-up study with minimally trained tutors did not replicate the findings (Volet, McGill, and Pears 1995). Other attempts at inducing students’ use of metacognitive strategies were reported by Vermetten, Vermunt, and Lodewijks (2002) with undergraduate law students; by Papinczak et al. (2008) with medical students; and by August-Brady (2005) with nursing students. All these studies, however, were concerned with inducing deep, self-regulated learning in individual students. None investigated the potential of metacognitive strategies to enhance deep-strategic collaborative learning. One recent study by Molenaar, Van Boxtel, and Sleegers (2010) examined the benefits of metacognitive scaffolds on learning outcomes in a collaborative environment, but the study was conducted with elementary school children. Overall, the higher education literature displays a paucity of intervention studies aimed at fostering deep-strategic, self-regulated learning in real-life, collaborative learning settings, acknowledging the challenges faced in using educational interventions to effect change in real-life learning settings (De Corte, Verschaffel, and Masui 2004).

The metacognitive intervention presented in this article addresses this gap. It was designed to investigate the effectiveness of a twofold metacognitive strategy aimed at inducing groups of university students to engage in productive learning from each other while working on a clinical case. Based on the nature of the intervention, the following outcomes were expected:

1. **Personal goals** – it was expected that intervention students would consider learning from each other as more important than their control counterparts. No difference was expected in regard to getting high marks since most veterinary students (the specific student population in this study) are high achievers.

2. **Experience of the group assignment** – it was expected that intervention students would find their group dynamics and the task less challenging to manage than their control counterparts. Additionally, it was expected that intervention students would perceive the clinical case study as less difficult than control students. No difference was expected in regard to interest in the clinical case since all pre-clinical students are interested in early exposure to authentic clinical materials.
Distribution of time spent within student-led informal group meetings – it was expected that intervention students would spend a greater proportion of their meeting time (observation data), and also report spending a greater proportion of their meeting time (self-report data), discussing the case rather than dealing with organisational and other matters. Since control students had reported, two years earlier, a greater proportion of meeting time spent sorting out organisational matters, compared to discussing and sharing understandings of the case, it was of specific interest to this study to establish whether this proportion would be reversed for intervention students, following the metacognitive intervention. It was also expected that intervention students would spend a greater proportion of meeting time engaged in high-level content processing of their clinical case, in comparison to their control counterparts (observation data). Evaluation of sources of learning to achieve the stated learning outcomes of the case-based assignment – it was expected that intervention students would not rate their individual research differently, but that their ratings of learning from others’ research, and learning from group discussions, would be more positive than their control counterparts.

Methodology

Participants

This semi-experimental study involved two cohorts of veterinary science students enrolled two years apart in the same second physiology unit taught in the same way by the same teacher, who was not a part of the research team. The earlier cohort \((n = 81)\) formed the control cohort (2006) and the most recent cohort \((n = 88)\) formed the intervention cohort (2009). The two groups were not enrolled simultaneously so the intervention did not pose an ethical dilemma.

As an integral part of this physiology unit, students are required to form self-selected groups of five or six members to complete a case-based group assignment. On both occasions, participants for the research project were recruited in class, when the teacher presented the case-based group assignment. Students were informed that the aim of the research project was to develop a better understanding of students’ experience of clinical case-based group assignments. Ten of the 14 groups \((n = 59)\) from the control cohort volunteered to participate in the research, and 11 of the 16 groups \((n = 63)\) from the intervention cohort. However, due to the poor quality of the video recording, data from one control group could not be used, thereby reducing the control cohort to nine groups \((n = 53)\). All intervention and control groups were intact groups, with all members participating in all aspects of the research. Ethics approval from the university and consent from both student cohorts were obtained prior to the start of the study.

Procedure

The case-based group assignment

The clinical case-based group assignment is a regular feature of the curriculum in the second physiology unit of the veterinary science degree program. This assignment has the specific learning objective of providing students with an opportunity to apply primary pre-clinical knowledge learnt to date to a real-life clinical case. This first exposure to a real-life clinical
case also has the objective of encouraging students to extract relevant physiology-based clinical concepts, and explore the underlying principles that make up treatment and management of the disease processes presented in the cases. A variety of complete real-life clinical cases are used to ensure that material for each group does not overlap.

Each group works on a different clinical case in their own time over a six to seven week period. Groups are required to set their own learning objectives based on their specific case, undertake research to learn about selected aspects of that case, and present their findings at the end of the semester. The teacher provides guidance through two mandatory meetings three to four weeks apart. The teacher’s role is to guide students into formulating concise, case-relevant learning objectives, and to ensure the groups are progressing in a satisfactory manner. Students are given a group mark based on their class presentation and a follow-up question and answer session led by the teacher. The assessment is based on the groups’ demonstration of having fulfilled their self-generated learning objectives. The group mark for this assignment constitutes 10% of the overall mark for the physiology unit.

Conceptual grounding of the metacognitive intervention. Conceptually, the metacognitive intervention was inspired by the collective works of Barron (2003), Greeno (2006), King (1992, 1998), Kollar, Fischer, and Slotta (2007), and Volet, Summers, and Thurman (2009). The specific metacognitive strategy developed for the intervention was twofold, in that it aimed to foster students’ meaning making in group interactions and high-level questioning.

The focus on meaning making in group interactions was inspired by Greeno’s (2006) emphasis on interactional processes in ‘learning in activity’, and Volet, Summers, and Thurman’s (2009) elaboration on social regulation processes in co-construction of knowledge. Regulation of meaning making in group interactions is metacognitive in nature, since it refers to the strategic monitoring of learning taking place in a joint activity (Paris and Winograd 1990). In the present study, meaning making in group interactions was conceptualised as group monitoring of the collective understanding of the clinical case. Promoting meaning making in group interactions was important since prior research with the same student population had revealed that group work does not necessarily equal effective collaborative learning (Summers and Volet 2010). However, these students were able to describe instances of effective learning from each other in naturalistic settings (Thurman, Volet, and Bolton 2009). In combination, these bodies of research provided useful contextual insight into how veterinary students typically engage in collaborative learning, generating the idea that a metacognitive intervention embedded within regular instruction should have the potential to foster deep-strategic learning in a group setting.

King (1992, 1998) provided the inspiration for the additional focus on high-level questioning. It is in the use of question asking and answering that King describes the association with metacognition (King 2002). According to King, high-level questioning in small cooperative groups provides students with opportunities to reciprocally monitor their understanding of the content material, and to integrate prior knowledge with current knowledge, thereby extending their learning. King argues that generic question stems, such as why, how and what if, elicit high-level explanations and elaborations, thus providing the impetus and opportunity for students to monitor and most importantly question their understanding of the content material.

To maximise students’ adoption of the twofold metacognitive strategy, the instructional message needed to be convincing, expeditious and contextualised to the
veterinary context. Moreover, it needed to be presented in everyday understandable terms in order to be readily accepted and utilised. Accordingly, the strategy was presented to students as ‘a set of tips’ for effective learning from each other. The contextualised nature of this intervention affiliates itself well with the work of De Corte, Verschaffel, and Masui (2004), who outlined major design principles for effective learning environments. They argue that an effective learning setting should ‘embed students’ constructive acquisition activities preferably in real-life situations that have personal meaning for the learners, offer ample opportunities for distributed learning through social interaction, and are representative of the tasks and problems to which students will have to apply their knowledge and skills in the future’ (370).

The phenomenon of ‘over scripting’, described by Kollar, Fisher, and Slotta (2007), where external scripts or strategies override acceptable, sufficient internal scripts displayed by good students, was considered when developing the metacognitive strategy in the present setting. To avoid this phenomenon, the strategy was designed to be sufficiently generic, to allow students to customise it to their own needs and requirements. In other words, scaffolding was provided but without overriding any internal learning strategies students may naturally possess.

Content of the metacognitive intervention. The metacognitive intervention was presented to students as guidance for effective collaborative learning in their case-based assignment. To set the scene and capture students’ interest, they were told that effective collaborative group work was not just about gathering information as individuals and putting a set of slides together, nor was it just about being good citizens who divide the workload fairly and ensure that everyone does their own part. It was stressed that groups might show evidence of good research and efficient group management, but nevertheless learn nothing from each other. With the scene set, the intervention was presented in terms of a set of conditions that provided a social basis for effective collaborative learning, a twofold metacognitive strategy (presented to the students as a set of tips) for effective collaborative learning, and the benefits of effective collaborative learning from a case-based group assignment.

The set of social conditions for achieving effective collaborative learning was presented first: all members to undertake adequate research preparation prior to the group meetings; full commitment from all group members to learn and help each other learn; respectful group learning atmosphere so that all members feel comfortable to admit lack of understanding without embarrassment; and all members to present their research in turn, actively listen to the contribution of others, and engage in overall discussions of the case. It was stressed that these conditions formed the required social basis for initiating and maintaining productive group learning activities, for providing opportunities for all members to participate, and for developing a better understanding of the case as a whole.

The twofold metacognitive strategy formed the main part of the intervention. First, students were provided with a range of examples of meaning-making interactions: ‘exchange definitions, share understandings’, ‘other ways to explain the same concept’, ‘teach others in your own words’. It was emphasised that such interactions would facilitate further inquiry and provide the potential to achieve a deeper understanding of the clinical case. Then, to introduce students to the nature of high-level questioning, as conceptualised by King (1992), they were presented with a range of sample questions, all aimed at meaning making and all contextualised to a veterinary context; for example: ‘What does [gluconeogenesis] mean? What would happen to
gluconeogenesis if the animal were diabetic? Why does it occur?’ The meaning-making question stems (e.g. What does ... mean? What ... if ...? Why ...?) were highlighted and discussed. Students were told that asking ‘what if’, ‘why’ or ‘how’ types of questions within their group would aid in the deeper exploration and understanding of the clinical case, allowing all members to question their knowledge and develop a better understanding of the case as a whole.

It was recommended that groups spent the majority (50–70%) of their meeting time using meaning-making interactions and high-level questioning, in order to maximise their learning. This percentage time was suggested as a reasonable research expectation to achieve a deep-level understanding of the case.

The benefits of effective collaborative learning from a clinical case-based assignment were presented as the final part of the metacognitive intervention. Students were told that a short-term benefit would be everyone’s overall better understanding of the case, allowing any member of the group to answer any question about the case at the class presentation, and in turn enhancing the chance of the group getting a higher mark. The long-term benefit of developing effective collaborative learning strategies was promoted as excellent preparation for the type of learning required in the clinical years of a veterinary science degree.

Presentation of the metacognitive intervention. The intervention was presented in the form of a PowerPoint presentation to the whole class, after the teacher had introduced the case-based group assignment and before the case files were distributed to groups. An experienced veterinary clinical teacher (one of the authors) presented the intervention, thereby reinforcing the credibility of the message. A handout summarising the content of the intervention was distributed after the presentation. When introducing the case-based group assignment to the class, the physiology teacher also stressed the value of peer learning to enhance understanding of the clinical case.

Instructional approach used with the control cohort

Students in the control cohort completed exactly the same assignment as the intervention students two years earlier, the only exception being that they were not presented with the metacognitive intervention.

Data collection and instruments

Two matched sources of data from intervention and control students were used to evaluate the effectiveness of the metacognitive intervention: questionnaires completed at the beginning and end of the group assignment, and video recordings of two of each group’s informal meetings (student-led, no teacher). The intervention students completed their beginning questionnaire prior to the metacognitive intervention delivery in order to provide comparable baseline data.

Questionnaires

The beginning and end questionnaires completed by intervention and control students included measures of personal goals and experiences of the task. The end questionnaire also included measures of distribution of time spent on specific activities during group
meetings, and evaluation of sources of learning to achieve the desired learning outcome of the clinical case-study group project.

**Personal goals.** Two statements relevant to establishing students’ motivation to engage in the group assignment were presented to students. They were asked to rate the extent to which these were important goals for them in the group project: ‘That we all learn from each other’ and ‘To get the highest mark possible’. The rating scale ranged from \( I = \text{not a priority for me} \) to \( 4 = \text{a top priority for me} \).

**Experiences of the group assignment.** Students’ perceptions of group challenges and task challenges related to the assignment (anticipated at the beginning and retrospective at the end) were investigated, using an instrument developed by Järvenoja, Volet, and Järvelä (under review). Five group challenges and five task challenges were presented for rating, using a scale of \( I = \text{a small challenge} \) to \( 4 = \text{a big challenge} \), with the option of selecting \( 0 = \text{no challenge at all} \). Examples of group challenges included: ‘Some group members having different work standards’ and ‘Some group members’ goals/priorities being different’. Examples of task challenges included: ‘Case material too difficult to understand, some parts can’t be explained’ and ‘Too much information and difficult to decide what to include and what to omit’. Järvenoja, Volet, and Järvelä state that, although each item represents a unique type of group or task challenge, the two sets of five items represent two coherent underlying constructs and thus form reliable scales, allowing comparison of the extent to which students are experiencing group or task related challenges overall. In the present study, Cronbach alpha coefficients were very high for both scales and on both occasions. The coefficient for group challenges was .77 at the beginning and .85 at the end, and for task challenges was .80 at the beginning and .75 at the end. Difficulty of the clinical case study and Interest in the clinical case study (anticipated at the beginning and retrospective at the end) were also elicited. The rating scale ranged from \( I = \text{not at all} \) to \( 4 = \text{very} \).

Self-report of distribution of time spent on different types of interactions during group meetings involved students’ providing individual estimates of the percentage of time their group spent on the following four broad types of interactions: sorting out organisational matters; discussing and sharing understandings of the case; listening to the group interactions in frustration; and engaging in other discussion.

**Evaluation of sources of learning** to achieve the desired learning outcomes of the group project involved students rating how much each of the following three activities related to the group assignment helped: ‘your own research on aspects of the case’, ‘research done by other members of your group’ and ‘discussions during face-to-face meetings with your group’. All items were rated on a scale of \( I = \text{a little amount} \) to \( 4 = \text{a huge amount} \).

It is important to note that this measure was introduced to the research program one year after the control cohort completed their case-based group assignment. Data from the two intermediate cohorts (the years between the control and intervention cohorts, 2007 and 2008) were used as a control for this measure. Using data from these intermediate cohorts \( (n = 240) \) was acceptable since these students had completed the same assignment under the same conditions as the earlier control cohort, the only difference being that the intermediate cohorts only completed the beginning and end questionnaires, with no video recordings of their informal sessions. The intermediate cohorts had not been presented with the metacognitive intervention.
Video-recordings of informal group meetings

The first round of video recording took place early in the first or second week of the seven-week-long assignment, when students met to discuss their clinical case and start generating their learning objectives. The second round took place around the fifth week, after the groups had had the opportunity to research selected aspects of their case. All video recordings of intervention and control student meetings were scheduled at times convenient to students and made under naturalistic conditions (no instructions from teachers or researchers, only filming students’ informal meetings, and the length of meetings was determined by students). The mean duration of the student-led meetings for the control cohort’s first round of meetings was 44 mins, 40 secs (SD = 10 mins, 53 secs), and for the second round of meetings was 25 mins, 4 secs (SD = 12 mins, 50 secs). The intervention cohort’s first round meeting mean duration was 46 mins, 59 secs (SD = 11 mins, 14 secs), and the second round mean duration was 43 mins 48 secs (SD = 12 mins, 46 secs).

Data analysis

Questionnaires (self-report data)

Comparison of the intervention and control students’ questionnaire data was undertaken by carrying out repeated measures multivariate analysis of variance for the data, involving beginning and end measures and t-tests for the end measures only.

In regard to the distribution of time measure, an index of the relative proportion of time spent on organisational matters versus discussing and understanding the case was created. This was done by subtracting students’ estimated percentage of total meeting time spent on organisational matters from their estimated percentage of meeting time spent on content-related discussion. Positive scores indicate a greater emphasis on content-related discussion during group meetings, and negative scores a greater emphasis on organisational matters.

Video recordings (observation data)

The analysis of the video footage of 40 meetings (9 x 2 from the control cohort and 11 x 2 from the intervention cohort) was based on the theoretical framework and corresponding coding system developed by Volet, Summers, and Thurman (2009). They distinguish between talk dealing directly with processing the learning content, in this case processing the content of the clinical case, and talk related to other matters, such as task, organisation or off-task.

The theoretical framework proposed combines the constructs of social regulation and content-processing for the identification of productive interactions in collaborative learning. Each construct is conceptualised as a continuous dimension. In the present study, the focus is exclusively on the content-processing dimension of the framework. Volet, Summers, and Thurman conceptualise content processing of the learning content (clinical case) along a continuum from low-level to high-level, but treat low-level and high-level as broad categories in their coding system, as it is difficult to capture intermediate points along the high-level–low-level continuum. Low-level content processing refers to verbal interactions pertaining to clarification of basic facts, providing definitions, or relaying information verbatim from an information source. High-level content processing refers to engagement in elaborating, reasoning, interpreting or
linking ideas, and explaining concepts in one’s own words. Since it is difficult to capture intermediate points along the low to high level continuum, the analysis involved the judges deciding on the best fit of the two categories, depending on the dominant level of content processing being observed.

Talk related to task and organisational matters refers to discussions related to the completion of the assigned task (e.g. selecting learning objectives, deciding on the scope of the assignment, what to include in the final presentation), and to discussions of organisational matters (e.g. scheduling future group meetings, exchanging contact details, delegating sub-tasks within the group). Talk related to matters that are unrelated to the assignment is categorised as off-task. All verbal interactions that did not refer to content processing are reported as other.

For the purpose of this experimental field study, aimed at comparing intervention and control students’ extent of engagement with the content of the clinical case during their informal meetings, the following coded data are reported: time spent processing the content of the clinical case as a percentage of the entire group meeting time overall; and time involved in high-level content processing of the content material as a percentage of the entire group meeting time overall.

Inter-judge reliability for observation (video) data coding

Sampling of the data from the intervention cohort (6/22 or 27%) and the control cohort (7/18 or 38%) student meetings was used to establish the reliability of the coding system for this study. Two judges were used, both blinded to the individual and group performance of the students. One judge, who is one of the authors, coded all the video data. The second judge, a social psychologist, who was not involved in the development of the research project but had extensive experience in discourse analysis and video coding analysis, took on the role of independent judge. A third independent person randomly selected the sample of observation data chosen to be double-coded and establish inter-judge reliability. Equal proportions of first and second student group meetings were chosen. The teacher was not involved in any aspects of the research process. Inter-judge reliability was determined by calculating the percentage of time the two judges were in agreement over the total length of the meeting (in seconds). A satisfactory level of agreement in coding was achieved for all groups, with judges being in agreement for 82.7% and 77.3% of the total length of time across all meetings respectively for the intervention and control cohorts.

Results

The impact of this intervention was examined by comparing control and intervention students’ personal goals and experiences of the group assignment (self-report data); distribution of time during group meetings (observation and self-report data); and evaluations of sources of learning to achieve the stated learning outcomes of the group assignment (self-report data).

Personal goals and experiences of the group assignment

Table 1 shows the two cohorts’ mean ratings of personal goals and experiences at the beginning and end of the assignment. The results of the statistical tests comparing the
Table 1. Mean ratings and standard deviations (SD) for self-reports of personal goals and experiences of the group assignment.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
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<tbody>
<tr>
<td></td>
<td>Beginning Mean (SD)</td>
<td>End Mean (SD)</td>
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<tr>
<td><strong>Personal goals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>That we all learn from each</td>
<td>3.25 (0.66)</td>
<td>3.16 (0.60)</td>
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<tr>
<td>other</td>
<td></td>
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<tr>
<td>To get the highest mark</td>
<td>3.31 (0.76)</td>
<td>2.95 (0.66)</td>
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<tr>
<td>possible&lt;sup&gt;1&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td><strong>Experiences</strong></td>
<td></td>
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<tr>
<td>Group challenges&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2.06 (0.87)</td>
<td>1.85 (1.18)</td>
</tr>
<tr>
<td>B</td>
<td>2.10 (1.01)</td>
<td>1.46 (1.27)</td>
</tr>
<tr>
<td>C&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1.91 (1.04)</td>
<td>1.60 (1.45)</td>
</tr>
<tr>
<td>D&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1.29 (1.09)</td>
<td>1.29 (1.37)</td>
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<tr>
<td>E</td>
<td>1.78 (1.05)</td>
<td>1.50 (1.29)</td>
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<tr>
<td><strong>Task challenges&lt;sup&gt;5&lt;/sup&gt;</strong></td>
<td></td>
<td></td>
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<tr>
<td>F&lt;sup&gt;6&lt;/sup&gt;</td>
<td>1.95 (0.92)</td>
<td>2.07 (1.10)</td>
</tr>
<tr>
<td>G</td>
<td>1.89 (1.03)</td>
<td>1.74 (1.19)</td>
</tr>
<tr>
<td>H</td>
<td>2.47 (0.97)</td>
<td>2.77 (1.13)</td>
</tr>
<tr>
<td>I</td>
<td>1.37 (0.96)</td>
<td>1.06 (0.95)</td>
</tr>
<tr>
<td>J</td>
<td>1.64 (0.84)</td>
<td>1.46 (1.03)</td>
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<tr>
<td><strong>Difficultly of the clinical</strong></td>
<td>2.65 (0.59)</td>
<td>2.74 (0.66)</td>
</tr>
<tr>
<td>case study&lt;sup&gt;7&lt;/sup&gt;</td>
<td></td>
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<tr>
<td><strong>Interest in the clinical</strong></td>
<td>3.33 (0.61)</td>
<td>3.23 (0.67)</td>
</tr>
<tr>
<td>case study</td>
<td></td>
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**Group challenges**
A Different understandings of the task
B Different priorities e.g. marks, time
C Different work standards
D Members not connecting well
E Different life circumstances

**Task challenges**
F Project required too much time, effort
G Case material too hard to understand
H Too much information
I Not enough direction from teachers
J Too hard to get a good mark

**Significant interaction effects Cohort by Time for:**
<sup>1</sup>Personal goal, Get the highest mark possible, F(1,166) = 14.32, p < .001, see Figure 1.
<sup>2</sup>Group challenges overall, F(5,162) = 2.74, p < .05.
<sup>3</sup>Group challenge C, F(1,166) = 4.96, p < .05, see Figure 2.
<sup>4</sup>Group challenge D, F(1,166) = 8.65, p < .01, see Figure 3.
<sup>5</sup>Task challenges overall, F(5,161) = 2.84, p < .05.
<sup>6</sup>Task challenge F, F(1,165) = 10.70, p < .01, see Figure 4.
<sup>7</sup>Difficulty of the clinical case study, F(1,165) = 4.94, p < .05.
two groups (multivariate analysis of variance with repeated measures) are reported at the bottom of this table.

**Personal goals**
Contrary to expectations and given the nature of the intervention, intervention students did not rate ‘that we all learn from each other’ as a more important goal than their control counterparts by the end of the group assignment. This may indicate that this goal statement was perhaps too general to differentiate between the two cohorts, since a deep-level meaning-making discussion, as well as a simple exchange of information, could equally be interpreted as learning from each other. In regard to the second goal, ‘to get the highest mark possible for the group assignment’, while control students had lowered their achievement expectations by the end of the assignment, this was not the case for intervention students. Figure 1 illustrates the different evolution of the two cohorts’ performance goals over the duration of the group assignment.

**Experiences**
The impact of the intervention had a significant impact on students’ accounts of their experiences of the group assignment.

**Group challenges**
As shown in Table 1, the expectation that the intervention students would perceive their group social dynamics as less challenging overall than the control students was
supported. The two cohorts’ experiences of two specific group challenges, ‘some group members having different work standards’ (item C in Table 1) and ‘some group members not connecting well’ (item D) evolved differently over the duration of the group assignment. Figure 2 illustrates how handling different work standards within the group became less of a challenge for the intervention students compared to the control students. In regard to group members’ interpersonal connectedness, no change over time was experienced for the control cohorts. In contrast, intervention students initially expected this aspect to present a moderate challenge, but ended up reporting it as being less of a concern at the end of the assignment (See Figure 3).

**Task challenges**

The expectation that the intervention students would experience the task as less challenging overall than the control cohort two years earlier was also supported. In particular, the two cohorts’ ratings of the specific task challenge, ‘the project required too much time/effort’ (item F in Table 1), evolved in opposite directions from beginning to end of the assignment (see Figure 4). Intervention students reported that time and effort at the end of the assignment was less of a concern, in contrast to the control students who reported that this was actually more of a concern. This finding supports the research expectation that intervention students would consider investment of time and effort less of a challenge. Noteworthy is the finding that both cohorts were satisfied with the amount of direction provided by their teachers about how to complete this project (item I). This highlights the perceived value of the formal structured support that had been provided to both cohorts by their teacher.

![Figure 2. Interaction effect Cohort by Time for group challenge ‘Some group members having different work standards’](image)
Figure 3. Interaction effect Cohort by Time for group challenge ‘Some group members not connecting well’.

Figure 4. Interaction effect Cohort by Time for task challenge ‘Project required too much time/effort’.
**Difficulty of and interest in the clinical case study**

As shown in Table 1, the intervention also had an impact on students’ experience of the difficulty of the clinical case study, with intervention students’ ratings being lower at the end than at the beginning and the opposite for the control students. This finding is consistent with the two cohorts’ experiences of group and task challenges. In contrast, the evolution of the two cohorts’ ratings of their interest in the clinical case study did not differ, supporting the research expectation that all students would value this initial exposure to authentic clinical case files, regardless of the difficulty of the task.

**Distribution of time during group meetings**

*Observation (video data)*

The video data of control and intervention groups’ actual engagement in the activity was critical for the purpose of comparison with students’ self-reported experiences. Table 2 displays the percentage of overall meeting time spent discussing the clinical case by control and intervention groups in two recorded sessions. For both cohorts, the groups are organised in ascending order of percentage time spent on content-related discussion in the second meeting. For clarity, shading was added to highlight any session where the group spent more than 30% of their meeting time discussing the content of their clinical case.

Comparing the shading across cohorts reveals that, in their first meeting, which took place just after students received their clinical case file, six of the nine control (66%) and six of the eleven intervention (54%) groups spent more than 30% of their time discussing the content of their clinical case. In contrast, in the second recorded meeting, which took place after students had completed background research on their case,

**Table 2. Percentage of meeting time spent on discussing the clinical case for control and intervention cohorts across two sessions.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Session 1</th>
<th>Session 2</th>
<th>Group</th>
<th>Session 1</th>
<th>Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>cJ</td>
<td>69.20</td>
<td>0.00</td>
<td>iC</td>
<td>52.60</td>
<td>4.00</td>
</tr>
<tr>
<td>cE</td>
<td>35.10</td>
<td>1.00</td>
<td>iA</td>
<td>52.00</td>
<td>18.90</td>
</tr>
<tr>
<td>cB</td>
<td>17.40</td>
<td>4.70</td>
<td>iJ</td>
<td>61.20</td>
<td>21.70</td>
</tr>
<tr>
<td>cI</td>
<td>27.20</td>
<td>10.00</td>
<td>iP</td>
<td>21.30</td>
<td>32.40</td>
</tr>
<tr>
<td>cK</td>
<td>42.60</td>
<td>10.60</td>
<td>iL</td>
<td>19.60</td>
<td>52.00</td>
</tr>
<tr>
<td>cN</td>
<td>22.60</td>
<td>22.20</td>
<td>iE</td>
<td>28.50</td>
<td>53.30</td>
</tr>
<tr>
<td>cG</td>
<td>38.60</td>
<td>48.70</td>
<td>iK</td>
<td>42.60</td>
<td>55.80</td>
</tr>
<tr>
<td>cC</td>
<td>46.50</td>
<td>55.00</td>
<td>iO</td>
<td>82.90</td>
<td>59.30</td>
</tr>
<tr>
<td>cM</td>
<td>32.10</td>
<td>85.20</td>
<td>iD</td>
<td>20.10</td>
<td>63.20</td>
</tr>
<tr>
<td>iN</td>
<td>9.30</td>
<td>64.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>il</td>
<td>45.60</td>
<td>65.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| >30%  | 6/9       | 3/9       | >30%  | 6/11      | 8/11      |
| 66%   | 33%       | 54%       | 72%   |           |           |
| Mean  | 36.8      | 26.3      | Mean  | 39.6      | 44.5      |
| (SD)  | (15.3)    | (29.8)    | (SD)  | (22.05)   | (21.5)    |
only three of the nine control (33%) but eight of the eleven intervention (72%) groups spent more than 30% of their meeting time discussing the content. This finding is consistent with the intervention message, which stressed the importance of spending more time during group meetings discussing the clinical case rather than organisational matters.

The opposite trend, in the number of groups who spent more than 30% of their meeting time discussing their clinical case from the first to the second session, was also reflected in the two cohorts’ mean percentage of meeting time spent discussing the clinical case over the two sessions. The bottom row of the table displays the mean percentages for each session and each cohort. It shows that over the two sessions, the mean percentage of meeting time spent discussing the clinical case decreased from 36.8% to 26.3% for control groups and increased from 39.6% to 44.5% for intervention groups.

The extent to which intervention students spent a greater proportion of their meeting time engaged in high-level content discussion of their clinical case in comparison to their control counterparts two years earlier was also examined. No significant differences were found between cohorts in either session. This indicates that, although intervention groups tended to increase the amount of time spent discussing their clinical case once they had completed their background research (session 2), there was no difference across cohorts in terms of depth of content processing of the clinical cases overall.

Self-report (questionnaire) data
The two cohorts’ self-reports of the proportion of time spent on organisational matters versus discussing and understanding the case (index analyses) were consistent with the observation data. As expected based on the intervention, the intervention groups reported a greater emphasis on content-related discussion relative to organisational matters during their informal meetings, while the control students had reported the opposite two years earlier. An independent-groups t-test comparing intervention (n = 88, M = 26.19, SD = 29.07) and control (n = 83, M = −15.81, SD = 42.47) cohorts revealed that their reports were significantly different, t(169) = −7.583, p < .001.

Evaluations of sources of learning
The research expectation that intervention students would find the group discussions during face-to-face meetings to be more useful to achieve the learning outcomes of the clinical case-study assignment, in comparison to the large control cohort (2007–8 data), was supported. This provides support for the impact of the intervention. No differences were found for the other two possible sources of learning created by this assignment, namely, learning from the research done by other members of the group, and learning from one’s own research on aspects of the case. Table 3 displays students’ ratings for the three sources of learning and the results of the three separate independent-groups t-tests.

Discussion
This semi-experimental study examined the potential of a metacognitive intervention to induce groups of university students to engage in productive learning while working together on a clinical case assignment. Reports of observations of student-led group interactions in natural settings are very scarce in the higher education literature, most
studies relying on self-report data. The use of a semi-experimental research design, combined self-report and observational data, and rigorous methods of analysis, including theory-based coding and inter-judge agreement, were critical to gauge the effectiveness of this intervention.

As expected, differences in content-related discussions between cohorts emerged only in the second recorded session, after students had had the opportunity to complete background research on various aspects of the clinical case. The lack of cohort differences in the initial recorded session (36.8% compared to 39.6%) was not unexpected, since at that time students were unfamiliar with their case, and thus focused on task delegation and organisational matters for the semester-long group activity. Productive content-related collaborative interactions require background knowledge, which these second-year students were not expected to have at this early stage.

In the second recorded session, more than double the number of groups from the intervention cohort spent 30% or more of their time in content-related discussions, compared to the control cohort, providing support for the effectiveness of the intervention. These findings are consistent with the two cohorts’ own estimates of the time spent on content discussion relative to organisational matters in their group meetings. The research expectation that groups should spend 50–70% of their meeting time discussing the clinical case was not achieved. However, the findings are encouraging in the context of a semi-experimental study, where other influences may have impacted on the intervention.

It is possible that intervention students reported a greater amount of time spent in content-related discussions because they knew this was expected of them. This cannot be said about the observation data, as these students had nothing to gain in pretending to engage in content-related discussion, for they knew there would be no penalty if they did not use the recommended strategy. This stresses the importance of using multiple data sources in metacognitive intervention research when involving groups.

The metacognitive strategy that formed the main focus of the intervention aimed to increase content-knowledge discussion, and also to encourage deep, high-level content processing (Volet, Summers, and Thurman 2009). The lack of significant differences in high-level content-related discussions between cohorts indicates that this metacognitive intervention was not powerful enough to achieve this aim. There are multiple explanations. One is that a metacognitive intervention presented in the most convincing, credible and contextualised way is not sufficient even for high-achieving-oriented students. Given these students were keen to follow advice, it is possible that they indeed tried to implement the twofold metacognitive strategy within their groups, but without meeting the research expectations. This was reflected in more groups reporting and being observed spending time discussing their case, and the overwhelmingly high ratings of learning from group discussions to achieve the learning objectives.

Table 3. Students’ evaluations of three sources of learning to achieve the learning outcomes of the clinical case group assignment.

<table>
<thead>
<tr>
<th>Source of Learning</th>
<th>Control n = 240 Mean (SD)</th>
<th>Intervention n = 88 Mean (SD)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own research</td>
<td>3.21 (0.67)</td>
<td>3.19 (0.54)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Research by others</td>
<td>2.86 (0.74)</td>
<td>3.02 (0.71)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Group discussions</td>
<td>2.89 (0.82)</td>
<td>3.26 (0.73)</td>
<td>t(171), 3.90, p &lt; .001</td>
</tr>
</tbody>
</table>
This suggests that students should perhaps be shown a demonstration of effective meaning-making interactions. A distinct advantage of demonstrating enacted high-level content processing is that it places the instruction in a ‘content-specific context’ and expands content knowledge. Beishuizen, Stoutjesdijk, and Van Putten (1994) argue that metacognitive help should be given in a content-specific context and not be limited to general hints alone, therefore expanding students’ content knowledge. Although the twofold metacognitive strategy presented to students in this study was customised to the specific context of collaborative case-based learning in veterinary science, peer modelling of high-level content processing in this context was not provided. The added value of modelling and scaffolding collaborative learning-enhancing strategies should be examined in future research.

One other explanation for the intervention cohort’s minimal engagement in high-level content processing could be attributed to the method of assessment. If students perceived that collaborative deep-level content processing was not necessary to produce a presentation of high standard, and that group members’ background research could simply be collated, then they had no reason to spend additional time and energy discussing reciprocal understandings within the group.

In regard to students’ experiences of the group assignment, the impact of the metacognitive intervention was demonstrated, with intervention students finding the task less difficult overall, and task management and group dynamics less challenging than control students. Interestingly, the findings regarding personal goals were opposite to expectations. Intervention students were keener to get the highest mark possible than control students. This may be a reflection of the general level of confidence the intervention students had about their group assignment, perhaps buoyed by their experience of finding the task less difficult and group dynamics less challenging overall. In turn, the lack of difference in the goal of ‘learning from each other’ could be explained in terms of multiple interpretations of what is meant by ‘learning from each other’, ranging from exchanging basic facts to complex elaborations of content knowledge.

The findings related to students’ evaluations of sources of learning to achieve stated learning outcomes of the case-based assignment were as expected. The impact of the intervention was highlighted in the significant difference between intervention and control cohort evaluations of their learning from face-to-face group discussions. It may be argued that this finding was influenced directly by what was presented in the intervention, and that intervention students responded accordingly in their self-reports, displaying attributes of ‘good citizens’. However, self-reports were only one of the sources of data collected for this study, and, in combination with recorded observations, provide complementary evidence of the value of the intervention. One possible limitation of this study is the absence of objective learning outcome measures to relate the observation and self-report data. Such measures were not available due to alternative forms of assessment for the group presentations.

In sum, this study provided evidence that it is possible to enhance the way groups of students work together: increasing the amount of time they spend discussing and explaining the clinical case, rather than simply managing, organising and delegating tasks. Examination of the added value of peer modelling high-level content processing will be a valuable follow-up intervention. In light of less than favourable perceptions of group learning activities among university students, it is imperative to address the paucity of intervention research aimed at promoting effective collaborative learning. Promoting effective peer learning across degree courses may enhance students’ ability to exhibit similar qualities in their professional lives.
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References


