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Producing and scrounging during Problem Based Learning

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ABSTRACT

When problem based learning occurs in a social context it is open to a common social behaviour, scrounging. In the animal behaviour literature, scroungers do not attempt to find resources themselves but rather exploit resources found by other group members (referred to as producers). We know from studies of animal behaviour (including humans) that scrounging can be expected whenever animals exploit resources in groups. We also know that scrounging can have deleterious effects on the group. We can expect scrounging to occur during social learning because the exchange of information (which I will consider here as a resource) is essential to social learning. This exchange can be seen as each individual scrounging from the other members of the group whenever the individual learns from the work of others. However, there is a danger if some individuals learn mostly through their own efforts while others indulge in "social loafing" relying heavily on colleagues to provide knowledge. Here I propose that game theory models developed to analyse feeding in animal societies may also apply to social learning. We know from studies of birds feeding in groups that scrounging behaviour depends on the extent to which resources can be shared. Further, when scrounging is prevalent groups tend to obtain fewer resources. By contrast, in social learning we attempt to facilitate sharing of knowledge. We thus encourage scrounging and run the risk of reducing learning within study groups. Here I analyse the role of scrounging in problem based learning. I argue that scrounging is inherent and necessary to any social learning process. However, it can have perverse effects if the acquisition of facts rather than understanding comes to dominate learning objectives. Further, disparities among individuals within a group can lead certain individuals to specialise in scrounging thus undermining the functioning of the group. I suggest that motivation, problem structure, discussion group dynamics, attention to results expected from students

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and careful evaluation can be used to encourage scrounging as a cooperative tactic while minimising its negative impacts on group performance.

Keywords: Scrounging, social learning, motivation, objectives, group size, evaluation

INTRODUCTION

Although problem-based learning (PBL) can involve just a single student (Woods 1994) it is commonly used in a social context. Usually a group of students is given a problem which they must analyse, evaluate and understand together. Understanding the problem will lead the students to learn something new. The learning process will always involve both individual and group activities. Here I will assume a PBL model like the one used at the Université du Québec à Montréal (Mauffette and Poliquin, 1997) based on the Schmidt's (1983) 7 jump model. I expect that the phenomena I describe here will apply to many PBL formats. Working in a group students must analyse problems and fix clear objectives about what they must do in order to address the problem they have been given. Individually each must search for the knowledge necessary to meet the group's objectives. Finally, the group must assemble their acquired knowledge in order to understand, and perhaps solve, the problem they have been given. This final phase usually involves a group discussion which I will call a tutorial.

We expect learning to occur throughout this PBL process in both the individual and group phases. The individual phase is important because, ultimately, it is the individual student who must learn. The tutorial, group phase, allows each student to compare knowledge with that of colleagues, to validate personal understanding of the concepts being studied, to critique and correct personal understanding and that of others, to form a synthesis of what has been learned and to consolidate this learning around the concrete example provided by the problem under study.

Both individual and group phases of this activity are essential to understanding the problem at hand and to assimilating the concepts necessary to this understanding. Without the tutorial students will be deprived of the opportunity to compare and contrast their understanding with others and will have less chance to synthesize their knowledge to obtain a deep understanding of the concepts under study. Without the individual phase of the process, groups will have nothing new to discuss and will be limited to sharing what knowledge they had prior to encountering the problem.

In an ideal world all students would thus invest time in individual study in order to develop a good understanding of the problem to bring to the tutorial. However, in reality, students must manage their time among a number of activities of which studying

(working on the current problem) is just one. They are thus likely to develop strategies to help them succeed in their studies despite their time constraints. One possible strategy is to minimize time spent on individual study and to rely heavily on the contribution of others during tutorials in order to understand a given problem. My objective is to discuss the likelihood and consequences of this strategy both for individuals who adopt it and for others in their study group. I will base my discussion on studies of the "Producer-Scrounger Game" in the field of animal behaviour (Barnard &Sibly 1981, Vickery *et al.* 1991, Giraldeau& Dubois 2008).

PRODUCING, SCROUNGING AND LEARNING IN GROUPS

Analysis of producing and scrounging among animals is based on the theory of games (von Neumann and Morgenstern, 1944). Originally a mathematical tool developed by economists, the theory of games can be used to predict the best choice of behaviour of an individual when the success of the behaviour depends on the behaviour of others. The theory evaluates not just the best choice of one individual but also the best choice of each individual faced with the prospect of interacting with others who are also attempting to choose their own individual best behaviour. This approach is been widely used in studies of animal behaviour since the publication of Maynard Smith's book in 1982.Here we will draw a parallel between a well-studied game (producing and scrounging) and learning in groups.

Animals often use the behaviour of others to locate resources (Giraldeau&Caraco 2000). In the animal behaviour literature this is called scrounging (Barnard &Sibly 1981) or using public information (Valone 1996). Animals that look for resources are called "Producers" and those who exploit resources found by others are called "Scroungers". There are a number of mathematical models (ex. Vickery *et al.* 1991) which predict when animals should scrounge and what proportion of a group should scrounge. Notably, if all group members decide to scrounge all the time, no resources will be found and all group members will obtain nothing. On the other hand, if only one group member scrounges it may profit from all the resources found by others while losing very little by not searching itself. Thus, there will often be a temptation to scrounge provided not too many others are scrounging.

There is considerable evidence that animals do scrounge from one another. The idea originated with Barnard &Sibly's (1981) observation of house sparrows feeding in flocks. Subsequently, zebra finches (Beauchamp 2001), nutmeg manikins (Coolen, Giraldeau& Lavoie 2001), crows (Bugnar&Kotrshal 2002; Ha & Ha 2003), and grackles (Morand-Ferron, Giraldeau& Lefebvre (2007), all flock feeders, have been shown to scrounge. Recently, primates have been shown to scrounge (Di

Bitetti&Janson 2001; Bicca-Marques & Garber 2005). There is even evidence that a non-social mammal (the red squirrels) will scrounge (Leroy 2010).

In the examples above, animals profit by learning the location of food from others. While the profit is food, the process involves learning. As learning is involved, animals can scrounge more than just resources; they can also learn from conspecifics. For instance, Giraldeau & Lefebvre (1987) showed that, under some circumstances, a pigeon can learn a complex task by watching another pigeon perform the task. We know that humans also learn by observing one another in a process sometimes called "social learning" (Kameda & Nakanishi, 2002, Mesoudi 2008; Eriksson &Stirmling 2009). The latter two suggest that humans may learn best through a mix of individual and social learning. This is an interesting conclusion in the context of PBL which asks students to alternate between individual and social learning.

I expect that models explaining animal behaviour are also relevant to human behaviour both because humans are animals and because humans live in societies where food and knowledge are shared. There is a difference, however, between sharing food and sharing knowledge in that food can be consumed only once while knowledge can be shared without decreasing its value to the animal which discovered it. I expect this difference may make information scrounging more prevalent than food scrounging and its consequences more extreme. Human intelligence may make us particularly adept at acquiring information from others.

SCROUNGING IN PBL

In the PBL context, if we consider knowledge as a resource that can be acquired by one individual and then shared by others, then problem-based learning is easily open to scrounging. We define producers as students who prepare themselves prior to group meetings and bring knowledge, ideas and understanding to the group. Those who don't prepare will bring nothing to the group which they could not have contributed prior to encountering the problem. They will simply try to scrounge new knowledge from those who have prepared for the group discussion. Still others may prepare only superficially and thus make a limited contribution to the group. These students will also try to scrounge knowledge from their better-prepared colleagues. This behaviour has been referred to as social loafing (Ingham*et al*. 1974) and its practitioners as free-riders. Here I will define scrounging as learning from the knowledge, ideas and understanding provided by other group members.

We can learn about the prevalence of scrounging that we should expect within PBL groups from studies of animal behaviour. The most relevant point in these studies is that scrounging occurs when resources can be shared and when the animal which finds

the resource is unable or unwilling to prevent others from exploiting its find. These conditions clearly apply to PBL because we encourage students to share their knowledge. Further those who discover the knowledge lose nothing in sharing it with others (unlike resources such as food which cannot be consumed by more than one individual). We should therefore expect scrounging to be common in PBL groups.

My personal observation in fifteen years' experience with PBL is that some students are often less than adequately prepared for tutorials. In our form of PBL we give a group of students a problem to analyse. Because the problem always surpasses their current understanding in their field of study they must analyse it, propose hypotheses to explain the problem and then seek a better understanding of the problem by reading in the subject area. Each student is responsible for reading all the material necessary to understand the problem. Once the reading has been completed the students meet again to discuss what they have learned, to compare their various understandings of the problem, to confirm and to consolidate what they have learned. In general, students come to this second tutorial with various degrees of preparedness. Occasionally a few students appear not to have prepared at all. These students tend to have little to add to discussions. When they do speak they either paraphrase what others have said or repeat ideas which were put forward when the problem was first introduced. Despite their lack of preparation, these students do learn. Evidence for this is the fact that they can paraphrase what others have said. In some cases a student may draw interesting conclusions from what others have said without having adequately prepared himself. This actually contributes understanding to the group. However, failure to prepare usually penalises all group members.

A student who does not prepare adequately before a tutorial will be less able to understand and integrate the ideas presented by peers during the tutorial and also less able to evaluate and criticize statements made by others. This leaves the student open to information cascades (Bikhchandi *et al.* 1998) in which false information presented by one group member happens to be accepted by the whole group as a result of a few uncritical acceptances by some early participants in the discussion. Rieucau & Girladeau (2011) showed than birds can be induced to make poor choices of where to feed if they are shown a video of other birds feeding at a poor quality location. Finally, the unprepared student will be less likely to develop a coherent understanding of the various concepts being studied in a given problem. The student who doesn't prepare hopes to gain an adequate understanding of the subject despite these impediments.

When one or more students within a group fail to prepare adequately the other group members will also suffer. Even if the remaining students are well-prepared the group is more likely to miss certain essential details of a problem. Indeed, the success of tutorial discussions often depends on students presenting different points of view or drawing

conclusions from different sets of information (see Dolman and Schmidt 2006 on cognitive conflicts leading to conceptual change or Savin-Baden 2000 on active participation in legitimate group debates). If some students don't bring the necessary information or level of reflection to the tutorial then discussions may reflect only the idea of a few students with little chance for in-depth analysis. I have seen a few tutorial groups in which one or two students have done the majority of the work with the rest of the group relying on them because they were known to be the brightest students in the class. In the extreme case this gives the role of teacher to the brightest students leaving the others as passive learners. Results from these groups suggest that the passive learners don't learn as well as I would expect, perhaps no better than if they had been presented the same material in a lecture format. Van den Hurk *et al*. (1999) have shown that student-generated learning issues can enrich discussions and improve learning within the study group.

The hard-working students also suffered. Lack of support and of discussion from other group members meant they had to work harder to develop the level of understanding they felt they needed. They were often forced to engage the tutor on certain points because their classmates were unprepared for discussions at an advanced level. The lack of effort by the scrounging students appeared to hurt overall team performance by reducing interpersonal exchanges as suggested by Van den Bossche *et al.* (2006).

It is clear that PBL places students in a position where scrounging knowledge from colleagues can be an attractive option. When students rely only on scrounging they will tend to learn less and they will reduce learning opportunities for others. This reduced performance by the group has a parallel in the animal world; groups in which scrounging is prevalent will likely find less food and fare less well than those which scrounge less (Vickery *et al.* 1991, Coolen, Giraldeau & Vickery 2007). There is some controversy as to whether human groups suffer a similar reduction in learning as Rogers (1988) claims that social learning will evolve to perform no better than individual learning while Kameda & Nakanshi (2003) propose that alternating between individual and social learning will benefit the whole group.

SHOULD WE TRY TO ELIMINATE SCROUNGING?

Based on this discussion it might appear that scrounging can be a serious problem in PBL, but scrounging, in the form of social learning, is an essential component of PBL. Sharing and comparing information, ideas and analyses is fundamental to PBL. We want students to scrounge from one another in the sense that each student will come to the tutorial with slightly different information and possibly quite different interpretations of their information. The discussion, validation and analyses of various students' points of view is in fact a form of scrounging that is essential if PBL is to

foster learning and the use of knowledge. Each student will supplement personal knowledge with what others have found. Students may adopt ideas proposed by others and readjust their conceptual map in a given field based on what colleagues say. All this is a form of scrounging in that it involves taking resources (adopting ideas) which have been found by others. It is all essential to PBL.

Thus we do not want to eliminate scrounging from PBL; rather we would like to ensure adequate levels of producing in order to maximise the combined benefit of individual and social learning. Specifically, we want students to invest sufficiently in individual learning so that their group discussions will promote clear understanding of the concepts being studied.

CONTROLLING LEVELS OF PRODUCING AND SCROUNGING IN SOCIAL LEARNING

Producer-scrounger theory can help us understand when students are likely to invest in producing and when they are more likely to rely only on scrounging. We know that scrounging will increase as resources become easier to share (Giraldeau, Hogan & Clinchy 1990). A list of facts is easily shared. Thus, if the learning objective of a PBL tutorial is to compile and learn a series of facts we can expect many students to rely on others to bring the facts to the tutorial and to share them (many students will not produce). If, on the other hand, we want students to understand concepts related to a series of facts it will be difficult to understand the concepts without the facts so most students will likely at least prepare their facts. If we ask students to use the concepts in order to build something (abstractly or concretely) they will need to prepare both facts and concepts (and probably develop some idea of how they will use them as building blocks). Thus, the level of understanding that we require of our students will influence the amount of effort they invest in individual learning.

We can analyse the situation in terms of the producer-scrounger game by considering the finder's advantage, the gain made by the producer which is unavailable to subsequent scroungers (Vickery *et al.* 1991). When only facts are being accumulated all group members will obtain all the facts during the tutorial. There will be no finder's advantage so we can expect most students not to produce (not invest in much personal learning). Producers (=finders) appear to be losers in this context because they do the work but gain no more than their scrounging colleagues. When prior personal learning is necessary to understand complex concepts and processes the finder (the student who invests in personal learning) has the advantage of better understanding and evaluating subsequent group discussions. This situation should encourage producing (investment in personal learning) because the finder's advantage can be quite large.

This situation takes us back to the reasons why teachers adopt PBL. PBL is appropriate to learning complex concepts which will be put to some use (either abstract or concrete). PBL will likely be inefficient if the objective is simply to accumulate information. It is unclear when the accumulation of information without context or use might be a legitimate learning objective. I raise the point here because some university courses seem to assume that knowledge should be accumulated and that a student's performance in a course should be measured solely by the amount of knowledge acquired (see Mayer 1999 for a discussion of information transfer versus construction). This approach is not well-served by PBL. I would argue that this approach is not appropriate to higher learning which should instead favour understanding and use of acquired knowledge, an ability to synthesise this new knowledge with old and an ability to criticise ideas based on the understanding acquired. These are objectives which can, and should, be developed in PBL (Kolmos and de Graaff 2003, Savery 2006) .

There are a number of strategies which can be adopted to favour social learning without suffering from excessive scrounging. Importantly, students should understand what is expected of them. They should realise that they will be expected to understand and use the ideas which they acquire during the course. If they will be required to produce something (an object, an argument, a treatise …) they should have a clear set of goals (Forsyth 2010) in advance so that they can adjust their personal study as a consequence. However, requirements should not be too rigid because allowing students to make choices increases their motivation to learn (Kolmos and de Graaff, 2003).

The evaluation of the student's performance should also reflect the learning objectives. There is no point in telling students that they must develop a deep understanding of the concepts in their field if course evaluations are based on exams which test the ability to remember facts. Students will adjust to learning objectives based on the evidence they receive about what is important in their evaluation. Biggs and Tang (2011) argue for the "constructive alignment" of objectives, learning opportunities and evaluation in order to obtain quality learning.

Group dynamics can also influence the way in which students prepare for tutorials. Making students responsible to each other (creating mutual dependency Fjuk and Dirckinck-Holmfeld 1997) within tutorial groups can generate social pressure which will motivate some students to prepare more than the strict minimum. If students don't prepare sufficiently for tutorials, tutors can speak to them privately or they can point out that poor preparation hurts not only the poorly-prepared individual but also the entire group.

Formal evaluation of a student's contribution to the tutorial group can discourage social loafing (Forsyth 2010). Most PBL programmes aim to create autonomous learners. In

these cases it is appropriate to evaluate the extent to which a student has learned personally prior to a tutorial. Students should understand that they expected to acquire not only understanding of the material but also the ability to find and synthesize knowledge on their own. Another common aim is to encourage students to work well in teams. In such cases it is appropriate to evaluate the student's contribution to the team effort. Such evaluations send a message to the student that personal preparation for a tutorial is important. Evaluations can be made by tutors, if they are involved in the tutorial, or by students. (See Papinczak *et al.* 2007 for a detailed analysis of the effects of peer evaluation in problem-based learning). My experience in a programme which uses both approaches is that students are often more severe than tutors in their evaluation of colleagues who do not pull their weight. These evaluations require some care in order to evaluate exactly the aims of the programme and encourage students to attain them. For instance it is important to evaluate the depth of understanding presented by a student more than the quantity of information brought forward.

It is important to note that certain benefits of PBL, such as the ability to research a topic and identify relevant material cannot be scrounged. Failing to produce (to accomplish the research phase of the PBL) in preparation for a tutorial will prevent a student from acquiring this essential skill. Students who have the goal of learning how to learn should thus be less tempted to scrounge from others what they should be preparing for their group.

In the context of producer-scrounger games, evaluating contribution to a group produces an additional finder's advantage. The student who brings interesting material to a tutorial not only gains a better understanding of the material (as discussed earlier) but receives a bonus based on a positive evaluation of the student's contribution to the group.

Evaluation of group performance can also encourage students to contribute more to their group (Forsyth 2010), to take responsibility for their work within the group and thus promote group cohesion. (See Van den Bossche*et al.*2006 for a discussion of the benefits of group cohesion). I suggest that such evaluations should be based on a scale which measures how well the group has attained the objectives of the exercise rather than a comparison of results among different groups. The latter approach may prevent groups from sharing resources which would be counterproductive to learning. In addition, it promotes an ethic of working more than others rather than working to attain a goal.

IMPOSING A COST OF SCROUNGING

Another possible way of encouraging producing is by imposing a cost to students for access to their colleagues' knowledge. For instance, students might be required to prove that they have prepared for the tutorial before joining in discussions. Students who could not prove that they had prepared sufficiently could be excluded for all (or part of) the tutorial session forcing them to rely only on their own personal work. This could act as a double-edged sword for both the student and the educator. The student who doesn't prepare for a tutorial will be obliged to rely only on personal learning. Since this was inadequate the student will have to work harder on individual studies to compensate for the lost access to group study. This additional personal work should be enough to regain eligibility to re-join the tutorial group.

The opposite result is also possible. Mesoudi (2008) showed that when a cost is imposed on access to social information, people tend to rely more on personal information. In this case, imposing a cost on access to tutorials could encourage some students to abandon the tutorials in favour of working on their own. It would be particularly disappointing if some of the harder-working students were to drop out of tutorials. Mesoudi's work may not, however, apply to PBL because his subjects acquired personal information at no cost compared to costly social information. In PBL, personal information comes at a high cost of effort invested compared to the acquisition of social information. Students may then compare the cost of personal vs social information when deciding how to study. Any attempt to impose costs on access to tutorials should take this into account.

THE EFFECTS OF GROUP SIZE

One might be tempted to increase the size of a study group in order to compensate for the lack of preparation by some students; suggesting that if each student works less, then having more students present will compensate for the lack of effort. (Miflin 2004 provides a recent analysis of the importance of group size in PBL). Producer-scrounger theory (Vickery *et al.* 1991; Coolen, Giraldeau & Lavoie 2001) shows that this approach is not likely to work because as group size increases the expected equilibrium proportion of producers decreases. Interestingly, Vickery *et* al. (1991) predict a nonlinear decrease in production which fits well with Ingham*et al.* (1974) observation that social loafing increases nonlinearly with group size. This increase in loafing (decrease in individual study effort) can occur because a student will feel the personal share of the load is smaller as the group gets larger thus justifying less effort in personal preparation (Forsyth 2010). Larger groups may also discourage producers in other ways. Each student has less time to participate as the tutorial group gets bigger. Students in a

large group may find they don't get enough time to express their ideas or that their idea has already been described by someone else. They may then use less effort to prepare for future tutorials. This phenomenon underlies the importance, regardless of group size, of requiring each student to contribute to the tutorial. When students present redundant material they often use slightly different language to express themselves. This can be used by a tutor to generate a discussion of the point in order to attain better understanding. Generating this discussion will have the side effect of confirming the value of the point made by both students (despite the redundancy). This will encourage students to keep seeking new ideas and to express them in discussions. Tutors can encourage students to give their own point of view on a subject covered by someone else in order to foster both deeper understanding and personal responsibility for thorough preparedness. For autonomous tutorials (without tutors) students will need to be trained to seek deeper understanding by exploring alternate points of view even when differences are slight.

MOTIVATION

Motivation drives students to learn. If students enrol for higher education we assume they do so because they want to learn. Why then don't they invest all their time in studying? I think the answer is at least two-fold. First, students have other things to do in their lives including eating, sleeping, and travelling to and from school. A normal student will also invest in social activity, exercise, and possibly employment or community service. All of these require time. This time will not be available for the study of problems set by a PBL tutor. We need to consider producing and scrounging in the light of these other activities and the relative importance that the student gives to learning in a daily time-budget. Some of the above activities are more important than learning. Certainly failure to eat or sleep will have a negative effect on a student's health (as well as on the ability to learn). So we can't expect learning to be the sole consuming passion of a student's life. Rather, we want to encourage the student to value learning highly enough to allocate sufficient time to studies even at the expense of such things as social activities, employment etc.

This brings us to the other part of our answer to the question of why students don't spend all their time studying. Sometimes studying is boring. The issue for PBL is to produce problems which will induce students to invest their time in searching for solutions (or at least better understanding). I have heard colleagues say that the problems in PBL are just scenarios which require students to study. They should be much more than that. Problems should challenge and engage students, generating a desire to know and to learn (see Mauffette, Kandlbinder & Soucisse 2004, Kolmos and de Graaff 2003). When students are motivated in this way they will increase the priority for learning in their daily time budget and seek better understanding of the problem.

When problems are boring, students are more likely to trade-off their study time to some more interesting activity and become PBL scroungers rather than PBL producers. (Van den Hurk *et al*. 1999 provide an analysis of the effects of student involvement in tutorials, study effort and learning).

Thus PBL practitioners have two ways to discourage scrounging: make the problems so interesting that students will prioritise their studies and make it clear that students will be evaluated on their preparedness for tutorials.

ALL STUDENTS ARE DIFFERENT AND CAN BE EXPECTED TO REACT DIFFERENTLY

My discussion so far has treated all students as equal. But every student is different (see Dillenbourg 1999 for a more thorough discussion of this point). Students differ in their abilities to read, to assimilate, to remember, to integrate and to explain that which they have read. These differences may lead some students to produce more than others. When birds forage in flocks those that are less able to find food for themselves are more likely to scrounge food from others than those who find food easily (Giraldeau & Lefebvre 1986, Hamilton 2002; Beauchamp 2006). We can expect a similar situation in tutorial groups where the quickest learners will likely come to tutorials prepared and slower students will be less well prepared. The latter will rely on the expertise of the top students in order to learn "socially" during the tutorial.

This is a pattern which I see often in tutorial groups: the top students take the lead in discussions and the weaker students follow them. This is particularly dangerous for the weaker students because they may lack the prior knowledge to keep up with the rest of the class. (Dillenbourg 1999 also addresses this situation). Tutors should be vigilant to avoid this situation. They can insist that all members of the group understand a given concept before moving on to new material. The ill-prepared student who is unable to keep up may be forced to do some additional reading following the tutorial. This sends a message to the student that it would be better to prepare before the tutorial than to be embarrassed in front of peers and forced to do the work later.

Another approach which can encourage weaker students to prepare properly for their tutorials, rather than merely scrounging, is to encourage them to improve on their weak points and to point out any innovative ideas they bring to the tutorial. The positive feedback should encourage them to try to repeat their success. In addition, if contributions to the tutorial are being evaluated, the evaluator should account for the student's capacity for personal learning when judging the student's success. To be harsh with a slow student who is working hard but having trouble keeping up with the others

can be very discouraging. Unjust appraisal of a student's work can undermine motivation and lead to a lack of future effort.

Individual differences among students can lead them to propose a division of labour where some students take on the responsibility of bringing new information and ideas to the group while accepting that others look after administrative details such as structuring communication within the group, communicating with the tutor and submitting final products. This appears to be an efficient use of manpower from the point of view of students who have a task to accomplish, but it isn't an efficient way to learn. Students will tend to refine their strengths while remaining weak in other aspects of team work. Further, learning will depend mostly on a few stronger students; weaker students may get credit for accomplishing other tasks but will be at risk of not learning the concepts under study. Tutors can ban such divisions of labour or they can attribute the non-academic roles randomly to group members for each problem and then insist that everyone is equally responsible for the academic aspects of the problem.

CONCLUSION

The sharing of ideas, which can be looked at as a form of scrounging, is essential to forms of PBL which use social learning. However, social learning is susceptible to levels of scrounging that can degrade the learning experience when students rely excessively on the work of others in order to learn rather than producing for themselves. A student who fails to prepare adequately contributes little to a group with the result that both the student and other group members will probably learn less. Educators can limit the negative effects of this scrounging in a number of ways. If problems are stimulating and require analysis (not just the accumulation of facts) students are more likely to make an important contribution to team tutorials. Social pressure and evaluation of individual effort and group results can also encourage students to produce for their group rather than only scrounging what others have learned. In all cases tutors should be attentive to each student's abilities and contributions in order to encourage realisation of the student's full potential in the PBL environment.

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[1] This text uses masculine pronouns to refer to people in order to make it easier to read. It should be understood in all cases that the people involved may be either men or women.

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