Chapter 6
Making Students Responsible for Their Learning – Empowering Learners to Build Shared Mental Models

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Previous chapters have focused on how higher education can prepare learners for an accelerating world in which workers need strongly developed self-regulatory competences. Helping learners to hone these competencies is one of the challenges of higher education. This chapter will describe attempts to empower students in a problem-based learning (PBL) environment using information communications technology (ICT) tools that support them as they take charge of their learning.

Traditionally, the task of motivating a learner has been associated with setting challenging goals. Although goal setting induces positive learning effects (Hattie 2009), recent meta-analyses (Burke and Hutchins 2007; Blume et al. 2010) suggest a myopic downside of goal setting – it can impede creativity, transfer and adaptive expertise (Ordóñez et al. 2009). Indeed, Bruns et al. (2013) showed that promoting a mastery orientation in learners who try to improve their performance in an area of weakness can lead to more transfer than goal setting. Results like these are in line with self-determination theory (Ryan and Deci 2000), which proposes that autonomy, relatedness and competence help motivate people to engage in (learning) tasks. Hence, by empowering learners an educator can hope to boost their intrinsic motivation.

Self-organizing learning environments (e.g., Mitra and Kulkarni 2010) provide a learner with maximal autonomy. However, providing autonomy by simply exposing students to learning resources does not imply they will know how to learn from them (e.g., Kirschner and Van Merrienboer 2013). When establishing a self-regulated learning environment, educators who value learner autonomy need to reflect on learning needs, learner competencies and balancing teacher- and student-centered learning activities. Yet, as Mitra's Hole in the Wall experiments

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illustrate (http://www.hole-in-the-wall.com), information technology can reward autonomous learners. Technology and the internet even change the nature of learning itself. For instance, Sparrow et al. (2011) showed that people become expert at remembering where to find information without being able to access that information in biological memory. The Internet extends into transactive memory, our shared store of knowledge.

This ever-expanding transactive memory system offers opportunities to learn continuously, both formally and informally, individually and in groups, synchronously and asynchronously. For instance, learners can use various tools (e.g., micro-blogging tools like Twitter™, bookmarking tools like Diigo™, FaceBook™, Google+™, LinkedIn™) to blend informal learning with formal training. Integrating informal learning into formal training activities is likely to increase training effectiveness (Salas et al. 2012; Sonnentag et al. 2004). Continuous learning is vital in many work settings, and knowing how to offer support for continuous learning will be a key priority for higher education institutions looking for new target groups, such as, for instance, groups of working professionals, whose time availability is fragmented and who therefore seek blended postgraduate learning opportunities.

Although technology has the potential to radically change learning spaces and empower learners, online education is more often teacher- than student-centered (e.g., Savin-Baden and Wilkie 2006). Standardized virtual learning environments tightly control teaching and learning. Participants in most MOOCs – on a diet of digital lectures and multiple choice quizzes – often testify to this. Recently, however, e-learning researchers have begun to address induction of confusion (Lehman et al. 2012) and self-directed information acquisition (Gureckis and Markant 2012). This development meshes with visions of future learners hanging out, messing around and geeking out in virtual collaborative study groups (Thomas and Brown 2011). Technology then would enable a culture of participation in which learners create new meaning by sharing contributions with a group of peers and seeing others build on these contributions. According to Thomas and Brown, the "collective indwelling" which can be observed among participants in games like World of Warcraft, forebodes the future of learning. Such a culture of participation in which learners are productively confused in order to trigger self-directed information acquisition also happens to lie at the heart of many student-centered learning methods like problem-based learning.

6.1 Problem-Based Learning

Problem-based learning (PBL) allows students to learn from each other while they co-construct meaning. Active, constructivist, and interactive learning approaches like PBL are believed to yield important cognitive and motivational benefits (Chi 2009). PBL motivates students to integrate new information with prior knowledge and personal experience that is activated by discussing authentic problems in small groups. Ideally, students should find positive value in learning materials, they should have a sense of achieving a worthwhile purpose, and they should feel confident about their ability to study or solve the authentic problem. Students would build new knowledge on prior knowledge, cued by an authentic problem. Assuming that prior knowledge is accurate and activated at the right moment, students would be able to form knowledge structures that they can later retrieve and apply effectively in real world settings. During a typical PBL tutorial group session (cf. Dolmans and Schmidt 2010), students clarify unknown concepts in the problem description, formulate a problem definition, and engage in problem analysis by brainstorming and then elaborating on and organizing the results of the brainstorm. Next, learning goals are formulated and students start their individual study. On returning, students report their findings and try to synthesize and integrate new information. Positive effects of PBL on graduation rate, study duration and practical and interpersonal skill development have been reported (Schmidt et al. 2009; Schmidt 2010).

It would seem that tutorial groups in PBL offer a safe and challenging environment in which students can debate and critically analyze contributions of fellow students and writings of experts. Task-related cultural or cognitive learner differences introduce heterogeneity, which can enrich the exchange of ideas and may stimulate creativity. Finally, by stressing constructive interaction either with experts or with peers, participative learning methods empower students to take control of their learning and to self-regulate, thereby fostering the growth mindset (Dweck 2006) that many believe to be a key quality of tomorrow's lifelong learners.

Unfortunately, conditions for group work and cooperative learning in a PBL environment are often suboptimal (e.g., Dolmans et al. 2001). Groups are less effective than they could be, for many reasons. For instance, when groups are large, free riders may fake active involvement. Information exchange is often biased towards common knowledge (cf. Mesmer-Magnus and DeChurch 2009). Information can be omitted from group products, because individuals choose to withhold it or because groups fail to incorporate it (Ekeocha and Brennan 2008; Stone et al. 2012). In diverse PBL groups, students often do not interact fluently, especially when they have low verbal ability or when group diversity creates tensions. Group members are less willing to share information with members they perceive to be different (cf. Van Knippenberg et al. 2004). Problem analysis in small groups can be frustrated because taking turns (production blocking) interferes with knowledge activation and idea generation. The resulting cognitive failures affect brainstorming persistence, enjoyment and productivity (Nijstad and Stroebe 2006). Perceived learner control may not be conducive for a mastery orientation: although in theory students have ample freedom to select learning goals, student expectations regarding assessment and restrictive curricular and module goals can induce a performance orientation. Students then may "game the system", especially if they lack a sufficient self-drive or if they dislike the subject matter (Baker et al. 2008). Finally, being graded not only seems to reduce autonomous motivation and promote performance goals, but also seems to trigger performance-avoidance goals (that make learners try to avoid incompetence) rather than performance-approach goals (that make learners try to attain competence; Pulfrey et al. 2012). Not surprisingly, problem analysis and group discussions in problem-based learning are often superficial or incoherent (e.g., Visschers-Pleijers et al. 2006). To summarize, a student-centered learning environment does not guarantee effective, active, self-regulated learning.

6.2 Blending Problem-Based Learning

ICT tools can improve group work and its outputs. For instance, blogs or wikis can facilitate knowledge sharing (cf. Wenger et al. 2009). Online learning environments allow students to exploit all that the Internet affords during self-directed information acquisition. Such tools can be utilized in blended PBL, which combines online delivery of content with face-to-face activities. By blending PBL one can contextualize learning problems.

Although PBL is believed to motivate students by asking them to work on authentic problems, students rarely explore how problems relate to current events. Web 2.0 tools may entice students to discover relations between teacher designed PBL problems (i.e., content that is designed to trigger reflection on either professional practice or current developments in research) and the 'nowness' (Gelernter 2010) students are immersed in when they use micro-blogging tools like Twitter™. PBL arrangements might include both asynchronous and synchronous tools for communication and collaboration. Asynchronous tools allow team members to contribute anytime and anyplace to an ongoing search for answers to learning objectives. Thus, more feedback can be given by peers, tutors and teachers than during synchronous (i.e. simultaneous or collocated) exchanges. Tools supporting synchronous communication can support collaboration in virtual learning environments. Synchronous communication seems to benefit from a whiteboard and/or visual organizer to record group discussion, to focus negotiation and to ensure common ground. Ideally, synchronous and asynchronous tools help students collaborate within and beyond specific time slots that are reserved for face-to-face or virtual tutorial group meetings.

Several tools could improve the outcomes of tutorial groups. At first glance, idea browsers or creativity support tools might be deployed to enrich problem analysis (DeRosa et al. 2007). However, one should not confuse the problems that students face in PBL with the hard, wicked problems for which idea browsers seem to pay off nor should one confuse students in PBL groups with members of intense problem solving teams (cf. Rentsch et al. 2010). A pilot using a creativity support tool during brainstorming confirmed that first year psychology students who used idea browsers considered the problems they analysed to be less interesting than students in control groups, who participated in regular PBL brainstorm sessions. Here limited time resources, the tensions between divergent perspectives and shared knowledge building (cf. Puntambekar 2006), and the absence of creativity requirements in PBL appeared to preclude a satisfactory use of idea browsers (cf. Unsworth and Clegg 2010).

6.3 Visualizing Group Output: Mind Mapping

Several factors support the assumption that visual organizers can improve outcomes of PBL group work. Mapping can prevent a group discussion from becoming superficial, incoherent, or biased towards common knowledge. Concept maps (Novak 1998) have been shown to contribute to student achievement and yield valuable insights into group knowledge representations (Hattie 2009; Mohammed et al. 2010). Maps invite a learner to relate new information to prior knowledge and to determine whether and how concepts relate; to determine the relevance of each new addition to the map before adding a concept; and to become more aware of knowledge gaps when constructing maps (Hilbert and Renkl 2008). Maps could also facilitate exchange of ideas in groups: they can challenge perceptions and help negotiate meaning. Visual representations offer continuous (visual) access to products of other team members, which can serve as memory cues or competitive stimuli. When a group member explicates a concept in a map, mental models of other team members are changed, which in turn can trigger novel ideas and further enrich the map (Rentsch et al. 2010; Van Gelder 2003).

Maps can be constructed when learning activities are initiated (e.g., during idea generation and problem elaboration) and when group members synthesize and integrate newly found information. For individual students, maps may also provide directions for self study and serve as an advance organizer for the reporting session, and facilitate the subsequent reporting of findings. Finally, group maps can provide teachers with detailed feedback on learning processes and outcomes. In a previous study (Fonteijn and Frerejean 2010), mind map construction and manipulation in a collocated group were compared to traditional note taking by a scribe. In the mapping condition, a scribe controlled a digital whiteboard, entered concepts during brainstorming, manipulated map nodes during clustering and revised the map or created a new one during problem synthesis. Students in tutorial groups using mapping tools were significantly more satisfied with problem analysis and synthesis than students in control groups. Overall, a large majority of students indicated they would like to continue using maps during the reporting phase of PBL sessions. According to students, discussion content was better organised and more structured, and more focussed on relationships between concepts. In addition, students reported that group members were more active and contributed more to discussions. Meetings with tutors confirmed student perceptions, and most tutors were pleased with the PBL process in the mapping condition. Unfortunately, most students did not use maps during individual study. Some students felt that mapping slowed the group and that the scribe was sometimes too preoccupied with the map. Mapping software that allows for multi-user interaction may ease the note-taking task.

Thus, ICT tools can help support PBL group work, either online or face-to-face, helping learners to develop (virtual) collaboration competences in the process. However, educators balancing virtual and collocated group work need to be aware of the different requirements of different modes of collaboration, as research on virtual teams shows.

6.4 Virtuality

Recent literature points to trade-offs related to the level of virtuality of team collaboration (i.e., the extent to which we cannot physically experience actions of team members). In a meta-analysis Mesmer-Magnus et al. (2011) concluded that high levels of virtuality hinder information sharing, while low levels improve it. Virtuality also improves sharing of unique information, but hinders openness of information sharing. Ortiz de Guinea et al. (2012) found that virtuality can relate positively to conflict, and negatively to communication frequency, knowledge sharing, team satisfaction and team performance. However, Ortiz de Guinea et al. showed that negative effects of virtuality held for short-term teams. These effects weakened or disappeared in long-term teams.

Martins et al. (2004) also demonstrated that time moderated the effect of virtuality on team performance. Social information exchange disappeared and satisfaction rose as time passed. Other moderators identified by Martins et al. included type of task and social context. For instance, virtual teams outperformed face-to-face teams on idea generation tasks. Face-to-face (F2F) teams outperformed virtual teams on negotiation and intellective tasks, although this effect was weaker in long-term teams. Regarding social context, cooperation and communication, openness improved virtual team performance. Liking a team member impacted evaluation of team member contributions in F2F groups, but not in virtual groups (cf. Ren et al. 2012).

Media richness (Daft and Lengel 1984) can affect team effectiveness, communication, team commitment, levels of trust and social climate. Furthermore, virtual groups often need more time to reach a decision, but virtuality may help a group to develop better goals. Data on team performance measures are mixed. Virtual teams are often less satisfied with team performance (except all female teams, or teams engaging in brainstorming). Finally, group composition tends to be less salient in virtual groups. For instance, Sproull and Kiesler (1986) showed that groups with reduced social context cues (i.e., virtual groups) reported fewer status inequalities. This finding suggests that tutors in virtual PBL tutorial groups might be less inclined to assume authority. Mixed results have been found regarding effects of gender, national culture and personality on virtual team performance. Martins et al. (2004) noted that national culture can negatively impact coordination and communication; extraverts are more likely to participate in virtual teams; technical expertise in a group can affect team success and group member trust; and female members of virtual teams perceived their teams as more inclusive and were more satisfied with the team.

Regarding virtual collaboration competencies, Hertel et al. (2005) stressed the importance of certain taskwork skills (e.g., conscientiousness), teamwork skills (collaboration), telecooperation skills, self-management skills, intercultural skills and interpersonal trust. Finally, Krumm and Hertel (2013) suggested that supporting other team members is less important in virtual teams than in F2F teams, while working conscientiously, as well as leadership, analysis, interaction and presentation skills seem more important in virtual teams than in face-to-face teams. The above results suggest constraints on successful implementation of online and blended PBL and inform the development of evaluation instruments for online PBL sessions.

6.5 PBL Online

In a second year module on cognitive science and a third year module on persuasion in a bachelor course in psychology, 36 students engaged in synchronous online PBL sessions. Students were familiarized with a webconferencing tool, (Elluminate™), that offers presence information of participants, a chat window, and a digital whiteboard. Third-year students ($N=14$) also used wikis and blogs to facilitate knowledge sharing. Second-year students ($N=12$) who volunteered to participate simultaneously logged contents of their discussions in mind maps (using a mind mapping tool that supports multi-user interaction and that has record/playback functionality. Evaluation results of both pilots showed students were generally very satisfied with the experience, most notably with the quality of group work, communication climate, and quality of feedback. Students indicated that the virtual learning environment improved their learning (all evaluation item means were 4.0 or greater on a 5-point Likert scale). Students spontaneously noticed various differences between online and traditional PBL, including an increased use of visual aids.

In a follow-up experiment, 24 second year psychology students volunteered to engage in online PBL. They again used various tools to facilitate information sharing (including Elluminate™ and MindMeister™), both synchronously (during online tutorial group meetings) and asynchronously. Questionnaires probed how online teamwork differed from F2F tutorial group interactions and how the various tools (digital whiteboard, chat, audio channel, presence information, mind maps, etc.) supported cooperation. Questionnaires mostly contained items that had been validated in the literature. Students in the two online groups were compared with controls who were matched on gender and nationality. All students were asked to answer questions on age, gender, nationality, distance between home address and university, ICT skill, confidence to work with ICT, personality characteristics (Van Emmerik et al. 2004), need for structure (Thompson et al. 2001), Core Self-Evaluation (Judge et al. 2003), importance of group goals (Jackson et al. 2006), and trust (Staples and Webster 2008).

The first tutorial group session occurred face-to-face. This allowed tutor and students to get familiar with each other, provided opportunities to train the participants in the use of the tools, and enabled detection of technical imperfections (e.g. poor audio equipment). After each of the nine subsequent tutorial group meetings scheduled over the course of seven weeks, students answered a questionnaire gauging self-reported cognitive functioning and motivational impact of the tutorial group (Singaram et al. 2010), perceived contribution to tutorial groups of self and others, perceived quality of the tutorial group, satisfaction with interventions by chair and tutor, and quality of preparation. In addition, students were asked to mention incidents that had a positive or negative influence on group outcomes.

Tutors graded participation of each student and the quality of problem analysis and synthesis. Earlier studies (e.g., Hofgaard Lycke et al. 2006) suggest that tutors in online asynchronous PBL settings pay more attention to work organization and less to content or subject matter. Note that content-related tutor interventions seem more likely to occur when tutors construct a teacher identity and act as authority figures in online space. Tutors were asked to log their experiences after each session in order to shed light on when tutors feel they need to intervene or direct the discussion as opposed to remaining silent and merely providing hints. In addition, data allowed comparison between tutoring in a collocated group and tutoring in a synchronous online group.

After the course ended, another questionnaire probed confidence and skill at working online, team coherence (Wendt et al. 2009), satisfaction with the (online) group work and process, and trust. Open questions probed what students valued, what was difficult, the quality of communication in the group, reasons for (dis) continuing online PBL, and suggestions for blended learning set-ups. In addition, exam scores were collected.

6.6 Student Data

Hardly any significant differences emerged between students in online and face-to-face groups. Hence there seems to be no reason to assume student volunteers in experimental groups and students in the control groups differed strongly in personality, importance of group goals, ICT skills, etc. One item suggested a difference: students in the online groups gave a slightly lower score on *I trust other group members* ($m = 2.3$, $sd = 0.77$, $N = 19$) than students in the face-to-face groups ($m = 2.9$, $sd = 0.84$, $N = 22$; $t(39) = -2{,}22$, $p = 0.032$). Trust-related items in the post-test, however, showed no significant differences between conditions. Students in the online groups scored slightly lower on the item *I am positive about working in a group* ($m = 2.9$, $sd = 1.16$ vs $m = 3.5$, $sd = 0.81$; $t(39) = -1{,}93$, $p = 0.062$). This finding seems to suggest that dissatisfaction with tutorial groups may have triggered some students to volunteer. Students in the virtual condition did not perform better or worse on the final exam, nor did they give higher or lower ratings to the tutor.

A few significant interactions were found. First, in the face-to-face (F2F) condition trust in other members was positively related to the grade, yet trust did not affect grades in the virtual condition. This could be due to the fact that in the virtual conditions groups have members with lower trust in other members. Next, Core Self-Evaluation and student participation seemed to have a stronger effect on student perception of group quality in the F2F group than in the virtual group (cf. Sproull and Kiesler 1986, for findings on reduced inequality within groups in which social context cues are attenuated).

After completion of the module, 15 students in the online groups commented on their experiences. Almost all students appreciated the travel time they saved by participating from home. Acquiring new skills, learning to communicate and to share information more effectively in groups, using mind maps and whiteboards to discuss visual materials, and the opportunity to review recorded sessions were listed most often as advantages. Several students mentioned getting a fresh perspective on learning in groups:

#4 I guess that this experience is really interesting and helpful for future situations, workplaces and possibly for considerations how to design future workplaces.

#16 you learn what is necessary (and maybe underestimated) for a group working efficiently

Other perceived benefits were more directly related to the PBL process:

#10 sharing of information is easier – there are notes of the discussion – you can playback a recorded session

#12 if questions arise, using google speeds up the process and saves a lot of time.

Five students felt online tutorial groups were more demanding:

#9 it is quite chaotic balancing both the elluminate program, your notes, the slides, the whiteboard etc. at the same time

#4 another aspect which was difficult for me was the ability to concentrate on the spoken words because during the first meetings I realized that visual contact really can be helpful for this. Gestures, mimics and so on are important cues which help you to keep on the task continuously.

A few students felt it was easier to concentrate in online groups, however. Similarly opposing comments were heard after online lectures. Some students felt they were distracted more easily, while others said they could focus better without typical background noise in a lecture hall.

Five students felt alarmed by uncertainty about what others were doing:

#1 You cannot see what others are busy with: if no one is talking, why is it the case? Are they checking their notes or are they not attending?

#7 it was not possible to use nonverbal feedback from group members to evaluate if they understood what I tried to explain or if I talked to much about unimportant stuff. (..) Often I was not sure if my contribution was important enough or if someone else could better talk about the stuff. With nonverbal feedback it would be easier to evaluate this.

#11 Sometimes I felt it was a shame that if I had just posed a question or had told something, a long silence was heard. Then I wondered if anyone was actually listening, or if I was just talking to my laptop. (..) It is very easy to say absolutely nothing during a group meeting or even to just walk away, that is not how it is supposed to be.

Some were more relaxed:

#4 I guess communication could be more fluent. (..) But you always need time to find the important notes when a question is asked f.e. and this takes time, of course.

Half of the students mentioned they experienced a higher threshold for participating in a virtual group than in a F2F group. They typically attributed this to lack of nonverbal feedback. One student felt her shyness was getting in the way of participating:

> #9 [This was a] confirmation that online peer anxiety is bigger than real life peer anxiety. (..) My reasons were that I'm quite shy as it is to speak up in a group I do not know, and this became even harder online. (..) It could be lowered by chatting, I never had any problems with that, only the speaking part.

Three students suggested the content of the module inhibited their participation, e.g.:

> #16 I also felt a higher threshold for participation, but I cannot say that it is only due to the online meeting. I think a reason for me was the topic of the course and the feeling that I did not understand the texts that well so I could report them to others.
>
> #5 It was interesting, and should be used in more courses, but preferably in more easy ones:)

Several students mentioned the above problems lessened over time:

> #5 At first it was a threshold to press the button, but it got better so the explicit communication was in the last meetings quite the same as in a normal group
>
> #8 [Interaction] was okay and improved during the weeks
>
> #2 The threshold to speak lowered as I began to feel more at ease in the group, so this may be a solution: taking care that there is a nice group dynamic (so) nobody needs to feel shy.

A few students experienced production blocking, e.g.

> #11 When someone explained something, it was not easy to ask a question. You (..) had to wait more often until someone was completely done talking. Then the question often was not relevant anymore.

And a few comments focused on participation, e.g.

> #2 some students refuse to collaborate in an online meeting, because there is no social pressure

Answering the question what was difficult, someone mentioned:

> #1 How to motivate other members to participate. Asking for feedback.

Two students suggested using Skype or webcams to enable participants to see each other. Other suggestions for improvements focused on social climate:

> #3 having everything online would necessitate more social gatherings of other sorts for (making up the) lack of real-life contact with other students.
>
> #5 maybe knowing the people better, you are talking to would help, and starting in small groups, where everybody has to say something to practice and then melt these small groups together (like in the 2nd prediscussion).

Students were also asked to indicate whether and how to blend virtual and F2F activities. A large minority preferred a mix of online and face to face meetings. A few students preferred to have all meetings online; one student did not want any further online meetings. Those who preferred a combination either opted for one or more F2F sessions, or a team building session to kick off, followed by online meetings, or they preferred an intermittent schedule, e.g.:

#15 I would alternate two online group meetings and one face-to-face meeting. So we could clarify things in the face-to-face group that did not become clear during the past two meetings.

Overall, most students noticed positive and negative aspects of online experience.

#1 I think it is a great opportunity but its success depends a lot on its group members (even more than in "normal" groups).

#13 You have to weigh advantages and disadvantages. When people learn to deal with it better, I think it works better than a regular tutorial group.

6.7 Tutor Data

Following each session tutors rated the quality of individual students' contributions. In addition, they estimated the number of times they intervened, regarding either process or content of the discussion. They also rated liveliness of interaction, performance quality of the chair, and quality of problem analysis and final discussion. No significant differences occurred between conditions, except for two items. First, students in online groups provided lower ratings for *How lively was the interaction in your group*? (online condition: $m = 7.4$, $sd = 0.98$; F2F condition: $m = 8.2$, $sd = 0.62$; $t(34) = 2.85$, $p < 0.01$). Additional tutor comments suggest that this lower score was related to lack of fluency (silences, poor use of feedback icons, technical problems) and unbalanced participation. The second item was *Estimate how many times you contributed to the session by commenting on group process or procedures* (online condition: $m = 2.8$, $sd = 1.5$; F2F condition: $m = 7.2$, $sd = 5.6$; $t(34) = 3.28$, $p < 0.01$; by comparison, tutors intervened by explicating content 2.9 times in the collocated group, and 2.2 times in the online group). Thus, tutors in virtual groups intervened less often than tutors in F2F groups. Tutor comments below are in line with this result, and suggest students were relying less on tutors in virtual groups.

AS1 (tutor A, Session 1) I was a lot quieter than in a face-to-face group; it was easier to let silences last and let them solve it themselves

AS2 like last time, I did not feel the need to intervene. I was able to think ahead and prepare pictures they needed later on.

AS5 This time, the group worked very autonomously so I did not have to do much. I gave feedback via icons and via chat; that was convenient because you do not disturb anyone (talking) but still give confirmation

AS8 today, I let them be and only intervened when they really got lost, which is easier in an online-group because no-one stares at you (to provide an answer)

Tutors had to adapt to the lack of nonverbal signals as well:

BS8 questions more often need a YES/NO reply to be able to get a more fluent discussion – this goes against the grain of a group discussion among psychologists

BS7 remarks from three students on being busy with another assignment and having prepared only one text, make me a bit more skeptical in the online group (without visual feedback in the form of notes on the table) than in a F2F group

AS6 it is more difficult to see if someone really understands or not. In the control group I can judge from the faces if someone really gets it or not, so in the online group I have to ask if they really understand.

The last comment meshes with two significant interactions. First, in the F2F condition, tutor ratings of student participation dropped more sharply with increasing student shyness than in the virtual condition. Similarly, in the F2F condition, participation ratings rose more sharply with student Core Self-Evaluation (CSE) than in the virtual condition. The dampening of the effects of shyness and CSE on participation ratings in virtual groups is in line with studies that suggest removal of social cues reduces within-group differences (e.g., Sproull and Kiesler 1986).

Technical problems were minor. Tutors noticed a few brief episodes of compressed speech and sometimes a connection with a group member was lost for a short time. These technical difficulties sometimes had unexpected effects, e.g.:

BS2 when a complaint on audio quality made the group temporarily switch from audio to chat, the result was that students who until then were invisible during the discussion suddenly started to contribute

In one instance, a participant could not use her microphone in Elluminate™, and compensated by participating via chat and the online mind mapping software. At another time, a server failure temporarily ended the webconferencing session, yet within minutes students autonomously reconvened on FaceBook™ and continued their discussion until the server was up again.

Quality of the mind maps varied. Sometimes students forgot about the map and needed explicit reminders from the scribe or the tutor. At other times the map was built by a small number of students or it consisted of a number of incoherent summary statements. It took some time for one of the groups to adjust to the situation:

AS2 this time they figured out how to make a mind map; when someone was talking, another group member added material to the map. It was very complete and comprehensive

AS4 today they kind of forgot there was a map, hardly anything was added, and little use was made of it

AS5 a very good map, that was largely constructed before the group discussion started (..) they used it to check if everything was covered in the discussion

AS8 the last couple of problems they clearly know how to work with the map, building it before the group meeting, then let the map guide the discussion and then add things that are not yet in there

In sum, the tutor took a backseat and students became more responsible for staying on track. Tutors noted that absence of F2F interaction affected their role. It felt easier to let the group take control, and to affect the discussion indirectly by pressing feedback buttons, asking questions via chat, or injecting visual materials into the discussion. Tutors of virtual groups intervened significantly fewer times on non-content-related matters than tutors of collocated groups. Tutors need to be aware that certain student characteristics (shyness, CSE) can seem less important in online groups than in F2F groups, and that they may find it more difficult to detect these differences. Tutors did make use of visual aids, unlike many students. Few students searched for additional materials. It is not clear whether motivation, high workload or poor digital literacy is to blame.

6.8 Tutorless PBL

As expected, diminished visibility of the tutor in online PBL did not bother students (physical presence of a teacher has not been known to produce great learning effects, cf. Hattie 2009). Removing the tutor from the tutorial group is the logical next step to empower students in PBL. In a system that compels students to acquire self-regulatory skills, one could argue that at the end of a three year PBL curriculum students no longer need a tutor. To test this assumption, 13 groups of 10–12 third year psychology students took a class in Decision Making without a tutor. Increased autonomy should motivate students, especially if they feel competent at what they do (i.e., exercising their PBL skills) and if the social climate favors collaboration and recognition of their performance (cf. Ryan and Deci 2000).

Nevertheless, the educational set-up required attention, since an earlier pilot had shown that having second year students work on a regular PBL problem in a tutorial group without a tutor can cause great uncertainty. Afterwards, these students strongly agreed with the 5-point Likert-scale item *A tutor should always be present during tutorial group meetings* ($m=4.3$, $sd=0.9$, $N=144$). In a similar pilot involving third year students who worked on a tailor-made problem, students responses were more moderate ($m=3.1$, $sd=1.0$, $N=35$). The tutorless module presented below further improved student sentiment, in that most students neither agreed nor disagreed with the statement ($m=2.9$, $sd=1.2$, $N=120$).

To make sure students paid attention to team processes, each group of students was required to prepare a team charter. Students had to agree on a name for their group, on how the group would cope with the absence of the tutor, how to divide roles (scribe, chair), how to punish free riders, etc. During the module, brief weekly meetings were convened for teaching staff and group representatives to monitor and discuss the group meetings and to share insights. Several activities were planned to keep the group on point during sessions. Group members were asked to present specific texts, but no other literature suggestions were given. Problem descriptions contained references to video fragments, which the groups watched before or during problem analysis. All groups were asked to produce a mind map showing the contents of the group discussion. After each session, the best two maps were selected by teachers and shared with all other groups. Thus, teachers indirectly provided (peer) feedback on the quality of group discussions. In addition, all groups were in direct contact with teachers through Elluminate™. Group representatives could ask questions via chat, or ask for comments on their current mind map. Finally, groups could share information via a blog and on a virtual group space.

Testifying to the fact that students in a PBL environment were able to work autonomously, teachers on call rarely needed to intervene. During 104 two-hour group sessions teachers received 52 chat messages. They were asked to help explain content on six occasions. There were 24 chat messages asking to confirm whether a learning goal was appropriate. The remaining 22 questions involved administrative or logistical details. Many groups did not feel the need to ask for any kind of confirmation.

Compared to the previous (tutored) edition of the course, exam and evaluation results were similar, as was the duration of tutorial group sessions. Self-reported individual study time increased. Evaluation results did not differ from those of a (tutored) course which all students were taking simultaneously.

Most students were pleased with increased participation ("more people contribute"), with their increased responsibility ("now students help each other when someone does not understand something; usually we look at the tutor"; "most students felt more responsible for the group"), and with the changed social climate ("you have to solve it as a group, trust on knowledge of other students"; "more cohesiveness, felt more like a team").

Mind maps were considered useful (5 point Likert scale item, $m=3.7$, $sd=0.92$, $N=116$) and students were satisfied with the quality of the maps they produced ($m=3.9$; $sd=0.82$, $N=116$). Students mentioned "mind maps provided structure". Students appreciated selection and distribution of the best two mind maps after each session. These maps typically reconfirmed that group discussions were on the mark and helped ease concerns of performance-oriented students. The quality of the maps themselves improved after one or two sessions: most groups easily adapted their maps so they more closely resembled the "best examples" from previous sessions. Subjectively, several students felt that constructing maps slowed the group down. Absence of the tutor also made students more aware of the importance of using PBL skills.

Overall, 65 % of the students would like to have participated more often in a tutorless group during their bachelor years ($N=113$). On the other hand, 27 % of the students would not like to repeat the experience. These students did not perform better or worse at the test, but they were less satisfied with the outcomes of the group sessions. As expected, a major inconvenience of the tutorless set-up was subjective uncertainty: "*not sure whether we discussed the right things, or kept on going on minor issues for too long*"; "*need more guidelines regarding literature*". Apparently, a large minority of PBL students had come to rely on tutors to reduce uncertainty. Although a few students noticed the possibility of intergroup collaboration, groups typically worked in isolation. A competitive reward for the groups that sent in the best maps may have prevented intergroup collaboration. Incidentally, several students complained about this reward mechanism: "*giving points for best mind maps demotivates when other groups repeatedly produce best maps*". The social value orientation of psychology students may indeed make them less sensitive to competitive reward mechanisms than other students (Van Lange et al. 2010).

6.9 Conclusion

This chapter presented examples showing how students might be empowered by diminished tutor presence and tools to support (virtual) collaboration. Results are encouraging. Tutorial groups under study performed as well as groups with more (visible) tutor support. The arrangements made students more aware of the importance of collaborative and PBL skills. Students were forced to rethink modes of collaboration they had previously taken for granted. The arrangements allowed students to build additional (virtual) collaboration competences. Students could contribute to group work in various ways, and most students did. The learning curve for webconferencing and visualization tools was not steep, although students did need time to learn (from peers) how to insert Internet resources, to balance the use of the various tools, use interaction buttons effectively, share an application in order to deliver a presentation, and find more efficient ways to communicate as a group (e.g., by using yes/no questions). Therefore, it is interesting to investigate how students will develop after prolonged virtual group work (cf. Ortiz de Guinea et al. 2012). Instructional sessions should focus on how participants can experience silence, how interaction icons can in part compensate for the lack of nonverbal feedback, and how chairing a virtual tutorial session changes from chairing a F2F group session.

Surprisingly, online groups and F2F groups were equally satisfied with team outcomes and team process. The number of women in each group, and the fact that psychology students were involved (cf. Martins et al. 2004; Van Lange et al. 2010) may help explain this finding. In addition, having been part of an experiment may have stimulated team spirit and strengthened social identity.

Social climate appeared to be an important variable. Many students in the virtual groups initially struggled with the lack of nonverbal feedback, and some asked for richer media (webcams) or F2F mix-and-mingle activities. Lack of social context cues did seem to reduce differences between tutor and student. In the tutorless arrangement, the team charter and the mild intergroup competition may have contributed to a positive social climate. Ren et al. (2012) found that interaction improved when group members were given tools for interpersonal communication and information about interpersonal similarity and activities of peers. However, interaction improved even more when tools for group-level communication and information about group activities and intergroup competition were made available. Interaction is likely to improve further when students trust each other and feel safe (see also Chai and Kim 2010; Gagne 2009; Yu et al. 2010). These factors merit closer attention, especially given the fact that students in the virtual groups may have been less trusting than students in the control groups.

Students in virtual groups also referred to topic motivation and the type of problems or learning tasks best suited for virtual or tutorless PBL as a potential moderator (cf. Baker et al. 2008; Lehman et al. 2012; Martins et al. 2004). Students may need more time to discuss some problems in interdependent groups. Time limitations may also vary from module to module, since the improvement in competence per unit time spent is likely to vary as well (Son and Seti 2010). The module selected for the online PBL pilot might not have supplied a good test environment. Student interdependence was higher than in most modules, and many psychology students feel underwhelmed by cognitive science. Not surprisingly, discussions in the module on social influence and persuasion were more vivid than discussions in the cognitive science module.

Mind maps provided a rich source of information to study team output. They could also be used to provide feedback to other groups as example models of group discussion content. In the tutorless arrangement, such feedback helped reassure students who were worried the group might be heading in the wrong direction. A recording function made individual contributions visible. Multi-user interaction helped the group to manage workload for scribes. Content and structure of the maps left room for improvement in the online groups, although one group gravitated toward an adequate performance level. Typically, this group also worked on their maps before scheduled meetings. For second year students, information exchange may have suffered from greater informational interdependence (Mesmer-Magnus and DeChurch 2009) or from high coordination requirements at the group level (Ekeocha and Brennan 2008). Coordinating the group product or resolving disputes or disseminating inferences takes time, which explains why some students felt mapping was rather time-consuming. Nevertheless, students were satisfied with the usefulness and quality of their maps.

Asynchronous communication (e.g. off-line construction of team mind maps) was uncommon in most groups. Some groups also communicated via FaceBook™, illustrating they felt a need for an extra group communication channel. Follow-up studies may focus on incentives for stretching learning beyond designated time slots.

As expected, online groups discussed visual materials more often than face-to-face groups. Working in an online learning environment stimulated students to browse the internet. In general, students seem more likely to reap benefits of self-directedness, if they are information literate (or learn to become so by watching their peers). Flipped classrooms and the growing number of open educational resources combined with tools for sharing and commenting and keeping records of team deliberations can further support self-directed learning and discovery. Even if such support does not boost traditional learning outcomes (knowledge, skills), it can increase motivation and epistemic curiosity.

The educational arrangements can be used to reach new target groups. Virtual environments may appeal to students in international tracks or virtual mobility classes. For instance, in the spring of 2013, a group of undergraduate exchange students were trying to discover how they would sell their psychological knowledge and skills and find a profession in a country where local languages do not even have a word for psychology. In doing so, they collaborated with psychology students in Mozambique via Google+, who in turn were pleased with the new outsider perspectives on their futures. Blended educational set-ups can also be used in postgraduate course offerings for working professionals. Testing blended PBL in a population of students who are well-versed in face-to-face PBL can guide the design of educational formats for novel populations of learners. Most students indicated they prefer a blended arrangement over a virtual PBL. Limited virtuality does seem to bring the best of both worlds (e.g., Mesmer-Magnus et al. 2011). How to strike a balance between online and face-to-face activities will need further study, but students have presented suggestions on which to build.

Additional outstanding issues can be addressed. For instance, how long do PBL students need a tutor? Do PBL groups need a single scribe? Should students consult their transactive memory (and Google) during group sessions or exams? What metacognitive support is needed to help students deal with simultaneous use of various communication and knowledge sharing tools (cf. Schwonke et al. 2013)? Do these set-ups harm certain students because they lack prior knowledge or skills or because they have certain personality characteristics? How much practice is needed to develop and hone (virtual) collaborative routines (like using interaction buttons efficiently)? The small number of groups (and tutors) involved in some the pilots and our student sample (psychology students from The Netherlands and Germany, who were familiar with PBL) obviously limit generalizability and preclude answers to the above questions. Replications with larger number of groups are needed.

Finally, self-regulating students affect tutor and teacher behaviour. For instance, tutors in virtual groups noticed that the number of direct appeals from students declined. They adapted by spending time anticipating impasses and looking for materials that could help solve them, while keeping a low profile in group discussions. In a tutorless set-up, reduced staff involvement releases teacher resources that can be invested elsewhere (e.g., providing feedback on student (group) assignments, preparing richer content). Teachers in the tutorless set-up, for instance, spent more time assessing the quality of group products. Still, it remains to be seen whether a tutor can be replaced by a cheering "granny in the cloud", or whether tutor competencies like detecting impasses and modeling the required depth of processing are key to high learning performance. Either way, if students are expected to perceive a need for self-directed information acquisition, teachers must design or mine educational resources that create conditions for productive confusion (cf. Lehman et al. 2012). While groups of learners must come to terms with interdependence, teachers can regulate emotions, provide metacognitive support, and make "gaming the system" less attractive by looking creatively at assessment practices. Signature pedagogies and differences between learners will require specific modifications. Few simple, one-size-fits-all guidelines can be presented here. For instance, awarding extra credit to the best group maps may have reduced autonomous motivation in some groups in the tutorless arrangement (cf. Pulfrey et al. 2012). On the other hand, competition among groups may boost social identity, which would stimulate collaboration (Ren et al. 2012). Although these examples may not bring one-size-fits all recipes, let alone contribute to fundamental debates on learner motivation, they may instill enough productive confusion in self-directed teachers and tutors to start appropriating their favorite educational arrangements. In today's changing educational landscape, teaching means creatively tweaking educational contexts to fit self-driven learner needs. Teacher identity will change along the way. Instead of filling vessels and lighting fires, they build firebreaks and backfires, enjoy the heat and occasionally put another log on the fire.

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