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To cite this article: Lisa Thomas, Sue Bennett & Lori Lockyer (2016): Using concept maps and goal-setting to support the development of self-regulated learning in a problem-based learning curriculum, Medical Teacher, DOI: [10.3109/0142159X.2015.1132408](https://doi.org/10.3109/0142159X.2015.1132408)

To link to this article: <http://dx.doi.org/10.3109/0142159X.2015.1132408>

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 Published online: 28 Jan 2016.

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Using concept maps and goal-setting to support the development of self-regulated learning in a problem-based learning curriculum

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Abstract

Problem-based learning (PBL) in medical education focuses on preparing independent learners for continuing, self-directed, professional development beyond the classroom. Skills in self-regulated learning (SRL) are important for success in PBL and ongoing professional practice. However, the development of SRL skills is often left to chance. This study presents the investigated outcomes for students when support for the development of SRL was embedded in a PBL medical curriculum. This investigation involved design, delivery and testing of SRL support, embedded into the first phase of a four-year, graduate-entry MBBS degree. The intervention included concept mapping and goal-setting activities through iterative processes of planning, monitoring and reflecting on learning. A mixed-methods approach was used to collect data from seven students to develop case studies of engagement with, and outcomes from, the SRL support. The findings indicate that students who actively engaged with support for SRL demonstrated increases in cognitive and metacognitive functioning. Students also reported a greater sense of confidence in and control over their approaches to learning in PBL. This study advances understanding about how the development of SRL can be integrated into PBL.

Introduction

Contemporary pedagogical approaches in medical education, and in higher education in general, focus on preparing students for independent learning beyond graduation. Graduates need to be prepared for a workforce in which they will be expected to perform new tasks and roles throughout their working lives. The Global Commission on Education of Health Professionals for the 21st Century challenges medical schools to enable their vision, that:

“All health professionals in all countries should be educated to mobilise knowledge and to engage in critical reasoning and ethical conduct so that they are competent to participate in patient and population-centred health systems as members of locally responsive and globally connected teams”. (Frenk et al. 2010, p. 1924).

This requires students to develop skills to initiate and direct their own learning. It is, therefore, important that opportunities for students to develop these skills are embedded in their studies (Murdoch-Eaton & Whittle 2012).

Problem-based learning (PBL) is one strategy that encourages an independent approach to learning. PBL is a pedagogical design whereby a problem or scenario is presented to stimulate learners to seek information as they attempt to

Practice points

- Embedded support for SRL in the PBL curriculum can improve student learning and confidence in transition to PBL.
- Learners engaged with SRL support in PBL report increases in cognitive and metacognitive functioning.
- Learners engaged with SRL support in PBL report greater confidence in selecting and applying appropriate learning strategies.

understand the issues pertinent to the situation. It was developed in response to the need for medical school graduates to be self-regulated learners in their ongoing practice (Barrows 1986). The original focus was on developing professionals who could communicate, cooperate and take responsibility for learning as they adapted to working beyond the classroom environment. By his own admission, the pioneer of PBL, Howard Barrows described its origins as being pragmatic rather than born from an understanding of educational psychology or cognitive science (Barrows 2000). Since its pragmatic conception, researchers have sought to understand the learning outcomes and experiences of students engaged in PBL (Albanese & Mitchell 1993; Beachey 2007; Prosser & Sze 2014).

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Skills in self-regulated learning (SRL) are important for success in PBL (English & Kitsantas 2013). Studies have shown that students who develop and apply skills in SRL more effectively engage in PBL (Blumberg 2000; Hmelo & Lin 2000). This has led researchers to investigate the development of SRL in PBL (Dolmans & Schmidt 2000; Evensen 2000; Evensen et al. 2001; Loyens et al. 2008).

Self-regulated learning involves the ability to initiate and direct learning beyond formal education, requiring control over one's own learning processes. Individuals with skills to instigate, monitor and sustain learning toward learning-goal achievement are described as self-regulated learners (Zimmerman 1990). SRL is a cyclical process involving a dynamic interplay among three phases of learning: fore-thought; performance or volitional control; and self-reflection (Zimmerman 1998). Self-regulated learners display metacognitive, motivational and strategic control of their learning (Zimmerman 1986). This control is accomplished through goal-setting, planning, monitoring, regulating and evaluation when learning (Boekaerts 1999; Hadwin & Winne 2001; Zimmerman & Schunk, 2001; Eilam & Aharon 2003; Perry et al. 2008). Many learners, even at the postgraduate level can benefit from specific training to support their SRL processes (Sandars & Cleary 2011).

There is a significant amount of new information for a learner to attend to when engaging with PBL for the first time. Often, PBL curricula do not explicitly focus on the development of SRL (Moust et al. 2005). Students can struggle in the transition from more traditional approaches to PBL as they attempt to understand the skills required. Evidence gathered from case studies of student experiences during the transition to a PBL medical curriculum suggests that not all students automatically acquire the necessary SRL skills for PBL, or do so through a great deal of unnecessary stress (Evensen et al. 2001; Lloyd-Jones & Hak 2004). Many learners lack effective strategies for directing their own learning because they are accustomed to more teacher-directed programmes in their previous studies. Learners are often expected to intuitively employ new strategies for studying in an unfamiliar environment. This creates challenges for students' emotional well-being and academic success as they move from a teacher-led environment to a student-directed curriculum (McLean & Gibbs 2009). The study presented here investigated the outcomes for students when support for the development of SRL was embedded into a PBL curriculum.

Methods

The study reported in this article investigated the outcomes for students when the development of SRL was integrated into the early stages of a PBL-based graduate-entry medical programme. The specific questions guiding the study were:

- (1) How do students engage in SRL activities that are integrated into a PBL curriculum?
- (2) What outcomes are achieved by students who participate in SRL activities that are integrated into a PBL curriculum?

The study was conducted with students in Semester One in the first year of a Bachelor of Medicine and Bachelor of

Surgery (MBBS) degree in a graduate-entry medical programme in an Australian university. Participants were recruited from the same first year subject, and were therefore all at the same stage of their studies. To successfully integrate the programme into the curriculum, support of the tutors was required and as this would involve an additional workload for them, the Dean gave approval for the programme to be offered to students on the basis of the voluntary agreement of their tutors. Tutors who led the PBL tutorials were asked if they would be willing to participate both in supporting the implementation of the programme and participating in data collection. Five of the 11 tutors agreed to participate in the study, and the students in these groups were then invited to participate also. A total of 35 of the 37 students enrolled in the five tutorial groups volunteered to participate in the learning skills programme for research purposes. It was a requirement of the ethics approval that students be able to withdraw at any time. As a result, the learning skills programme was offered as an optional additional support for students.

Design of the learning skills programme

The study was informed by a needs analysis and pilot work conducted with students from the previous cohort (see Thomas 2013 for details). The researchers developed a learning skills programme to support the development of skills in SRL. This was designed for integration into the "Introduction to Medicine" content block at the beginning of Semester One, Year one. Figure 1 illustrates the steps in the programme, which is then described in detail below.

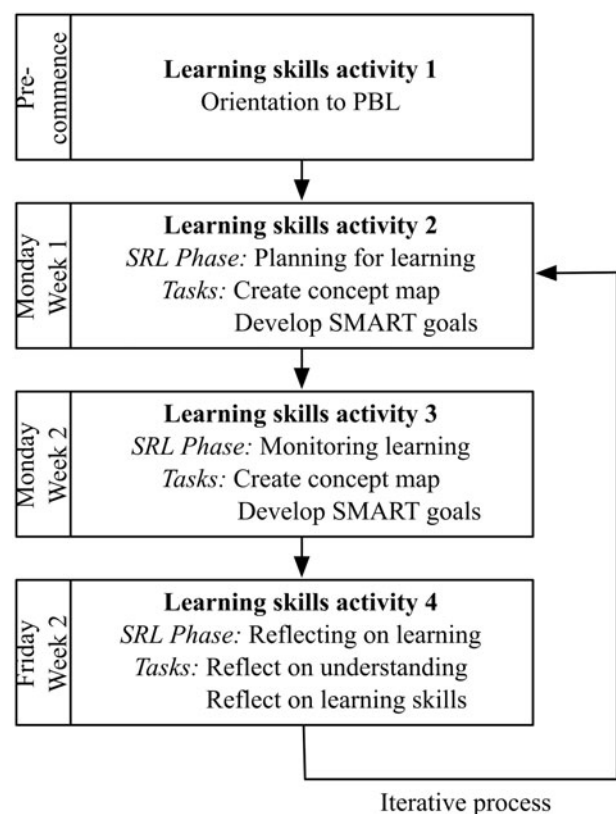


Figure 1. Learning skills programme design.

The learning skills programme consisted of four learning skills activity sessions, embedded into PBL curriculum activities and repeated over two fortnightly cycles. A resource book was designed in which participants were asked to do the learning skills activities.

Learning skills activity 1

An introductory workshop was held. This included a lecture in which students were provided with an orientation to PBL, the rationale for the curriculum design in the medical school and the importance of effective learning skills in this context. Second-year students were invited to talk about the learning challenges they faced in first year and how they overcame them. The learning skills programme was then presented to students as an optional support for their learning.

Learning skills activities 2, 3 and 4

Activities 2, 3 and 4 were wholly integrated into PBL tutorials. Activities were supported by a resource book, specifically designed for the learning skills programme. The PBL tutors were provided with guidance on the activities so that they could design the tutorial around the learning skills activities. The researchers also contacted the tutors prior to each tutorial to discuss the activities.

Activities 2 and 3 aligned to the SRL phases of “Planning for learning and Monitoring learning”. For these, students were supported to create concept maps and set learning goals. Concept maps are commonly used to represent knowledge through a graphical arrangement of key concepts with connecting lines to demonstrate meaningful relationships between concepts (Novak & Gowin 1984). This information–organisation strategy derived from theory can be a powerful tool to promote meaningful learning (Van Zele et al. 2004). While constructing a map, learners engage with knowledge and create a representation of their understanding as they identify the meanings and relationships between central ideas (Heinz-Fry & Novak 1990). Concept maps were used in this programme to help students identify their current knowledge as they iteratively set goals for future learning. An example of a student-generated concept map from this study can be found in the Supplementary material online.

Students were also supported to develop SMART (specific, measurable, attainable, relevant, timely) goals in the learning skills programme. The SMART guidelines have been shown to be effective for goal-setting in many discipline areas, including health sciences, business management and psychology (Barclay 2002; Monaghan et al. 2005; Shahin & Mahbod 2007). SMART goals were used in this programme to help students to plan for and monitor their learning. An example of a student-generated SMART goal from this study can be found in the Supplementary materials online.

Activity 4 aligned to the SRL phase of “Reflecting on learning”. Participants were prompted to reflect on aspects of their learning such as the efficacy of their approaches and the knowledge gained over the previous two weeks.

Research design

Data were collected and analysed using a mixed-methods approach. This allowed the investigators to gain a deeper understanding of the phenomenon under investigation by combining standardised instruments with qualitative participant commentary. The range of sources included the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al. 1991), individual interviews and work samples. The multiple forms of data from each participant enabled within- and cross-case analysis. In mixed-methods research, case studies can support the investigation of complex conditions in the cases under examination (Yin 2009). To achieve this, it is essential that the researcher obtain multiple data sources, and that these data can be triangulated (Yin 2009). This collection of a rich data set informed the case study analysis allowing for a deep understanding of the outcomes of a learning skills programme to explicitly support the development of SRL in PBL.

Data collection

The MSLQ was used to collect self-reported, quantitative data about outcomes for learners who participated in the study. The MSLQ consists of different sections that can be used for various research purposes. The Cognitive and Metacognitive Strategies module was used to investigate selection and use of SRL strategies. The MSLQ cannot be reproduced here, but is included in Pintrich et al. (1991). The MSLQ was applied both pre- and post-programme intervention. Self-report questionnaires are commonly used to measure SRL by allowing learners to provide data about mental processes that researchers cannot observe (Winne & Perry 2000).

Participants were also invited to a 60-min individual, semi-structured interview at the end of the programme. The interview explored participants’ engagement with, and perceived outcomes of the learning skills programme. Further data came from the participants’ concept maps and goals created as products of the learning skills programme and recorded in their resource books. Used as the only source of data, documents may offer only a limited understanding, but when analysed along with other data, they can prove a valuable addition to understanding experiences and processes (Flick 2006).

Data analysis

The MSLQ pre-test and post-test results were compared to ascertain changes in self-reported cognitive and metacognitive strategy. Qualitative analysis of the interviews and the full contents of the resource books was also conducted. For each qualitative source a coding framework was developed and patterns in codes were analysed to reveal broader themes. Concept maps were coded as either: no attempt, basic, intermediate or advanced. Goal setting work samples were coded into: no attempt, content focus, learning strategy focus or content and learning strategy focus.

Data were collected throughout the four week programme with interviews conducted one week after completion of the programme. At the commencement of the programme,

35 participants had agreed to participate in the study. At the end of the four week programme, 20 participants remained. This high rate of attrition is likely due to the voluntary nature of the programme. Of the 20 remaining participants, 7 (one male and six females) provided a full complement of data. The gender distribution of the participants does not represent the gender distribution of the cohort, which was 52% female and 48% male. Data from the seven participants were analysed as individual case studies within the broader dataset. The collection and analysis of this dataset allowed for rich cases to inform an understanding of the outcomes for students when SRL skills are explicitly supported upon transition to PBL.

Results

It is beyond the scope of this article to present the details of all seven case studies. For the purpose of reporting a succinct overview of the results, Supplementary Table 1 (online) summarises the findings from all seven cases. Within this article, one case is presented in detail to illustrate how the various data sources were used to inform the findings.

Supplementary Table 1 summarises the engagement with activities and outcomes of participation in the learning skills programme. The findings suggest that participants engaged metacognitively with the activities by making adaptations to suit their own personal learning preferences. Such adaptations include, for example, moving the concept mapping from the resource book to larger formats (such as whiteboards and poster paper) which allowed for more detailed maps, or only completing certain sections of the SMART goals to align with their own learning needs. The outcomes of their engagement are demonstrated through changes in their MSLQ scores, as well as reports of greater confidence in, and awareness of effective learning strategies.

Case study – Participant 7

Participant 7 (P7) was a 22-year-old female graduate of a Bachelor of Biomedical Science degree. P7 engaged with the learning skills programme and offered to participate with data collection processes. She completed three of four concept maps, and two of four SMART goals produced during the learning skills activities.

In her interview P7 described her learning strategy prior to the learning skills programme as already incorporating concept maps. However, as a result of the learning skills programme she had changed the way she used concept maps. Prior to the programme she would create a separate concept map at the end of each lecture, mapping what she had learnt. At the completion of the programme she reported that she now tried to integrate multiple concepts into one map, though she had to do this on large sheets of poster paper. She then displayed these on her bedroom walls so she could look at them often; recognising this as a good learning strategy as she reported “I remember specific things where they are on the map rather than just reading a whole bunch of text . . . I’ve got posters everywhere all around the walls because that’s how I learn”. P7 said she used her maps to see connections

between concepts and that it “definitely helped me identify where the gaps were, so it was good”.

P7 also indicated in her interview that she found learning about the SMART goal guidelines very valuable stating that “Now I make goals I know I can achieve in a day, and if I achieve them and have spare time, it’s great, I go on and do extra things. But if I just get those done, it’s good”. Prior to the learning skills programme she had been setting goals that she felt were unattainable in the time-frame she had. This caused her to feel unproductive in her work. The learning skills programme allowed her to establish goals that were more achievable and realistic. P7 did not use the SMART goal guidelines exactly as presented, but adapted it to ensure her goals were attainable and specific. She reported that this had reduced her stress and enabled her to concentrate in lectures and focus on getting work done.

In her parting statement P7 said:

I like the SMART goal. Like the attainable part of it made me realise that I was setting goals that were not realistic, and I was just getting really stressed. It was like a cycle of stress. It was horrible. But now I’ve rung home and told my mum about the programme and how I’ve changed my goals and I’m not as tired anymore. Especially, I can concentrate in lectures and I’m getting most of my work done that should be getting done

A comparison of P7’s pre- and post-MSLQ tests demonstrated an increase in her scores for elaboration, organisation, critical thinking and metacognition/self-regulated learning. These results were triangulated with the other data sources in the analysis of P7’s case to further inform findings associated with the outcomes of her participation in the learning skills programme. P7’s case demonstrates that after participating in the learning skills programme she felt more in control over her own learning, and felt as though her levels of stress had decreased. She had also developed some effective learning strategies and adapted them to suit her preferences.

Discussion

Studying in a PBL curriculum requires students to become effective self-regulated learners (Blumberg 2000; Hmelo & Lin 2000; English & Kitsantas 2013). Such learners are those who are in control of the processes of instigating and maintaining learning (Zimmerman 1989). Traditionally, PBL has not been designed to explicitly support the development of SRL (Moust et al. 2005). However, there is belief that PBL can be enhanced by integrating SRL support into the curriculum (Sandars & Cleary 2011).

This study investigated the impact of a programme aimed at supporting learners to enhance their SRL skills for engagement in a PBL medical curriculum. The findings of this study suggest that when learners actively engage with such a programme, they report increases in their cognitive and metacognitive functioning, and also increased confidence with relation to their approaches to learning.

Learner-generated concept mapping was introduced as a cognitive strategy for knowledge acquisition in this study. Analysis of the data showed that concept mapping supported the development of SRL skills as learners adapted the strategy to their personal preferences. The learner-generated concept mapping activities provided a metacognitive support for SRL processes, as they were embedded in the activities for the processes of planning, monitoring and modifying learning. In turn, learners demonstrated greater metacognitive functioning as they adapted the strategy to best suit their learning needs. This suggests that active engagement with concept mapping, in a PBL curriculum, supports the development of higher metacognitive functioning.

The findings of the study reported in this article support the idea that an increase in effective SRL skills is an outcome of engagement with a programme that aims to explicitly support such skills. The MSLQ scores of the learners in the case studies showed increases in the scores for elaboration, organisation, critical thinking and metacognitive self-regulation between the pre- and post-test. As suggested by the designers of the MSLQ, such results are evidence of changes to students' uses of different cognitive and metacognitive strategies (Pintrich et al. 1991). Evidence of participants' metacognitive control to adapt and use the strategy to suit personal preferences further supports this.

The findings of this study further suggest that learner confidence in relation to approaches to learning increased among participants through engagement with support for SRL. A student's beliefs about their success, referred to as "self-efficacy", as a learner can greatly affect their ability to plan for and engage in learning. As self-efficacy can change depending on the context, learners who may have been very successful in one environment may see their self-efficacy towards learning falter when entering a new setting (Bandura 1997). On transition to a PBL context, learners can experience high levels of stress and uncertainty as they attempt to understand the most effective learning strategies (Evensen 2000). Research has reported that when learners are supported in the development of SRL skills, they display increases in self-efficacy (Zimmerman & Kitsantas 1997). In this study, learners reported reduced feelings of stress and greater feelings of confidence in their approaches to learning after engagement with the learning skills programme.

Equally, the more self-efficacious a learner is, the more committed they are to leading and directing their own learning (Bandura 1991). In this study it was shown that as participants began to feel more confident with their approaches to learning, they moved away from the programmed support and adapted the strategies to suit their own learning preferences. This may suggest that through the programme, students developed such confidence in their approaches that they could move away from a set structure to explore SRL strategies suited to their own learning. Thus, the aim of the intervention in reducing learner stress and increasing confidence towards learning in PBL may have been achieved for these students.

It is important to acknowledge the limitations of this study. The study was conducted in a graduate-entry programme and as such the students have developed good SRL skills through their previous university study. It may also be the case that

simply engaging with a PBL programme promotes SRL independently of a learning skills programme. Also, data were only drawn from participant self-perception. This may explain why there were no negative results. Further research using experimental designs could test such propositions. It should also be noted that the small number of volunteer participants may not be typical of the wider student population. Due care should be taken when drawing any generalisations from these results. Finally, this study investigated two strategies to develop SRL, but there are other strategies that should also be explored.

Conclusion

The findings of this study show that integrated, explicit and contextualised support for SRL strategies may improve student learning on transition to the PBL context. Outcomes for learners who engage with such support include increases in cognitive and metacognitive functioning and increases in confidence with their approaches to learning. The implications of this research point to the need for a strategy for transitioning to PBL that incorporates activities to support learners to understand and implement effective learning strategies for the new learning context.

Notes on contributors

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Glossary

Self-efficacy: One's belief in one's own ability with regard to a particular task

Cognitive functioning: The mental process of knowing

Metacognitive functioning: The knowledge of when and how to use particular strategies for learning and problem solving

Acknowledgments

This research was conducted at The University of Wollongong, NSW, Australia.

Declaration of interest: LT was supported by an Australian Postgraduate Award scholarship to undertake this research.

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Supplementary material available online
at <http://dx.doi.org/10.3109/0142159X.2015.1132408>