Construction of PBL cases

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Twelve tips for constructing problem-based learning cases

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Abstract

Background: One of the key elements for introducing a problem-based learning

(PBL) programme is constructing good PBL cases. Good cases should reflect the educational principles of PBL including (a) integration of basic and clinical sciences together with professionalism and psychosocial components, (b) encouragement of discussion of cognitive domains such as identification of problems, generation of hypotheses, construction of an enquiry plan, weighing evidence for and against each hypothesis, interpretation of findings, construction of mechanisms, using evidence to refine the hypothesis and construction of a management plan, (c) encouragement of discussion of cases in small groups with an emphasis on student-centred learning, (d) promotion of collaborative learning and contribution of students to the case discussion and (e) encouragement of teamwork and self-directed learning strategies.

Aims and methods: Despite the importance of construction of good PBL cases to the success of a PBL programme, the art of construction of these cases is understudied or described in the literature. Based on our experience in PBL and evidence from literature, we described 12 tips for constructing good PBL cases.

Results and conclusions: Constructing good PBL cases is an art that necessitates teamwork and input from several different disciplines. Cases should be constructed using a template reflecting the educational objectives of the programme. This approach will ensure optimum learning outcomes and consistency in the design and delivery of cases.

Introduction

In problem-based learning (PBL), cases are used to drive learning of basic and clinical sciences in an integrated manner. The outcomes of PBL are likely to be contingent upon the actual activities that students engage in during the tutorial (Hak & Maguire 2000), and these learning processes, in turn, are ultimately

stimulated by the quality of the written cases studied in the tutorial. We believe that the art and science of case construction is crucial yet understudied or described in literature. With this principle in mind, case scenarios should not only tell a story but rather be designed in a way that encourages the discussion of educational principles embedded in the case template (Bransford et al. 2000). Case scenarios are used in PBL for the following reasons:

- Scenarios attempt to situate learning in contexts that are similar to what learners face in their real-life situations.

- Scenarios allow students to generate hypotheses for the problems and think about approaches to make priorities between their hypotheses. Scenarios serve as a vehicle for integrating knowledge and linking basic sciences with clinical situations.

- Scenarios stimulate discussions between students and allow them to discuss moral and ethical issues that can be raised in the case.

- Scenarios allow students to provide evidence and reasoning for their views/actions.

- Scenarios enforce the retention of information learnt in long-term memory.

Construction of cases is not a simple task and requires subject matter and educational expertise, staff training and establishment of writing teams, a process that is time consuming and might not be visible. While this could be possible for some schools/universities, other schools might choose to purchase cases from another university. However, this approach may not totally resolve the school's needs. Often these purchased cases require amendments to suit the teaching and learning needs of the school and in some situations, this will require a lot of work and major changes.

There is no single version for PBL cases and different schools have their own

designs. The choice of the structure and design of the PBL programme should be based on the degree to which PBL is represented in the entire course, the objectives of the programme and whether there are any other learning means to support the PBL programme. Currently, most schools choose to adopt a hybrid PBL curriculum (with supplemental lectures, practical classes, seminars and e-learning) rather than a pure PBL programme. Also, different institutions vary greatly in the timing of their cases. For example, some have two or three cases each week, while others might have one case extending over several weeks. However, the latter format might reduce the number of cases allocated in each module/block and students might lose interest. PBL cases used for teaching should be realistic, energising, challenging and instrumental. These qualities were described in a review on teaching cases by Kim et al. (2006). Considering also the cognitive principles that form the rationale for PBL (Schmidt 1983), PBL cases should reflect the qualities of good PBL cases (Box 1).

Box 1   Qualities of good PBL cases

CSV   Display Table

Designing a case is very similar to designing a building; each component serves a particular function and any disturbance at the base or at any level could cause problems to the whole building. Similarly, each component in a PBL case has a function and any disturbance could affect the whole case. Therefore, planning and assessing the flow of the case and the functionality of each component is necessary for creating good PBL cases (Chin & Chia 2005).

This article aims at addressing tips for establishing PBL cases and key principles that authors have to consider as they design their cases. These tips reflect the collective experience of the authors, who are a diverse group of problem-based educators in four different continents.

Tip 1

Establish writing teams

Ideally, the writing team for each PBL case should be established at least 12–18 months ahead of the implementation time. Giving enough time for teams to plan their cases, research literature, construct their cases and review them is an important key for success. Each team is comprised of a representative from each discipline included in the block, e.g. basic sciences, clinical medicine, radiology, professionalism and psychological medicine. Members are usually trained in workshops on how to construct PBL cases, use the programme's PBL template, construct tutor's guides and collect required images (Barrows 2000; Azer 2007).

What are the responsibilities of the writing teams? Generally, these teams have the following responsibilities:

- Discussing and identifying the objectives of each PBL case.

- Deciding on how to turn objectives into events in the case that foster students' discussion in relation to the particular objectives (concept).

- Researching literature and collecting resources that can help in the writing process.

- Identifying cues (problems) in the trigger text and designing trigger images that initiate students' discussion (Azer 2007).

- Outlining the main character in the trigger (e.g. a patient) with regard to age, gender, ethnicity, occupation and psychosocial issues related to the case, or the main phenomenon to be explained.

- Deciding on the flow of the case and the key educational issues planned for

each part of the case.

- Constructing the triggers for the case. A trigger is the starting part of a case. It is usually about 5–7 lines and comprises cues (problems) that students need to identify and generate hypotheses for each cue (for more details about case triggers, see Azer (2007)).

- Constructing the tutor guide and preparing resources needed for the tutors.

- Ensuring that the case is up-to-date and relevant. This can be achieved through continuous review and feedback from tutors and students (discussed further under Tip 12).

The team should plan their meetings and the stages of writing, reviewing and finalising the case and the tutor's guide. In some programmes, the writing of the case is developed by an individual who consults with the key personnel from disciplines.

Tip 2

Identify the educational objectives of the case

A fundamental element in constructing PBL cases is identifying the case educational objectives. Normally, the block where the case will be used has objectives or learning outcomes and the case objectives must be derived from and tightly connected to the block objectives. Objectives allow the faculty to target certain outcomes and define specific learning areas. They highlight what we want students to do, address a number of cognitive skills and define principles to be raised in the case. Each case usually has 6–7 objectives. Because PBL aims at integration of basic and clinical sciences as well as professionalism and psychosocial, moral and ethical issues, objectives should be written in a way

that enforces integration. Each objective should start with a verb that clearly describes what we aim for students to do. Examples of these verbs are: correlating, interpreting, explaining, providing evidence, justifying, integrating, showing relationships, constructing mechanisms and discussing. (Dolmans & Snellen-Balendong 1997; Azer 2008).

Identifying the case objectives first will help the writing team in constructing the broad outlines of the case and working out the details that end with a case reflecting these educational objectives. Examples of learning objectives of a case might be: (a) correlating the anatomical structures of the skin with their functions, (b) describing the physiological mechanisms responsible for maintaining the body temperature when exercising in a hot environment, (c) discussing how psychological stresses and worries might contribute to the patient's physical illnesses and (d) using knowledge from basic sciences to interpret patient's symptoms, clinical findings and investigation results.

Tip 3

Construct a template for cases

Good cases are built on a template that accommodates the educational objectives of PBL (Jonassen 1997; Hung 2006). Designing a template is not an easy job and the course designer usually seeks expert advice. The template becomes the framework on which cases are designed and includes the case objectives, triggers and the arrangement of information to be presented in each tutorial. For example, a template for a programme may have the case presentation and history presented through a series of triggers and physical examination in tutorial 1 and further investigations and psychosocial issues in tutorial 2. The rationale for constructing a template may include:

- Ensuring that cases address cognitive skills.

- Creating cases that follow the same design and sequence of events. This consistency allows students to become autonomous in their discussion.

- Ensuring that authors maintain certain educational principles in each case. The congruence between content validity, learning objectives and learning experience is achieved (Coderre et al. 2009).

- Designing cases that suit the stage in the curriculum (e.g. focus on basic sciences and the use of the deductive theory to refine their hypotheses or focus on designing a management plan and the discussion of options available),

- Providing students with the opportunity to identify their learning issues and develop their self-directed learning skills.

Good cases are constructed in a way that enhances understanding rather than memorisation of factual knowledge (Schmidt 1983; Weiss 2003). To ensure consistency between cases, these cognitive domains should be embedded in the template and they should encourage discussion of basic science and application of knowledge learnt (Duch 2001). These cognitive domains may include (Azer 2005, 2008):

- identification of problems in the trigger;

- generation of hypotheses for each problem;

- developing an enquiry plan and collecting more information;

- interpreting new findings from history, examination and investigations;

- weighing the evidence from history, clinical examination and investigation (if applicable), results or the knowledge base of the students for and against each hypothesis;

- developing an approach to deal with uncertainty and making decisions;

- building mechanisms; and

- discussing psychosocial issues, legal and professional issues related to the case (if applicable).


Tip 4

Think about integration, logical flow of the case and authenticity

Cases constructed for PBL programmes should represent a prototype and address core components of the curriculum (Maudsley 1999). The case shall be authentic – reflecting a real, scientifically sound and logically accepted case. Therefore, the writing team might use real cases and modify them to suit the stage of the curriculum and the students' learning needs. Therefore, cases should:

- reflect real practice, common cases in the community, important physiological or pathological phenomena;

- should not be too rigidly structured;

- be written for students and encourage student-centred learning;

- facilitate integration according to the block or module (e.g. basic and clinical sciences as well as professionalism, ethics, law and psychosocial domains); and

- be logical in their flow and address the educational outcomes of each tutorial (see Figure 1 for the sequence of events in tutorials 1 and 2).

Figure 1. Example of sequence of events in tutorials 1 and 2.
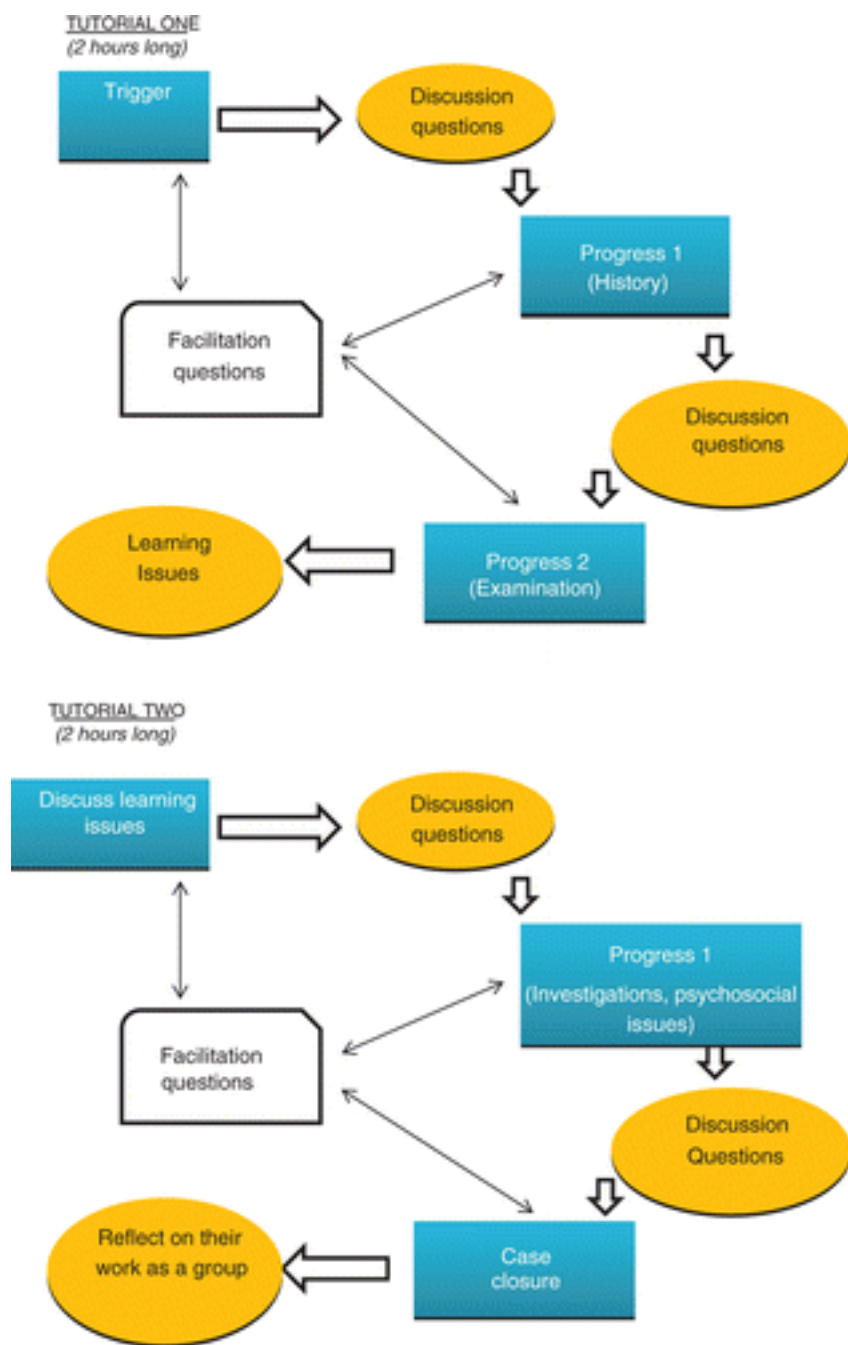
Tip 5

Adjust cases to students' learning needs

Case designers should construct cases in a way that suit students' needs and the stage of the curriculum. The writing teams might create cases for each block/module. Cases should build on what was already learnt, e.g. from previous cases, and should encourage students' researching skills and lateral thinking (Hmelo-Silver 2004; Hmelo-Silver & Barrows 2006). For example, constructing the

first PBL case in year 1 might be challenging because the aim is to introduce PBL to students who have limited prior knowledge in anatomy, physiology and other basic sciences. A good case at this stage should encourage the discussion of physiological changes (such as loss of fluids, temperature regulation and fluid homeostasis in a marathon runner exercising in a hot temperature) and/or psychosocial issues (such as the challenges faced by a first year university students who have moved from a small community and find it difficult to adapt to the new environment and course expectations). On the other hand, the last case in year 1 might provide students with the opportunity to revisit concepts addressed in several body systems studied during the year. Therefore, the sequence of body systems (blocks) studied in years 1 and 2 should be thoroughly planned. Doing so will help students to progress smoothly from one block to the next and use new knowledge learnt to build on what they already know. In later years, cases should deal with all relevant clinical causes including differential diagnosis, investigations and management plans and social and ethical issues while not forgetting about relevant aspects from basic sciences.

Tip 6

Start the case with an engaging trigger

The trigger is the starting point and case designers may consider the following principles as they create their trigger (Roberts & Ousey 2003; Azer 2007, 2009). A good PBL trigger:

- addresses key objectives of the case;

- highlights 3–4 cues/key problems;

- encourages students' broad discussion;

- uses present tense;

- provides information about the age, job and background of the patient (if relevant);

- reflects a realistic scenario; and

- has an innovative design.

During the writing process, continued revision of the trigger text and cues is important. Then, on completion of writing of the case, authors should review again the case trigger and examine the flow of the different components of the case and make any adjustments needed.

Example of a trigger

> *Mohamad Ali, a 20-year-old first-year science student at King Saud University, participates in a cross-country race organised by the students' union. It is only the second week in his course and he feels stressed. Also, he is a little worried being away from his family in Jeddah. It is mid-morning, very hot and Mohamad is sweating a lot during the race. About 40 min into the race, he suddenly collapses.*

Tip 7

Design images for the case and investigations

Well-designed visual cues add new information to those obtained from the trigger text. These visual triggers may be static images or a series of images, digitalised mini-videos, shock-wave movies, a cartoon, investigation results (such as a chest X-ray), a picture drawn by a child for a paediatric case or part of an article from a daily newspaper (Azer 2007). The visual trigger may be

accompanied by a soundtrack, including lifelike sounds produced by digital synthesis, such as heartbeats and cardiac murmurs, the voice of a patient with a voice disorder or a conversation with a patient presenting with a psychiatric problem (Chur-Hansen & Koopowitz 2004).

Visual triggers complement information obtained from the trigger text and aim at reinforcing a number of educational objectives such as: (a) enhancing students' observation skills, (b) showing the background and the circumstances for the problem discussed, (e) giving students an idea about the severity of a patient's presentation such as a patient with crushing chest pain given oxygen by a mask and treated in the ICU, (d) allowing students to visualise the patient in the case, interact with the case scenario and turn the case into a realistic experience and (v) enabling students to discover any contributing factors (Azer 2007).

In addition to trigger images, other images may be included in PBL cases such as: radiology images, histopathology images and/or blood films and biochemistry, haematology and pathology reports.

Virtual PBL cases are now being added to the student learning experience, and can be used within the tutorials, or for students to work through individually or in small groups in their own time. Virtual cases increase the flexibility level in delivery that is not available in a paper-delivered case (Poulton et al. 2009).

Tip 8

Ensure that a deductive approach is applicable

A good PBL case should demonstrate logical flow and allow students to use knowledge obtained from history, examination and investigations to revisit their hypotheses and rank them (Azer 2004). To explain how the deductive approach can be used in the case, authors need to ensure that as the case progresses, new

information from history, clinical examination and investigations results become available and students have to use the new information to weigh the evidence for and against each of their earlier hypotheses. Such design is important in PBL and will enable students to learn how to use evidence to justify their views and apply scientific approaches in the decision-making process. Therefore, the PBL case design should enable students to:

- learn how to collect information and deal with uncertainty;

- interpret knowledge obtained;

- use new knowledge in ranking their hypotheses;

- group their hypotheses into most likely, less likely and those that can be excluded;

- revisit issues/concepts learnt from previous cases; and

- learn how to use evidence in making a decision.

Tip 9

Ensure that learning objectives are well represented in the case

As stated earlier, the first step in constructing a PBL case is identifying its learning objectives. This task should be completed by the case writing team as they plan to identify the broad lines of the case. The team writing the case should ensure that the case design encourages students to discuss each of these objectives. Therefore, the function of the case writing team is to turn the objectives into a case, while students in their small groups should be able to identify their learning issues and their learning needs. In PBL, students are not provided with the case objectives and it is their role to identify their learning issues. Matching the

learning issues, identified by the students, with the case objectives, will provide course designers with a good evaluation about the effectiveness of the outcomes of the case (Azer 2008). It has also been suggested that student-generated case diagrams of mechanisms (linking hypothesised causes with the patients' sign and symptoms) can also be examined for coverage of the initially intended learning objectives (Guerrero 2001).

Other factors that might affect these outcomes are: (a) effectiveness of students' discussion and group dynamics and (b) the facilitation skills of the tutor. Some schools might choose to show students the intended objectives at the end of each PBL case. Doing so might allow students to discover objectives that they have addressed or included in their learning issues and during the case discussion. However, such practice may make students prone to rely on this information and thus become less motivated for a thorough discussion of the case. Tutor feedback on the learning issues generated by students will be helpful, but at same time it should not be teacher directed.

Tip 10

Think about students' engagement with the case

An important key for constructing successful PBL cases is to make them engaging. There is evidence that engagement occurs when students find that the case: (a) relates to their learning needs, (b) builds on what they learnt from previous cases, (c) encourages their interaction and thinking processes, (d) relates to their life and feelings and touches on psychosocial/moral issues, (e) is well structured so as to provide students with the opportunity to ask questions, research, answers, debate issues, feel uncertain, critically analyse issues, make decisions and work together, (f) allows students to apply knowledge learnt to real-life situations, (g) gives some challenging situations and enforces students to

research their learning issues and look for answers and (h) gives students a sense of satisfaction and a learning experience as they complete the case discussion (Azer 2008).

Construction of engaging cases helps students to discover that there is something new in each case. Through this process, learners will gradually form their learning experience and learn how to deal with uncertainty and construct approaches to help them in their small groups to find solutions to the challenges presented. The design of the PBL case may be based on progressive disclosure, an open-ended design or targeted towards a specific educational aspect (for example, management rather than diagnosis). Selection of a particular design should be made depending on the objectives of the course and the outcomes identified.

Tip 11

Construct a tutor guide for each case

The development of a PBL tutor case guide is an important part of the case writer's role. Case writers need to be mindful that the tutors in a PBL programme can have a wide range of science and clinical backgrounds and with varying degrees of experience in PBL facilitation, and so the guide needs to be written addressing these factors. A tutor guide should include the following elements:

- The objectives that should be addressed through student learning on the case. These objectives will also help the tutor frame their facilitation of the case.

- Background information and explanatory notes on the focus of the case in relation to others completed or to be done and within the overall block or module. These background notes should include some explanations of the

clinical elements and scientific basis of the problem as this will be important for non-expert tutors in this discipline.

- Associated learning activities which will be covered separately during the case that may support student learning.

- For each trigger of the case, some additional explanatory notes can be provided on key terms which will be important.

- Sample facilitating questions can be provided to help tutors either within the tutorial for each session or trigger. These may or may not be used by the tutor in the tutorial but provide a guide as to the areas that should be addressed. It is important that these questions are not seen as a prescriptive requirement.

- Key readings for the tutor can be provided or a list of readings given so that tutors can seek out both the science and clinical information they may need in preparation for the case. This support material is important as the knowledge and experience of tutors will vary.

Tip 12

Review and encourage feedback

Cases should be carefully reviewed before releasing them to the students and feedback from students and facilitators reviewed following introduction of the cases (Washington et al. 2003).

Key questions that authors can use in the evaluation process are:

- Does the case focus on student-centred learning?

- Are the objectives of the case well represented in the case?

- Is the flow of the contents of the case logical?

- Is the case authentic?

- Does the case build on what students have learnt earlier?

- Is the case free from grammatical errors or issues that might confuse students?

- Is the case written in an innovative and creative way?

- Does the case address core issues in the curriculum?

Feedback from students and tutors after the case discussion is a vital source for case improvement and overall quality control in the curriculum (Guerrero 2005). Students might provide their views through electronic questionnaires released at the end of each case while tutors might provide theirs in the debriefing sessions. These comments will help the Course Committee to optimise cases prior to their next use in the curriculum. Key feedback items might include: feedback on the trigger text and trigger images in addressing the desired objectives of the case, the flow of the case and whether the educational objectives of the case have been identified in students' learning issues and overall educational values of the case.

Conclusion

In this article, we have presented 12 tips to guide the construction of PBL cases. These tips reflect our experience in this area and the current status of available literature.

Acknowledgements

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