The focus of this presentation is to overview the paper by Kirschner et al (2007)1 (KSC), as well as the responses and to provide a critique using the context of PBL in the University of Sydney Medical Program (USydMP).

KSC Assumptions & Arguments

- Minimally Guided Instruction (MGI) is less effective and efficient than Direct Instructional Guidance (DIG)
- PBL is a type of MGI approach
- MGI = a learning situation where learners must discover or construct essential information for themselves

These are the underlying issues in the KSC paper and which I, and others, take argument with.

This is in contrast to direct instructional guidance (DIG) where information that fully explains the concepts and procedures that students are required to learn, as well as learning strategy support compatible with cognitive architecture, is provided.

What is regarded as effective and efficient learning here? Is it learning that enables transfer? That is retained for long periods? That is enjoyable? Easily assessed? It is never explained, hence, I would like to go back to what the goal of instruction is per se.

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Goal of instruction

- to provide the level of assistance that will eventually result in independent performance (Ryan 1997)
- What is the optimal level of assistance?

it seems that the argument should be about what is the optimal level of assistance, rather than a blanket statement that MGI is ineffective. I am sure the answer does not lie at either extreme – all or nothing as KSC have argued. As acknowledged by others, we need to do more work regarding the optimal blend of social and self-directive processes (Zimmerman and Lebeau 2000).

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Responses to KSC

- Hmelo-Silver et al (2007) – PBL ≠ MGI because there is a lot of structure and guided support/scaffolding
- Schmidt et al (2007) – PBL is compatible with cognitive architecture. E.G. Prior knowledge, Elaboration

Guidance & support in PBL

- Scaffolding
- Modeling of questions
- Tutor guide (example)
- Electronic CRG (example)
- Timetable (example)
- PBL supported with lectures, clinical day and other tutorials
- Reading list
- Web support (example)
- Provided texts

By the tutor

The tutor uses questions to explore and stimulate students' thinking. This helps the group to set standards for depth and breadth of knowledge, develop reasoning ability, enhance communication skills, adopt professional behaviour and attitudes and develop skills of self and peer assessment (Mennin and Majoor 2000)

In the USydMP, students' time is quite structured, even to the extent of ensuring sufficient 'white space' in their timetable for SDL. [show example timetable] Students' time is structured with lectures, lab sessions and a clinical day, all of which are centred around the PBL case of the week to support students learning. Students meet 3 times a week, each for 90 minutes to discuss the case and their knowledge is constructed and expanded through the careful selection and timing of appropriate lectures, the provision of textbooks in the room, and a list of selected references and one page summaries relevant to the case. As such, the course operates a hybrid PBL system. There is no acknowledgement of such systems in the KSC paper, hence again, the critique of broad sweeping generalizations. Students are also guided by course objectives and suggested readings [show screen shots].

Going downhill	SESSION 1	
Tutor	**Clinical Reasoning**	**Discussion and Learning Topics**

Tutor	Clinical Reasoning	Discussion and Learning Topics
Trigger:	**Identify Cues** *What is observed and/or described in the presentation?* (20 mins)	

Trigger: (Tutor column)

Image: A plump man in his forties sitting back, eyes closed, looking exhausted and flustered; then a view of his ankle, which has a grossly discoloured, dappled appearance, being subjected to finger-tip pressure during a doctor's physical examination.

George Cromwell says that he hasn't been well for the last two years but he hasn't bothered to see a doctor. He says that over the last few months he has been getting breathless when he does any physical activity. In the last few weeks he's noticed that his breathlessness has been worse and he has decided to come to the doctor, adding that in recent weeks he seems to have put on a fair bit of weight and that he has noticed his ankles seem to be swollen. He's had trouble sleeping in bed because of the breathlessness and has had to use three pillows to prop himself up.

Mr Cromwell does shift work as a train driver and not being able to sleep properly is beginning to worry him.

Identify Cues — Anticipated Student Response:
- Middle aged male - train driver
- Been unwell for last two years
- Not seen a doctor
- Breathlessness on exertion over last few months
- Breathlessness worse in last few weeks
- Seems to have put on weight
- Uses three pillows to alleviate breathlessness in bed
- Swollen ankles - last few weeks
- Concerned that he is unable to sleep because of breathlessness

Identify Cues — Discussion Points:
- Why has George not come to the doctor earlier (men's health issues)
- Does George look in good shape? Does he look after himself?
- How does somebody get like this?
- Is George's occupation an issue?
- What is the significance of the pillows. Is there a technical term for this situation (orthopnoea)?
- How easy is it for someone to "put on weight" over a short period of time?

Problem Formulation *Synthesise your thoughts about the problem into a statement and identify questions to investigate.* (10 mins)

Key emphasis for the case
- Review of the anatomy and physiology of the heart as a pump
- The pathophysiology of the failing heart
- The causes and clinical/laboratory assessment of heart failure
- Principles of the treatment of heart failure
- The detection of harmful levels of alcohol intake
- The population burden of heart failure
- The molecular biology of cardiomyopathy
- Historical aspects of the circulation

Problem Formulation — Anticipated Student Response:
Middle aged male train driver, not well for two years, has a two month history of worsening breathlessness, initially on exertion now at rest and causing difficulty in sleeping. He also has swollen ankles and has gained weight over the last few weeks.

Problem Formulation — Discussion Points:
- Why is George breathless?
- Why are his ankles swollen?
- Why has he "put on weight"?
- Is the time frame of George's presentation significant (progression over a long period)?
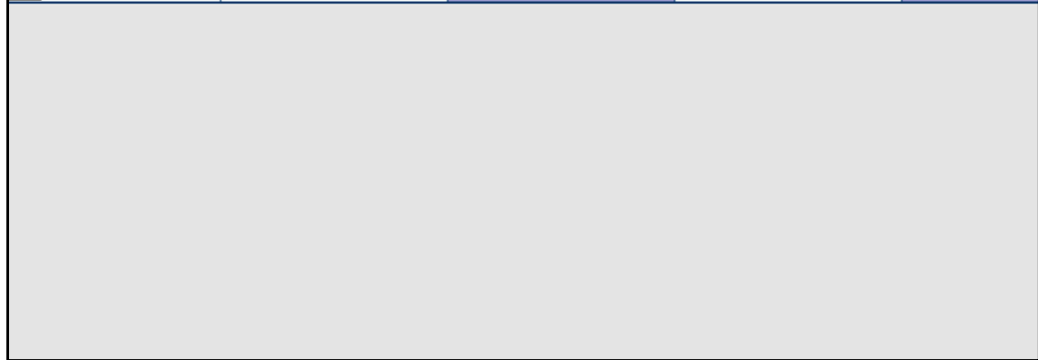
Presentation

Betty Johnson is a 75-year-old female who is brought into casualty in the early hours of the morning with severe, colicky, abdominal pain of 5 hours duration. Her lips are dry and cracked and she has vomited once in the ambulance on her way to hospital.

Questions

1. What problem is the patient presenting with?
2. What are the most likely hypotheses to account for the problem/s?

m - 10am | Footbridge d2/Dent2 Normal Structure of the erus and placenta	10am - 11:30am | Path Lab 559, Blackburn Med2 Gps 25-32 BCS1 Pathological uterine conditions	9am - 10am | Footbridge Med2/Dent2 Dysfunctional uterine bleeding	11:30am - 1pm | Path Lab 559, Blackburn Med2 Gps 1-8 BCS1 Pathological uterine conditions	
am - 11am | Footbridge Theatre d2/Dent2 Sex and behaviour	10am - 11:30am | Leeuwenhoek W201 Med2 Gps 17-24 BCS2 Structure of the female reproductive tract and placenta	10am - 11am | Footbridge Med2/Dent2 From menarche to menopause and beyond	11:30am - 1pm | Leeuwenhoek W201 Med2 Gps 9-16 BCS2 Structure of the female reproductive tract and placenta	10am - 11:30am | PB Med2 Gps 1-16 PBL 3
:30am - 1pm | Footbridge d2/Dent2 CDr Specialisation & tterns of referral		11:30am - 1pm | PBL rooms Med2 Gps 17-32 PBL 2		
	11:30am - 1pm | Path Lab 559, Blackburn Med2 Gps 17-24 BCS1 Pathological uterine conditions		2pm - 3:30pm | Path Lab 559, Blackburn Med2 Gps 9-16 BCS1 Pathological uterine conditions	12pm - 1pm | Eastern Auditorium Med2/Dent2 Androgen
m - 3pm | Footbridge d2/Dent2 Clinical aspects of men's sexuality	11:30am - 1pm | Leeuwenhoek W201 Med2 Gps 25-32 BCS2 Structure of the female reproductive tract and placenta	2pm - 3:30pm | PBL rooms Med2 Gps 1-16 PBL 2	2pm - 3:30pm | Leeuwenhoek W201 Med2 Gps 1-8 BCS2 Structure of the female reproductive tract and placenta	2pm - 3:30pm | PBL r Med2 Gps 17-32 PBL 3
m - 4:30pm | Footbridge Theatre d2/Dent2 PPD Ethical issues in man fertility				
30pm - 5pm | Footbridge Theatre d2/Dent2 - Summative Exam Info ssion				

SUMMARY   FONT: LARGE SMALL

A 43-year-old train driver presents to his local doctor with increasing breathlessness over the preceding few months. He has a long history of heavy drinking and smoki
past history. His clinical signs and investigations are consistent with congestive cardiac failure due to dilated cardiomyopathy, probably caused by alcohol. He respond
represents three months later with a deterioration in his symptoms, warranting hospital admission. His wife is concerned over the effect his illness may have on his em

The case raises the following topics:

- Review of the anatomy and physiology of the heart as a pump
- The pathophysiology of the failing heart
- The causes and clinical/laboratory assessment of heart failure
- Principles of the treatment of heart failure
- The detection of harmful levels of alcohol intake
- The population burden of heart failure
- The molecular biology of cardiomyopathy
- Historical aspects of the circulation.

Please note that the list of issues above should not be considered a definitive list of assessment topics.

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KSC Arguments & Assumptions (2)

- Learning = a change in Long Term Memory (LTM)
- PBL/problem-solving places a huge burden on working memory
- Individual cognitive perspective
- Worked example = epitome of DIG

A second major point made in the paper is that learning equates to a change in long term memory (LTM) and that any instructional procedure that ignores the structures that constitute human cognitive architecture is not likely to be effective, and MGI is one such procedure. Further, if nothing has been changed in LTM, nothing has been learned.

Again, this is another generalization. There are many divergent views of learning and this paper fails to acknowledge this. This paper focuses on PBL from an individual cognitive perspective and as such, this may have blocked other ways of understanding these learning processes (Lycke 2002). One perspective is that learning is a process that results from interactions with the environment (Dolmans, Gijselaers et al. 2002). A similar perspective, socio-cultural in nature, is one in which the learner transforms and is transformed when participating in PBL groups (Lycke 2002). A third perspective is the idea that learning involves the whole person, involves the construction of identity, ways of understanding, viewing oneself and being viewed by others (Koschmann, Evensen et al. 2000)

This paper also fails to acknowledge that learning outcomes are multi-faceted

the goals of learning should include not only conceptual and procedural knowledge, but also the flexible thinking skills and practices required in order to prepare for LLL. So, ones opinion about whether or not MGI is efficient and effective, or whether constructivist and PBL teaching works, depends upon how one thinks about learning, what outcomes one is trying to achieve, and how best to measure and evaluate those outcomes.

Responses (2)

- PBL acknowledges limits on working memory & is structured to minimise cognitive load (Hmelo-Silver et al (2007)
- PBL not equated with problem-solving (Schmidt et al 2007)
- Learning for understanding and meaning not memorisation and recall

Cognitive load refers to the load on working memory during problem solving, thinking and reasoning.

solving a problem is not the aim of PBL. In PBL, patients' problems are used as a springboard for leaning; the solution of the problem, although worthwhile, is not an end in itself (Shin, Haynes et al. 1993)

problem solving by definition involves reflection and reflection can occur only when the problem is unfamiliar to students and an appropriate model answer has not been made available (Liddle 2000). Providing a worked example, argued by KSC to be the epitome of DIG, defeats this purpose.

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CIPHER

PBL cases are organized around authentic, relevant problems and questions – importance of activating prior knowledge with a PBL trigger. This activation through problem discussion facilitates understanding and remembering new information, a change in LTM. By activating and sharing prior knowledge among group members, intrinsic load decreases, enabling students to deal with more complex tasks. Learning in context assists students to organize their LTM for ready retrieval (Walton and Matthews 1989)

Emphasis on collaborative learning and activity. Collaboration distributes cognitive load among members of the group and allows the group as a whole to tackle problems that necessitate access of knowledge beyond that possessed by any individual group member (Faidley, Evensen et al. 2000)

Teacher plays key role in facilitating the learning process and may provide content knowledge on a 'just-in-time' basis

PBL uses text-based resources for both problem-data and SDL

Group discussion facilitates Elaboration by self explanations and stimulates the integration of new information into the knowledge base already present in LTM. In the USydMP this is facilitated by the audio and visual cues accompanying the trigger [show example]. It is argued that information will be better understood and remembered if there is opportunity for elaboration (Albanese 2000)

Training students in collaboration and facilitation skills, or role as chairperson and scribe before instruction starts

Assigning learning tasks to groups rather than individuals

Time released information

KSC Arguments & Assumptions (3)

- Chess experts – the way in which an expert works ≠ way in which one learns
- DIG provides more immediate recall of facts + longer term transfer & problem-solving skills than unguided approaches

Responses (3)

- Pattern recognition in medical students and doctors; increased when problem conveyed more realistically e.g. video based scenario's
- Depends how learning and transfer is defined + what outcomes looked for
- Expertise visible through tutor scaffolding and modeling of questions
- With increasing expertise, support is faded
- PBL is focused on flexible, not direct application of knowledge; Preparation for Future Learning

doctors and senior medical students also use pattern recognition in identifying patients problems and possible causes to provide treatment quickly. In the USydMP and my observations of PBL groups, students frequently referred back to similar cases where patients presented with similar signs and symptoms. The likelihood of effective pattern recognition and future transfer of learning is increased by conveying the problem more realistically, as in a video-based scenario (Hallinger 2002)

I would argue that this depends on how learning and transfer is defined and what outcomes were looked at. This hasn't been included in KSC's description of such studies. These studies also measure learning on transfer success and this is an entirely different issue and again, depends on how transfer is defined and assessed.

In responding to this issue, Hmelo-Silver et al (2007)[2] write that teachers make key aspects of expertise visible through questions that scaffold student learning by modeling, coaching, and eventually fading some of their support. Research has shown that the helpful behaviours of tutors which students reported on were flexibility, encouraging independence, giving students responsibility for their learning and encouraging students to learn – all features which are the essence of PBL (White, Amos et al. 1999).

Schmidt et al (2007)[3] write that with increasing expertise, students are provided with less and less specified resources to stimulate them to search for relevant literature themselves, and this is also the case in the USydMP. In Years 3 and 4 of the program, there are no one page topic summaries, fewer lectures, and less guidance. The tutor is however always a clinician and therefore an expert, in contrast to years 2 and 3 when it was common practice to have non-content expert tutors. However, my research has shown that this has had a detrimental effect on student engagement with PBL. I suggest that this is because their context and role changed, rather than a fault of PBL as a MGI approach however. Had students context and timetable and role remained the same as year 2 for their 3rd year they would have become bored and disinterested. We changed the PBL approach to accommodate students increasing expertise, but this was not congruent with their other tasks and expectations of them, and altogether, became too much for some students. Hence, we recognize the need to further support students in third year with guidance about how to approach some tasks.

Schmidt et al's (2007)[3] second point on this issue of transfer and expertise is that PBL is focused on flexible, not direct application of knowledge, and as a consequence, the kinds of transfer that is aimed at include the ability to prepare for future learning whereas many forms of guided problem-solving focus on direct applications or 'sequestered problem solving tasks'. This ties in with the theoretical basis for PBL and the importance of contextual learning. The basic premise is that when we learn material in the context of how it will be used, it promotes learning and the ability to use the information (Albanese 2000). This is the notion of encoding specificity and refers to the fact that the more closely a situation in which something is learned resembles the situation in which it will be applied, the more likely it is that transfer of learning will occur (Albanese 2000).

KSC Arguments and Assumptions (4)

- Worked example = epitome of DIG; reduces working memory load
- Weak-guidance forces weak problem-solving strategies = heavy extraneous cognitive load
- Providing a learner with problem solution enhances learning compared with discovery learning

Responses (4)

- Worked example fosters rote learning, not suitable for lifelong SDL needed in medicine
- Patient data sheet in USydMP
- Whiteboard reduces working memory load

Knowledge is increasing exponentially and in medicine there is a lot of ambiguity. There will not always be worked examples that are appropriate. Learners need to be equipped with skills to find information and reason through cases, need to be prepared for lifelong SDL and as such it is inappropriate to expect students to learn and retain everything, as some of that information will not be useful or appropriate in the long term. PBL tutors prepare students for a fast-changing world in which they must constantly acquire new skills and knowledge (Dolmans, Gijselaers et al. 2002). Whilst this worked example may be good for LTM, it fails when students need to apply this knowledge and transfer learning to different contexts or when things change.

 In the USydMP, students have access to the patient data sheet at the end of the problem which contains all of the information needed. To complete the picture they could perhaps be given access to the tutor guide but we have never seen the need for this. Usually, the tutor themselves will outline what the key emphases for the case is and there is a problem summary which performs this function as well at the end of the case which students can use to focus their learning.

In the USydMP, load on working memory is reduced by the group using the whiteboard. Each PBL group appoints a scribe, and this role rotates around the group. The scribe is responsible for putting all information from group discussion up on the whiteboards in the room for people to see and reflect on and add to as their progress through the week. Load is also reduced by tutor scaffolding and providing expert guidance when necessary, Load is also influenced by prior knowledge or expertise. Hmelo-Silver et al (2007)2 also acknowledge this point that structure is provided through whiteboards that communicate problem-solving processes as well as through the tutor facilitator. Maintaining the whiteboard as part of the PBL process becomes a routine that helps support intellectual discourse. It also provides predictable ways to move through activity structures, set social norms for participation and use of resources and foster interaction. Routine becomes automated and itself reduces cognitive load demands.

Further thoughts/responses

- Too generalised
- Agree with more learning strategy support needed & direct teaching of SDL skills
- PBL is critiqued but fail to acknowledge positive findings from this method e.g. enjoyable, increase motivation, retain knowledge longer, impact on SDL
- KSC do not acknowledge goals of PBL approach
- Comparison with PBL not fair

All three reviews conducted in 1993 for example found that both students and faculty in PBL schools enjoy the educational process more than those in traditional schools and it is likely that those who enjoy the experience and their interactions would be more likely to engage in LLL (Albanese 2000). All three reviews of the outcomes of PBL vs traditional approaches to undergraduate medical education all acknowledged philosophical advantages of PBL through valuing explicitly students and adult learning principles (Maudsley 2001). Further, the PBL 'experiment' has been endorsed as an educational strategy by the World Federation of Medical Education and the WHO (Finucane, Johnson et al. 1998).

Research has found that PBL:

Fosters over time increased retention of knowledge

Enhances intrinsic interest in the subject matter

Has a large and potentially long lasting impact on SDL skills

Students place greater emphasis on understanding and less on memorizing

Skills such as critical thinking, problem solving, and the ability to transfer knowledge have been shown to improve in PBL environments

(Norman and Schmidt 1992); (Vernon and Blake 1993); (Major 2000)

In comparing PBL as a MGI approach with other methods, the authors do not acknowledge the goals of the PBL approach which go beyond traditional measures of knowledge and knowledge application and frequently include Preparation for Future Learning, SDL and reasoning skills. Indeed, many advocates of PBL would argue that students' attainment of academic self-direction is the primary and most enduring contribution of this important approach to teaching (Zimmerman and Lebeau 2000). What does this academic self-direction involve exactly? It is said to comprise the ability to formulate learning goals, identify resources for learning , choose relevant and appropriate strategies for learning, and evaluate the learning outcomes (Dahlgren and Dahlgren 2002). In PBL, students learn how to learn and can go on acquiring knowledge for the rest of their life (Walton and Matthews 1989). Schmidt et al (2007) critique the KSC paper on the grounds that the evidence cited in favour of DGI comes mostly from highly structured domains and studies on individual learning settings instead of group based settings such as PBL and so the comparison in not fair

Sweller et al are under the impression that PBL emphasizes SDL over direct instruction and I believe are misguided in this view. In the USydMP for example, SDL is encouraged outside of the PBL tutorial and group, not within it. Because students come from a variety of backgrounds and with different learning needs, we expect them to identify their own learning goals, with the support of the lectures and other structured teaching sessions. I also disagree with comments made about collaborative learning which our positive student evaluations provide evidence to refute. I suggest that collaborative learning in this setting is more efficient and aids in self-regulation and learning in general through elaboration and shared expertise.

Conclusions

- Lack of evidence for KSC to support their claims about PBL
- Although lack of objective evidence that PBL produces better doctors than traditional approach, PBL does achieve the aims it intended
- Studies on PBL difficult to compare
- Group and the tutor determine success of PBL in meeting objectives
- A cognitive approach is an extremely limited tool for researching such a complex phenomenon (Loftus and Higgs 2005).

Although I disagree with many of the points raised by in the KSC paper, I would like to thank the authors for their paper and raising the issues discussed which have prompted PBL researchers to re-consider the issues which remain unanswered in this type of instructional approach.

Does constructivist and PBL teaching work?

- It depends!
- What trying to achieve, how measured, curriculum vs PBL component
- If you want to motivate students, create links with practice, have learners retain their knowledge and enjoy the learning experience, than yes, PBL teaching does seem to work.

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Thank you for your attention!

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