Workshop on Effective Implementation of Student-Centered Learning Techniques, Part 3: Problem Crafting for PBL

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Synopsis

This workshop provides an overview of Problem based Learning (PBL) and the different models associated with PBL (which includes POPBL). The main focus of the workshop is on the systematic approach of crafting complex problems for PBL. To get the full benefit from this workshop, participants should have implemented Active & Cooperative Learning.
Learning Outcomes

By the end of this workshop, participants will be able to:

• justify the need for PBL
• explain different PBL models and the reasons behind them
• undergo the Cooperative Problem Based Learning (CPBL) process and explain the significance of each step
• craft problems for CPBL to attain outcomes
Contents

- Introduction to PBL
- PBL Models & The CPBL Process
- Problem Crafting CPL – Phases 1-3
- Problems Presentation
- Closure
Introduction to PBL
Focused Discussion Session...

• Please take about 30 seconds to write on a piece of paper what you understand about Active Learning (AL), Cooperative Learning (CL) and/or PBL

• Any experience with AL, CL and/or PBL? Your thoughts on your experience? Please share them with your neighbour

• We will discuss after about 3 minutes
THE CONE OF LEARNING

AFTER TWO WEEKS WE TEND TO REMEMBER…

10% of what we read
20% of what we hear
30% of what we see
50% of what we see and hear
70% of what we say
90% of what we say and do

Adapted from: Edgar Dale, Audio Visual Methods in Teaching
Principles of Cooperative Learning

- **Positive Interdependence**
- **Individual Accountability**
- **Face to Face Interaction**
- **Regular Grp Function Assessment**
- **Appropriate Interpersonal Skills**

Cooperative Learning
Informal
Ad-hoc groups perform structured active learning activities

Formal
Formally assigned long-term groups may perform longer structured activities

Plus: Cooperative Base Groups
The Active Learning Continuum

- Make the lecture active
- Informal Group Activities
- Structured Team Activities
- Problems Drive the Course

- Instructor Centered
- Collaborative Learning
- Cooperative Learning
- Problem-Based Learning

- Student Centered
- Active Learning
- Informal Group Activities
- Structured Team Activities

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Traditional Teaching and Learning (T&L) Model

Deductive T&L
- Told what to learn
- Learn
- Give exercises for illustration

Problem-Based Learning Model

Inductive T&L
- Identify what to learn
- Learn
- Apply
Can we learn from problems?

Problems

- Provide opportunity to improve a situation
- Can be a catalyst for inquiry, learning, and problem solving
- Activates prior knowledge to use as a base to acquire new knowledge
- Mimic real work demands
- Multi-dimensional and integrative
What is Problem-based Learning (PBL)?

Problems/case scenarios as a stimulus for learning and encouraging active processing of information, activation of prior knowledge with opportunities for elaboration/organisation of knowledge

Why PBL...?
## The Grand Challenges in Engineering Education

<table>
<thead>
<tr>
<th>Global Sustainability</th>
<th>Destruction of forests, wetlands, and other natural habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global warming</td>
</tr>
<tr>
<td></td>
<td>Ballooning global population</td>
</tr>
<tr>
<td>Energy</td>
<td>Unsustainable fossil fuel</td>
</tr>
<tr>
<td></td>
<td>Sustainable energy technologies</td>
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<tr>
<td></td>
<td>Alternative energy technologies</td>
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<tr>
<td></td>
<td>Energy infrastructure</td>
</tr>
<tr>
<td>Global Poverty and Health</td>
<td>Green revolution</td>
</tr>
<tr>
<td></td>
<td>1/6 population - extreme poverty</td>
</tr>
<tr>
<td></td>
<td>Globalization</td>
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<tr>
<td>Infrastructure</td>
<td>Aging infrastructure</td>
</tr>
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<td></td>
<td>Urbanization</td>
</tr>
<tr>
<td></td>
<td>Manufacturing to knowledge services</td>
</tr>
<tr>
<td></td>
<td>Systems integration</td>
</tr>
</tbody>
</table>
Why PBL?

Can we develop future graduates if we...

• Teach content that becomes obsolete
• Impart skills that are not sufficiently transferable to the work place
• Use learning processes that do not impact on life-long learning
• Use learning environments that do not encourage motivation and independence
Pedago-pathologies

Amnesia

Fantasia

Inertia

Lee Shulman – MSU Med School – PBL Approach (late 60s – early 70s), Currently President of the Carnegie Foundation for the Advancement of College Teaching

Why PBL?

Research on Learning

• Brain preferences indicate that attention and arousal is enhanced with holistic, pictorial and broad-based presentation (rather than separate entities and single concepts)

• The learner is intuitively searching for context. Context provides meaning.
Why introduce PBL? - an institutional perspective

- After 15 months of study, first year students following a PBL curriculum showed greater improvements in meta-cognitive processes of planning, monitoring and evaluating their own learning than a matched group of first year students following a non-PBL curriculum within the same discipline of engineering.

- Group A are degree students, group B are associate degree students

*Downing 2007*
Why introduce PBL?
- an institutional perspective

Mean difference LASSI score (3 components and overall)
Group A (non-PBL) vs. Group B (PBL)

- Group A Mean Difference
- Group B Mean Difference

Self-regulation: -0.64
Skill: 0.98
Will: -0.30
Overall: -0.20

Downing 2007, 2010
Implementation in Process Control & Dynamics

• Required for undergraduate chemical engineering students in their fourth year

• Notorious as a “killer” subject
  – High percentage of failure and low passing grades
  – Had to open-up UM/BA section!

• Difficult subject
  – Covers mathematical modelling of process dynamics, control systems design and analyses of chemical processes
  – Requires strong background in differential equations and previously taken chemical engineering courses
  – Need to understand process operation and relate mathematical equations to physical reality

• In a typical lecture, students very passive
Test Results for Question on PBL Topic from week 8 to week 12 (out of 33)
### Survey after 4 weeks of PBL...

<table>
<thead>
<tr>
<th>Questions posed (simplified)</th>
<th>Positive</th>
<th>Negative</th>
<th>Undecided</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S1</td>
<td>S5</td>
<td>S1</td>
</tr>
<tr>
<td>Feelings on PBL?</td>
<td>65</td>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>Learned more in PBL compared to lecture?</td>
<td>73</td>
<td>79</td>
<td>17</td>
</tr>
<tr>
<td>Recommend PBL in other subjects?</td>
<td>96</td>
<td>96</td>
<td>4</td>
</tr>
<tr>
<td>Attend another course using PBL?</td>
<td>95</td>
<td>94</td>
<td>0</td>
</tr>
<tr>
<td>Problem-solving ability increased?</td>
<td>76</td>
<td>96</td>
<td>15</td>
</tr>
<tr>
<td>Self-dir learning and motivation increased?</td>
<td>87</td>
<td>96</td>
<td>7</td>
</tr>
<tr>
<td>Interaction and team-work skills increased?</td>
<td>89</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Self-confidence increased?</td>
<td>70</td>
<td>84</td>
<td>18</td>
</tr>
</tbody>
</table>
The Psychology of Problem Engagement

Using problems as the driving force for

• Motivation
• Learning
• Thinking
• Collaboration
• Innovation
• Enterprise
• The following three slides show the opinion of three students who had undergone PBL in different semesters. Read the slides and share what you can deduce with your neighbour.
“I had survived through separation I, Chem Eng thermo, differential equation in which these subjects had presented me with the impression that as long as you study 24 hours 3 days before the test/exam, don't worry, it will cure ur sickness of "Oh..I don't know anything about this subject". So by having this deep in my mind, I had the conception that "ok..as long as I study hard 3 days before the test for Process Control..I won't die larr". ...So this is my initial hypothesis before entering the first class for Process Control. "Study hard like how I study before..and I will survive...“

Frankly, the education system has really make me forget all about team work stuffs and I was too busy about the A or B that I might get in the end. This misconception has really drive me crazy all the semester. I think that the knowledge part is already a hard part....but the biggest challenge isn't about process control, it's about how to get our team going. How to merge all people's idea into 1 great solution, how to transform members who are quiet into people who will talks a lot during the discussion, how to distribute task among members so that they don't think the leader is heavy one side...all these are the biggest challenges. ..with no team working spirit, I can guarantee you that you won't come out with a good solution for the case study. So I think that the core of PBL system isn't just about transforming the learning system from spoon feeding into peer to peer learning system, but it's about teamworking spirit ...”
“... At first, when we started the class with case study 1a, i take the class so lightly by just study in class and do nothing at hostel .... but then , when we start the discussion in class, i was the one who sit and do nothing ...., and it really made me feel PRESSURED .. hohoh ... i don’t wanna be the black sheep in the group and later on i started study like hell .... and for heaven sake, i think i can strongly give opinions and argument to the cases .... hahaha .... IT’S ALL ABOUT THE PRESSURE. In class, that’s the awesome part .. I’ve never seen a class a 2 hour class where no one is sleeping .. even yawning ... my gosh .... and for those sleepy heads in class for sure are pressured to see everyone so gutsy and up on their toes to give opinion and take part in class ... everyone struggling to state and protect their opinion which make the class in some sort of debating ...hohoh ...”
Student 3

I had my first team discussion on last Wednesday for our Case Study 1B. That day supposedly is a “holiday” for me since I don’t have any class for the whole day. Usually on the holiday, after the Subuh prayer, I will continue my sleep. But on that day, I’ve to skip my routine since I doubt I might be late for our first discussion. Well, first impression is important right?

We reach at KTDI, it was 10 minutes before 9 am. Actually other groups were already started their discussion that morning. By 9 o’clock, the numbers of group discussion were increase. There few corners at the KTDI dining Hall were occupied by other teams. When I went to faculty on that afternoon, the panorama is quite the same. Few groups of people were discussing on that case in the different spots and corners at the faculty. It’s not a common phenomenon for me as I never had that kind of discussion before. Yes, I already had group assignment and lab report before, but common practice was, all of our group member are doing their specific part on their own, and the we’ll combined all the assignment or report together with no discussion.

I was trying to do the same trick for this case study, but when some of my friend told me that I wouldn’t gain that much if I did it, then I decide to gave myself some new experience. To be my surprise, it’s true! I wasn’t notice that it took us three hours after I finished the discussion. Those three hours of interesting discussion, debate, and argumentation really help me to understand this case study better compare to if I’m doing on myself. The four of us really take part of the discussion and try to solve the problem. Although some of us really didn’t prepared for the discussion, but for me it’s just our first case study. We were in our early stage of PBL, so it’s not that easy to coop with the “system”. After finished the case study, then I eventually know, how to read the Piping and Instrumentations Diagram (P & ID). It also helps me to differentiate the control loop for multiple processes.

For my next case study, I will definitely be more prepared before attending the group discussion or the class. And for this time, I’ve to read the whole 2nd chapter of Seborg’s and explain what I’ve read for the rest of my teammates.
From a “C” Student

I love PBL. It is a different kind of learning. Though I think it is almost “sunset” that I manage to experience PBL, nothing is ever too late.

PBL forced me to read. It made me learn, study, read and practice ... The most precious benefit I get from PBL is I read. The greatest pleasure I get from PBL is friends. The best thing about PBL is appreciation.

I’m now clear about the right strategy to learn; before this, I used to cry. And now, I really know how to communicate!
“PBL in the classroom is not only about infusing problems into the class, but also about creating opportunities for students to construct knowledge through effective interactions and collaborative inquiry.”

Tan, O. S. (2003) in *Problem-based Learning Innovation*
The PBL philosophy

• A constructivist perception of learning and teaching:
  – **Learning** is the student’s individual process of constructing knowledge and meaning
  – **Teaching** is the ”setting up of a situation from which a motivated learner cannot escape without having learned” (Cowan)

• In other words: Student-Centred Learning (SCL)

• Many different models exist
Problem-Based Learning Approach

Realistic Problem

Lecturer as Designer & Coach

Student as Problem Solver

LO:
- Content
- Attitude
- Skills

Facilitation skills required to make thinking visible. Proper assessment made on both content and process. Need TRAINING!

Do not readily have the skills for PBL – must be prepared and motivated by lecturers

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Problem-based Learning (PBL)

Content-based Learning
Given problem to illustrate how to use it
Learn It

Told what we need to know

Learn It

Problem-based Learning
Apply it

START

Identify what we need to know

Boud (1997): “The principle idea behind PBL is that the starting point for learning should be a problem, a query or a puzzle.”
Types of Problems in Curricula

- Real World
- Routine
- Artificial
- Novel

The kinds of learning needed

Current preoccupations
Problem Solving Topology

**What’s the Difference?**

**Problem Solving**
- Process to obtain best answer to an unknown, subject to constraints
- Ill defined
- Novel
- No explicit statement
- More than one approach
- Algorithm to solve unclear
- Integration of knowledge
- Strong skills of presenting results

**Exercise Solving**
- Process obtain the one and only answer
- Well defined
- Encounter similar problem before
- Explicit, hints given
- Usually one approach to one answer
- Recall familiar solutions – usual method
- Subject by subject
- Presentation skills not required
Feedback from students on getting realistic problems

Solving the case study reveals the importance of the knowledge gained in this class in industry.

I understand how the learning process in this class is related to develop...
PBL Models & Processes
Example PBL Models

1. Medical School Model:— University of Maastrich (UM)
2. One-day One-problem Model: Republic Polytechnic (RP)
3. Problem-oriented Project Based Learning (POPBL): Aalborg University
4. Cooperative Problem-based Learning (CPBL): UTM, U of Delaware, Temasek Polytechnic
The Maastricht Medical School Model

• Introduced PBL in the Medical School at the founding in 1975
• The PBL approach spread to other professional programmes, including engineering
• Model adapted to suit the specific demands of each institution
• In engineering the model is ‘adapted POPBL’
• Thematic block of 6 weeks – 1 problem per week → 6 related problems
The Maastricht Model - Principles

• Learning based on problems and case studies (= real patient records)
• Integration of disciplines and skills
• Interdisciplinarity secured via interdisciplinary teams of teachers responsible for themes
The Maastricht Model - Structure

- Curriculum structure - thematic blocks of 6 weeks
- One problem per week – 6 related problems
- Study groups of 8 – 10 students
- Regular meetings within the study group
- A non-expert group tutor participates in all meetings
- Self-directed learning + skills training sessions
- Individual block and progress examinations
The Maastricht model - the 7 steps method

1) Clarifying terms and concepts not readily understood
2) Defining the problem
3) Analysing the problem
4) Summarising the various explanations of the problem into a coherent model
5) Formulating learning objectives
6) Studying individually
7) Reporting and synthesizing the newly acquired information.

1) – 5) and 7) in the study group, 6) individually
RP – ’one day – one problem’

- Diploma program: 3 years, 30 modules
- 1 semester = 16 weeks, 5 modules per semester
- 4 contact hours per module and per week
- 20 contact hours per week
- 4 ‘understanding tests’ per module and semester
RP – ’one day – one problem’

- 25 students per class – 5 teams of 5 students
- A facilitator assigned for the day for each class
- A problem given in the morning
- Five different but related problems per week
- Daily assessment supplemented by ’understanding tests’
# The daily routine at RP - 1

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Activities (and actors: f=facilitator, s=students)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First meeting</strong></td>
<td>Presents problem trigger + scaffolding (f)</td>
</tr>
<tr>
<td>(1 hr)</td>
<td>Analyse problem (f + s)</td>
</tr>
<tr>
<td></td>
<td>Identify known – unknown - learning needs (f + s)</td>
</tr>
<tr>
<td></td>
<td>Assign research duties (s)</td>
</tr>
<tr>
<td><strong>First break out</strong></td>
<td>Search, select, structure information</td>
</tr>
<tr>
<td>(1 hr)</td>
<td>Make meaning</td>
</tr>
<tr>
<td><strong>Second meeting</strong></td>
<td>Discuss progress and difficulties (s + f)</td>
</tr>
<tr>
<td>(1 hr)</td>
<td>Helps develop learning strategies (f)</td>
</tr>
<tr>
<td>Sessions</td>
<td>Activities and (actors)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Second break out</strong></td>
<td>Review resource materials</td>
</tr>
<tr>
<td>(2 hr)</td>
<td>Peer teach each other</td>
</tr>
<tr>
<td></td>
<td>Prepare presentations</td>
</tr>
<tr>
<td><strong>Final meeting</strong></td>
<td>Present outcomes – discuss, justify, defend (s)</td>
</tr>
<tr>
<td>(1 hr)</td>
<td>Presents ‘the sixth outcome’ (f)</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>Do an individual written quiz (self assessment)</td>
</tr>
<tr>
<td>(½ hr)</td>
<td>Write in personal reflective learning journal</td>
</tr>
</tbody>
</table>
## The Aalborg Model – POPBL – Study Structure

<table>
<thead>
<tr>
<th>Bachelor programmes</th>
<th>Master programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Semester</td>
<td>Master’s thesis</td>
</tr>
<tr>
<td>9. semester</td>
<td>Specialisation</td>
</tr>
<tr>
<td>8. semester</td>
<td></td>
</tr>
<tr>
<td>Bachelor project</td>
<td>7. semester</td>
</tr>
<tr>
<td>Specialisation</td>
<td>6. semester</td>
</tr>
<tr>
<td>Bachelor education</td>
<td>5. semester</td>
</tr>
<tr>
<td></td>
<td>4. Semester</td>
</tr>
<tr>
<td></td>
<td>3. semester</td>
</tr>
<tr>
<td>Basic education</td>
<td>2. semester</td>
</tr>
<tr>
<td></td>
<td>1. semester</td>
</tr>
<tr>
<td></td>
<td>Basic education</td>
</tr>
</tbody>
</table>
The Aalborg Model – Semester Structure

Project courses (P) – supporting project work – min. 25% (7-8 ECTS)

Study courses (S) – general knowledge – max. 25% (7-8 ECTS).
Separate exams.

Project work – groups of 2 – 7 students – min. 50% (15 ECTS).

P-courses and project examined together.

1 semester = 15 weeks + 5 weeks = 30 ECTS = 900 hours student work
The Aalborg Model – Semester Timing

<table>
<thead>
<tr>
<th>Mm. 1</th>
<th>S-course 1</th>
<th>S-course 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mm. 2</td>
<td>S-course 2</td>
<td>P-course</td>
</tr>
<tr>
<td>Mm. 3</td>
<td>P-course 1</td>
<td>P-course</td>
</tr>
<tr>
<td>Mm. 4</td>
<td>P-course 2</td>
<td>P-course</td>
</tr>
<tr>
<td>Mm. 5</td>
<td>P-course 1</td>
<td></td>
</tr>
<tr>
<td>Mm. 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mm. 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mm. 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mm. 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mm. 10</td>
<td>Free study act.</td>
<td>Free study act.</td>
</tr>
</tbody>
</table>

- 10 Mm/week – 1 Mm = 4 hours = ½ day
- 5 weeks
- Free study act.

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innovative ● entrepreneurial ● global
• The following slide contains a comparison of the three PBL models. Take about three minutes to look at the slide on your own, then discuss for about three minutes what you can understand or do not understand with your neighbour.
<table>
<thead>
<tr>
<th></th>
<th>RP</th>
<th>UM</th>
<th>AAU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of stud.</strong></td>
<td>5</td>
<td>8 - 10</td>
<td>2 – 7</td>
</tr>
<tr>
<td><strong>Lectures - problem work</strong></td>
<td>No lectures (?)</td>
<td>Few lectures</td>
<td>½ lectures ½ project</td>
</tr>
<tr>
<td><strong>Length of problem work</strong></td>
<td>One day</td>
<td>One week</td>
<td>One semester</td>
</tr>
<tr>
<td><strong>Pre-structure of problem</strong></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>‘Teacher’ direction</strong></td>
<td>High</td>
<td>Low</td>
<td>Low to medium</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>Presentation + learning</td>
<td>Learning</td>
<td>Report, product, presentation + learning</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>Individual Daily+ ‘understand’</td>
<td>Individual Block+progress</td>
<td>Individual S-course+proj.</td>
</tr>
</tbody>
</table>
Project-based Learning vs. Problem-based Learning
What’s the difference?

<table>
<thead>
<tr>
<th>Problem-based</th>
<th>Project-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content/learning issues not taught/revealed</td>
<td>Content already revealed</td>
</tr>
<tr>
<td>Learning issues in problem well defined by lecturer</td>
<td>Specific learning issues not defined – depends on students</td>
</tr>
<tr>
<td>Systematic facilitation in problem identification stage, self-directed learning and peer teaching, synthesis</td>
<td>May or may not be guided in systematic problem-solving</td>
</tr>
<tr>
<td>Closure and process reflection</td>
<td>Not necessary</td>
</tr>
</tbody>
</table>

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What is Problem/Project-Based Learning?

- Problem Engagement
- Inquiry and Investigation
- Problem Definition
- Problem Resolution
- Problem Debriefing

Problem-Based

Product emphasis

Process emphasis

From Strobel, 2011

Stepien & Gallagher
Kolmos, et al, 2009
Different levels of implementation

- Micro Level
- Macro Level
- Mega Level
Course 1

Course 2

...

Course n

Corner Stone Project

Semester X
Project-Oriented Problem-Based Learning (POPBL)

Course 1
- Micro Level Project 1

Course 2
- Micro Level Project 2

Macro Level Project

Course 1

Course 2
Project-Oriented Problem-Based Learning (POPBL)

Mega Level Project

Course 1

Course 2

Course n
Opening of UNESCO Centre on PBL in Engineering Science & Sustainability, Aalborg U, Denmark, May 2014
PBL in Malaysia
Part of the PBL in Asia Series
UTM Centre of Engineering Education (CEE)
http://tree.utm.my
What does it take to successfully be a PBL champion?
What does it take to successfully be a PBL champion?

• Clearly understand and visualize the PBL cycle that will be implemented

• Be willing to be a PBL learner – ie do a PBL on PBL
  – Identify and examine the shortcomings in knowledge or implementation of PBL
  – Motivated to read to fill in gaps in knowledge (self-directed learning) – take a scholarly approach
  – Work in a team (collaboratively learn with others)
  – Apply knowledge found to improve implementation
  – Evaluate results and reflect implementation to come up with CQI actions
COOPERATIVE PROBLEM-BASED LEARNING (CPBL) & PHASE 1 OF CPBL
The PBL Process

Meet the problem

Self-directed learning

Synthesis & application

Presentation & reflection

Closure

Phase 1

Problem identification & analysis

Phase 2

Phase 3
Medical School Model

Typical course implementation

Small groups in a medium/large class using a floating facilitator
Performance Level of a Group (K. Smith, 2007)

- **Pseudo-group**
- **Individual Members**
- **Traditional Group**
- **Cooperative Group**
- **High-performing Cooperative Group**
Principles of Cooperative Learning

- Positive Interdependence
- Individual Accountability
- Face to Face Interaction
- Appropriate Interpersonal Skills
- Regular Grp Function Assessment

Johnson, Johnson & Smith in “Active Learning: Cooperation in the College Classroom”, 2006
Pattern in CL Activities

- Individual construction
- Construction and/or interaction with neighbor/team member
- Overall class interaction with instructor

Involves everyone in the class!
The PBL Process

Phase 1:
- Meet the problem
- Problem identification & analysis

Phase 2:
- Self-directed learning
- Peer teaching, synthesis & application
- Presentation & reflection

Phase 3:
- Closure
PBL Phase 1 + CL = ?

Meet the problem

Self-directed learning

Problem identification & analysis
PBL Phase 2 + CL = ?

Peer teaching,
synthesis & application

Peer teaching

Team synthesis for application and solution formulation

Team consensus on final solution

Should additional scaffolding be added?
Cooperative Problem-Based Learning (CPBL) Model

Phase 1
- Overall class problem identification & analysis
- Team discussion & consensus in problem restatement & identification
- Individual meet the problem, restatement & identification

Self-directed learning

Phase 2
- Individual notes, Peer teaching in team & overall class discussion
- Team synthesis & application for solutions formulation
- Team consensus on final solution generation

Phase 3
- Presentation, reflection & team feedback
- Closure

* Insufficient understanding of learning issues to solve problem
** Incomplete or misunderstanding of problem requirements

IEEE & IJET paper 2011
Forum Post from a Student:

“Going through the CPBL cycle has helped me a lot in completing the case study. With this cycle, I'm able to settle the problem step by step and at the same time reducing the stress on thinking how to settle this complicated problem myself. The discussions with team mates and during classes reduce my burden on this problem and it became easier for me to solve the problem.”
UTM CPBL Model

- PBL + CL = CPBL
- Small groups (3 to 5 students per team) in a medium to large class (30-60 per class) – floating facilitator
- Used to cover content – in the form of learning issues (knowledge gap) – which must be learned to solve problem
- Designed based on **Constructive Alignment and HPL Framework**
- Duration: 1 to 4 weeks
On-going Work:
Researching the Effectiveness of Cooperative Problem Based Learning (CPBL)
Research on CPBL

• Does CPBL enhance:
  – Motivation and Learning Strategies
    • Motivated Strategy for Learning Questionnaire (MSLQ), \( \alpha = 0.97 \)
  – Problem-solving
    • Engineering Problem-solving Instrument (EPSI), \( \alpha = 0.94 \)
  – Team-working
    • Team-working Effectiveness Score (TES), \( \alpha = 0.98 \)
• Pre and post test given to measure the difference at the end of the semester compared to the beginning of the semester
### Motivated Strategy for Learning Questionnaire (MSLQ)

<table>
<thead>
<tr>
<th>Section</th>
<th>Component</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Value</td>
<td>1. Intrinsic Goal Orientation 2. Extrinsic Goal Orientation 3. Task Value</td>
</tr>
<tr>
<td></td>
<td>Expectancy</td>
<td>4. Control of Learning Beliefs</td>
</tr>
</tbody>
</table>

Overall reliability, $\alpha = 0.97$
## Result of pair t-test

<table>
<thead>
<tr>
<th>Scale</th>
<th>p&lt;0.05</th>
<th>Effect Size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic</td>
<td>0.000</td>
<td>1.49</td>
</tr>
<tr>
<td>Extrinsic</td>
<td>0.018</td>
<td>0.41</td>
</tr>
<tr>
<td>Task Value</td>
<td>0.000</td>
<td>1.41</td>
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<tr>
<td>Control Belief</td>
<td>0.000</td>
<td>0.99</td>
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<tr>
<td>Organization</td>
<td>0.000</td>
<td>1.38</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>0.000</td>
<td>1.95</td>
</tr>
<tr>
<td>Effort Regulation</td>
<td>0.000</td>
<td>0.89</td>
</tr>
<tr>
<td>Help Seeking</td>
<td>0.000</td>
<td>1.30</td>
</tr>
</tbody>
</table>
Motivation
Intr = intrinsic goal orientation
Extr = extrinsic goal orientation
Tskv = task value
Cont = Control of learning beliefs

Learning Strategies
Org = organization
Crit = critical thinking
Eff = effort regulation
Hsk = help seeking

Value
Expectancy

Cognitive/
Meta-cognitive
Resource
Management
Problem Solving Ability - Deep Thinking

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>p&lt; .05</th>
<th>Effect Size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Identification</td>
<td>8.86</td>
<td>Sig</td>
<td>1.80</td>
</tr>
<tr>
<td>Analysis and Synthesis</td>
<td>8.89</td>
<td>Sig</td>
<td>2.09</td>
</tr>
<tr>
<td>Solution Generation</td>
<td>9.68</td>
<td>Sig</td>
<td>1.84</td>
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<tr>
<td>Reflection</td>
<td>10.02</td>
<td>Sig</td>
<td>1.59</td>
</tr>
<tr>
<td>Self-directed Learning</td>
<td>7.42</td>
<td>Sig</td>
<td>1.74</td>
</tr>
</tbody>
</table>
Problem Solving Assets

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>p&lt; .05</th>
<th>Effect Size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>11.402</td>
<td>Sig</td>
<td>1.92</td>
</tr>
<tr>
<td>Expectation</td>
<td>8.615</td>
<td>Sig</td>
<td>1.76</td>
</tr>
<tr>
<td>Process</td>
<td>9.898</td>
<td>Sig</td>
<td>2.08</td>
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</table>
### Team-Working

<table>
<thead>
<tr>
<th></th>
<th>Sig. (2-tailed)</th>
<th>p&lt; .05</th>
<th>Effect Size (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interdependence</td>
<td>.040</td>
<td>Sig</td>
<td>-0.265</td>
</tr>
<tr>
<td>Potency</td>
<td>.023</td>
<td>Sig</td>
<td>-0.293</td>
</tr>
<tr>
<td>Goal Seeking</td>
<td>.018</td>
<td>Sig</td>
<td>-0.306</td>
</tr>
</tbody>
</table>
PHASE 1 OF CPBL
Cooperative Problem Based Learning (CPBL) Model

Phase 1

- Indiv. meet the problem & identification
- Team discussion & consensus in problem restatement & identification
- Overall class problem identification & analysis
- Self-directed learning

Phase 2

- Peer teaching, team & overall class discussion
- Team synthesis & application for solutions formulation
- Team consensus on final solution generation

Phase 3

- Presentation, reflection & team feedback
- Closure

* Insufficient understanding of learning issues to solve problem
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LET’S FORM TEAMS AND START PHASE 1 OF CPBL
TLA in Phase 1

- Individual Problem Restatement & Prob Identification (PR&PI)
- Team discussion & consensus on PR&PI
- Overall class discussion
Problem Restatement & Identification (PR & PI)

• Identify:
  – What is known
  – What data or information needed
  – New knowledge needed to solve problem → learning issues
Why is it important to activate prior knowledge in learners?
Why is it important to provide context?
How does learning actually occur?

Let’s look at part of the third segment of the video “Teaching Teaching, Understanding Understanding”
# Phase 1 of CPBL Process

<table>
<thead>
<tr>
<th>Process</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Meet the problem.</strong> Students read and address problem. Come-up with a problem statement agreed by the team</td>
<td>Teaches students to encode and organize information in useful ways. Allows students to find what they know and what they don’t know. Misconceptions can be corrected in discussion of the problem. Ensure sweeping assumptions and biases are avoided</td>
</tr>
</tbody>
</table>
### CPBL Process

<table>
<thead>
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<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. <strong>Problem identification.</strong> Students discuss and analyze problem using prior knowledge and resources available. May use KNL or FILA table to analyze problem</td>
<td>Development of cognitive skills for problem-solving process</td>
</tr>
<tr>
<td>Facilitator poses questions: ie.</td>
<td>Development of self-monitoring skills to identify the learning needs</td>
</tr>
<tr>
<td>• Do you need more information?</td>
<td>Development of habitual student-initiated questioning</td>
</tr>
<tr>
<td>• Are you sure of the facts or will a review be helpful?</td>
<td></td>
</tr>
<tr>
<td>• Do you think more information on this area would be helpful?</td>
<td></td>
</tr>
</tbody>
</table>
The KNL Table for Problem Identification/Analysis

<table>
<thead>
<tr>
<th>What we know</th>
<th>What we need to know</th>
<th>Learning issues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Let’s try to look at a problem...
The Mosquito Problem

There is an explosion of mosquitoes in a suburban region of Kampala, Uganda. Local news report that several villages and towns there have been under siege from disease-carrying mosquitoes. According to a report from a nearby medical centre, a number of people have been hospitalized. The usual method of mosquito control do not seem to be effective. You are with a group of humanitarian volunteers & workers. The group has been approached to help with the problem. You have access to further support, resources and funding, which will be given based on your recommendations. What recommendations will you make to help solve the problem?
How to tackle the problem?
Now let’s look at YOUR problem....