

"Problem-based Learning: helping your students gain the most from PBL" 3rd edition, March 1996

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### 3. What about process skills used in PBL?

Whether we use active learning, cooperative small group learning or fully-developed small group, self-directed, interdependent PBL students need

- To manage change ... because what you are doing is a change from what they are used to;
- To solve problems, identify issues, think critically, generate and test hypotheses ... because we are actively solving problems;
- To know the skills in lifetime learning... because they are actively focusing on learning and perhaps cooperatively teaching and learning together.
- To work effectively in groups... because working effectively is more than just "being in a group".

Using these skills will take away at least 20% of your curricular time (Albanese and Mitchell, 1993). Indeed, if we desire these skills as measurable outcomes of the program, then we may need to take even more than 20% of your time away from learning subject knowledge.

Much has been said about PBL and problem solving skills, group skills, self-assessment skills and process skills, in general. Behind all the rhetoric, all agree that

just setting up a small group, self-directed, PBL group does **not** develop these skills. (Norman and Schmidt, 1992 and 1993; Woods, 1993)

You provide an opportunity; but you do not develop skill. To develop skill requires that you explicitly take the skill apart, ask them to try it, figuratively hold up a mirror so that they can see how they did the skill, describe potential target skills, and then give them practice + feedback, practice + feedback until they know they have the skill. Continually ask them to reflect on the processes they are using. Writing a reflective journal about those processes has a very positive impact. This all takes time.

We need to decide

- a. When and to what extent are we going to address the process skills.

b.How important we feel the process skills are as desired outcomes for the course/program.

c.How explicit we plan to be in their development.

As a personal sidenote, in the late 1970s our Department concluded that we can't teach everything that students need to know in their career. With knowledge expanding as rapidly as it is, we cannot possibly "provide lectures" and give courses on all the knowledge a professional will need in his/her career. We decided that instead of trying to give lectures on every conceivable topic, we would help them develop lifetime learning skills so that they could acquire the new knowledge as they needed it. Expressed in other words, "We were going to teach our students how to fish rather than continually give them more fish."

In our program, we cancelled four technical subjectcourses and replaced them by four courses to develop our student's skill in lifetime learning, problem solving, group process, self-assessment, and communication. Since we value those "process skills" we assess both our students' comprehension of Chemical Engineering **and** the process skills required to put that knowledge to work effectively and efficiently. Process skills are valued; they are built explicitly into the program; they are assessed. Our students know the fundamental core knowledge of Chemical Engineering. They know less Chemical Engineering enrichment areas than students graduating from other Chemical Engineering programs (maybe 20% less). They do have the lifetime learning skills, the problem solving, group and self-assessment skills that will allow them to keep up-to-date and continue to learn on their own or to learn cooperatively. Our graduates are different because they possess a completely different set of well-developed process skills. This decision was made in the late 1970s. We have never regretted it. The responses from employers and alumni are that these process skills are the ones needed by the professional in today's world.

### **3.1 Developing process skills for the tutor, for the students or for both?**

Process skills are required for small group, self-directed PBL to function effectively. Many schools focus on training programs for the tutors. That's good because most of us have not had a chance to get feedback about these vital skills.

When resource limitations mean that tutorless groups are used, the students should receive those training programs.

Ideally both tutors and students should receive training.

Consider now the issues of when to develop the process skills, how vital are these skills for your graduates and how explicit do you want to be in developing the skills.

### **3.2 When to develop the process skills**

When to develop the process skills? Some of the options include:

Admit only those students who possess the process skills already. This is the approach taken by McMaster Medical School, MD program. They pretest the students; the student's skill in PS and group skills are criteria for admission. This is assessed during 2 h simulated tutorial scored by 3 assessors viewing through a one-way mirror. Resources: 400 students assessed in two successive 2 day weekends. Training session for the assessors. Each assessing group observes for 1 h, writes up critique for each of 5 to 6 students observed, and then repeats the cycles.

Train the tutor and depend on the tutor to supply these process skills; hope that, by modeling the skills, the students may acquire some of them.

Develop the process skills **before** allowing the students into the PBL activities. Three options are: provide 40 h of workshops; provide 100 h of workshops or use the MPS-Osterman feedback lecture. Newcastle Medical school and the McMaster Engineering and Management program provide 40 h, week-long course for the process skills. The content and activities vary. The McMaster Chemical Engineering department has three required courses with about 100 h of workshops before the PBL starts.

Details of the 40 h version are given in Table 6-1. The 120 h version, called the McMaster Problem Solving program (MPS), identifies self-contained topics for each processing skill.

For problem solving: MPS 1-5, 7, 11, 14, 23, 24.

For self-confidence: MPS 1, 3, 4, 5, 7, 11, 52.

For group skills: MPS 26, 28, 29, 45.

For self-assessment: MPS 3.

For managing change: MPS 5, 45, 49.

For lifetime learning: MPS 12, 36.

Descriptions of selected units are given in Table 3-1. Details about the MPS-Osterman feedback lecture are given in **Resources**, section **A.1**.

The Postface gives more about the MPS program.

Develop the process skills **concurrently**. Five versions are currently being used: 1) do nothing explicitly; hope the skills are developed; 2) require students to monitor the process skills, in general; 3) require students to monitor and reflect about specific process skills; 4) require monitoring, reflection and journal writing and 5) intersperse selected workshops and integrate these with the PBL activity.

Options 2 & 3) example feedback forms are given in **HTGTM**.

Option 4) use the feedback forms; example reflective journals are given in **Resources**, Sections **F.2**, **F.3** and **F.4**.

Option 5) selected workshops are given in **Resources**, Sections **B** and **C**.

### 3.3 Process skills as valued outcomes

Now that the question of "When" has been considered, let's focus on the extent to which you value the skills and their development as outcomes. Table 3-2 gives an idea of what might be done if we don't see the skills as valued outcomes, if we see them as being 20% as important relative to the "subject knowledge;" 35% and 50%. For example, in my course, the weighting is about 50%. To me this means I pay as much attention to the student's acquisition of the process skills as I do to the acquisition and application of the Chemical Engineering subject knowledge. What about in your course?

### 3.4 Developing process skills

Research has also shown that **skill** in solving problems does not happen by watching others solve problems (Woods, 1993). Nor is skill developed by having students solve many problems in the PBL format. What is needed is practice **with feedback about the problem solving process, the group process, self-directed skills and self-assessment skills**. Skill is developed by explicitly taking the process apart; developing the student's confidence with each part and continually integrating and applying the skills. Skill is developed by giving them a chance to do the process skills, to have someone hold up a mirror so that they can get direct and rapid feedback about what they did. Then, with this as a starting point, they can compare what they did with research evidence about what should be done. Then, give them a chance to set goals and practice with feedback. Research has also shown that empowerment and confidence develops from student's reflection, monitoring the process skills or behaviour and working to achieve their goals (Chamberlain, 1978; Alverno College, 1978; Schon, 1987; Woods, 1988).

Skill is developed by actions and activities. Such a focus on the students' process will, undoubtedly, mean that their processing effectiveness will **decrease** for a short while. It is vital that you and they be patient. Developing the skills is as much a journey in developing self-confidence as it is about the skills.

A major challenge is to develop the process skills such that they can be used in any context. For example, students who have experienced a separate course on "process skills" using context-independent materials (such as puzzles and games) usually find that they cannot apply the skills in other contexts. They cannot transfer the skills. On the other hand, trying to develop the skills at the same time students are learning the new subject knowledge is challenging too because students self-report that the process skills are so complex that they cannot do both at the same time. This is particularly true for problem solving skills. Perkins and Salomon (1989) give an excellent overview of the issues.

To help the students develop the skill **and** transfer it effectively to the context or subject domain I have found that the process skills are best developed through a three-stage process of:

- building the skill in a stress-free exercise so that they can focus on the mental processes being used (rather than on the subject-knowledge and the process skill);
- bridging those process skills to apply them in a simplified PBL situation;
- extending the application of those process skills to any type of PBL or everyday situation.

[Woods, 1987]

This three-stage development process is enriched by requiring the students to write a reflective journal in which they consider the build, bridge and extend experiences. For the **building** they assess the degree to which they developed the skill in the context-independent portions of the workshop. For the **bridge** stage, they reflect on the workshop task elements that included subject-rich activities. In the **extend** stage they reflect on their use of the skill in their subject courses and in their everyday life.

Table 3-1: Example MPS Units to develop process skills.

MPS Unit	Description	Comments	Time
1	<p><b>Awareness</b> of the Mental Process we use when we solve Problems.</p> <p>Participants solve aloud, for a listener, short, IQ type exercises and thus become aware of the process they use. As the workshop progresses, through evaluation and feedback participants become more systematic and careful. They also appreciate the approaches that others take. Above all, participants gain confidence that they can identify where they are in the process of solving a problem, describe what they have done and identify where and what might be causing them to get stuck. Personal performance can be compared with target performance. For more see Woods (1984).</p>	<p>This is an excellent first workshop. This Unit is a prerequisite for most other Units.</p> <p><b>Prerequisites:</b> none.</p>	1-4 h

2	<p><b>Background to Problem Solving</b>  What is Problem Solving? What fundamentals from Psychology form the underpinnings? Lecture plus self evaluation of the component skills used in problem solving.</p>	<p>Good to combine with Unit 1; or it can stand alone.</p>	<p>1 h</p>
3	<p><b>Self-assessment</b> Participants create goals and measurable criteria for an everyday task. Short activities are interspersed to clarify the notions of "observable activities" and "measurable criteria". The activity is then repeated for a) goals to address needs highlighted from Units 1 &amp; 2; b) the preparation of job descriptions or performance review documents and c) job application and career goals. For details see Woods et al. (1988) and PS News <b>84</b>.</p>	<p>This is the key, but challenging, Unit from which the participant's confidence is developed. The skills learned are used continually throughout the rest of the program. This approach of using self assessment is also the basis for the programs at Alverno College and at McMaster University's Medical School. The Unit itself is challenging. Criteria and constraints are introduced and used. Instructor's might find some material from Unit 19, Criteria Identification, to be helpful. In the full MPS program, this Unit is used for each of the subsequent Units and is complimented with Journal writing and with personal performance reviews. Usually this one is bypassed if the participants can attend fewer than 5 days of workshops.</p> <p><b>Prerequisites:</b> Units 1 and 2 so that the concepts of performance evaluation can be thought of in the context of the skills they want to develop.</p> <p>Related to MPS 23, 24, 31.</p>	<p>3-6 h</p>
4	<p><b>Strategies</b> Participants learn how to use organized patterns and monitoring to improve their ability. To develop the skill, they work in pairs and prepare strategy charts for each other that show stages of development of these skills. Personal development can be compared with</p>	<p>This requires the Awareness Unit as a prerequisite. Because the workshop activities build on skills developed in Unit 1, this is an excellent one to follow the Awareness Unit. It also should be given early in the program because it helps one to see that "having a</p>	<p>1.5-5 h</p>

	<p>research evidence to help each set personal goals. For more see <b>HTGTM</b> Chapter 3, problem 3.2, p. 3-23; <b>Resources</b> Section <b>B.4</b> and Woods (1985a).</p>	<p>strategy" is not the only skill needed to be a successful problem solver.</p> <p><b>Prerequisites:</b> Unit 1. (It helps if they have had Units 2 and 3.)</p>	
5	<p><b>Stress management</b> Questionnaires about daily stress and major-event stress help participants to appreciate their current stress levels and those experienced by others. Selye's model of the body's response to stress is used to help participants understand the methods used to manage stress. About a dozen coping techniques are introduced. Practice is given on some of these.</p> <p>Can include students completing the Rotter locus of control and the Billings-Moos inventories. For details see <b>Resources</b> Chapter <b>E</b>. Example checklist <b>HTGTM</b> p. 1-9. For more about the MPS workshop see Woods (1985b) and PS News <b>85</b>.</p>	<p>This is a very popular Unit. The purpose is to develop the attitudinal components needed in applying the first step in the McMaster 6-step strategy introduced in Unit 4.</p> <p><b>Prerequisites:</b> none but it builds on Unit 4, Strategy, and would have to include the fundamentals about attitudes from Unit 2, if it was not experienced before.</p>	1-2 h
7	<p><b>Creativity</b> The principle of deferring judgement is introduced. Groups of 6 practice applying this principle as they generate large numbers of ideas about the attributes of objects. Each is given a chance to be a leader of a brainstorming session. Suggestions are given about how to cope with silences and negative feelings. About a dozen "triggers" are introduced to help get the ideas flowing. The size of the group gradually is reduced. The emphasis shifts from "quantity of ideas", to "quantity and variety of ideas" to "quantity, variety and originality of ideas". The contexts change from properties of objects to options in situations. The approaches used in this workshop are compared with numerous other techniques</p>	<p>Many students have experienced 10 min to 60 min brainstorming or lateral thinking sessions and so hesitate to spend this amount of time on this Unit. We have found that these skills are extremely difficult to put in place-- especially when we are trying to have individuals outperform groups. Hence, the workshop time is needed and the skill is re-enforced in Units 10, 14, 15 and most of the Units in the next two block on interpersonal skills and defining real problems. The Unit requires that the instructor has 2 projectors for him/herself plus one for every 6 participants. These are in a room where these can be projected onto the walls; the room will get hot because of the heat generated by the projectors.</p>	6-8 h

	<p>such as brainwriting, and Synectics.</p> <p>If time allows, the internal and environmental barriers to creativity are examined and action plans formulated. Use of the Basadur preference for ideation questionnaire and the Kirton Adaptive-integrative inventory are useful. Example feedback form in <b>HTGTM</b> p. 3-15. For details see Woods (1986).</p>	<p>Preplanning is needed to ensure that there are enough electrical power circuits so that the fuses do not blow. You need about 1 circuit for every two projectors. If the participants have not had Unit 2, then the key components from that Unit are introduced in this one.</p> <p><b>Prerequisites:</b> Desirable if they have had Unit 6 and it helps if they have had Units 1, 2 and 3.</p>	
11	<p><b>the Unique You</b> Participants complete such inventories as the Myers-Briggs Type Inventory, Kolb's learning style, the visual-verbal-symbolic preference, Perry model, Lancaster Approaches to Studying Questionnaire (LASQ), Basadur preference for ideation questionnaire and the Kirton Adaptive-integrative inventory on their own time. We continue to search for other inventories that help participants to learn more about their own preferences. The accompanying lecture suggests the implications. For more see <b>Resources</b> Chapter E. A description of the workshop with an example reflective writeup is given in PS News <b>93</b>.</p>	<p>Many inventories are available. However, we want to be able to help people see the implications of their results. For some inventories this is not always clear. The inventories listed opposite have clear implications for learners.</p> <p><b>Prerequisite:</b> none.</p>	2 h + 3 h doing forms
12	<p><b>Learning skills</b> The tutor joins with the students in attending a "lecture" in another course. Students reflect on the purpose of the lecture, compare lecture notes taken with those taken by the tutor and by other students. Explore the implications of the learning styles identified in MPS Unit <b>11</b>. Classify information during a 20 min "lecture" period into fundamentals, illustration, empirical correlation, assumptions and limitations and try to relate the content to their knowledge structure.</p>	<p>Eye-opener for the students to see what others get from the "lecture." They have great difficulty sorting out the information. They tend to see it as one homogeneous and overwhelming mass of stuff that is equally important. They are surprised to learn that there are very few key fundamental ideas. They need practice on elaboration.</p>	1 h taking notes; 2 h workshop.

	<p>Emphasis on the importance of frequent review and on writing things down, seeing connections and elaborating on ideas. <b>HTGTM</b> Chapter 7. Elements of this workshop are in the SDL workshop, <b>Resources Section B.6</b></p>		
14	<p><b>Creating the Look Back and extending experiences</b> Participants come to the workshop with the marked solution to a common "homework" problem. The task is for groups of five to create several imaginative problems that would be solved based on the <b>same</b> fundamentals. Practice extending <b>all</b> of the components in the problem situation. Groups present their problems. The class assesses whether the newly-posed problem could be solved using the same fundamentals. The emphasis is on "elaboration." Provide a rich description of the completed activity.</p> <p>A second part of the workshop addresses "how to check whether an answer you obtained is reasonable." Criteria are given; practice on estimating answers. Numerous options for checking the answer.</p>	<p>Vital workshop to help students shift a solved-<b>problem</b> into an <b>exercise</b>. In the future, when students encounter a problem statement based on the same fundamentals this activity should help them to recognize the pattern and recall the solution. The workshop also reemphasizes the importance of being able to guesstimate and of checking and double checking. This workshop closes the loop of "objectives" &lt;-&gt; "criteria" &lt;-&gt; "resources". They see that we set goals, establish criteria. We do a task. Then, we consider the evidence and apply criteria to ensure that we have indeed achieved the correct goal. The workshop enriches MPS Unit 3 on assessment. This workshop helps to develop student's confidence.</p>	2-4h
17	<p><b>Time management</b> Three guiding ideas. Classify tasks as to importance and urgency. Work toward doing important tasks under non-urgent conditions. Reflect and document what you currently do. To establish <b>importance</b> set personal, fundamentally-important goals. Feel good about what you do, develop trust, do tasks that meet your goals, keep a balance and perspective.</p> <p>To control <b>urgency</b>, be proactive, be</p>	<p>Based on Covey's 7 habits of successful people with practical workshop on self-awareness plus plenty of practice in the workshop. This has been very well received from 18 to 80 year olds; students and administrators. Closely related to MPS Unit 5, stress management and MPS 52, handling anger.</p> <p><b>Prerequisites:</b> helps to have completed MPS Unit 11 and MPS 31 on goal setting.</p>	2-4 h

	in charge. Say NO! look after both the task & morale: monitor & reward; do key parts by applying Pareto's principle; prioritize; be organized; anticipate. This includes role-playing. The workshop closes with hints and suggestions on how to get organized and get control of your life.		
23	<b>Criteria</b> Define the concept; distinguish between <b>must</b> and <b>want</b> criteria. Use six different methods to create criteria. Practice making the criteria measurable. Examples and applications to make criteria -and goals- consistent with the resources available.	This seems to be a relatively difficult concept. Related to workshops MPS 3, 31 and MPS 24 on self-assessment, goals and decision-making. You can't have <b>any</b> of these without criteria. Many professionals need this workshop.	2 h
24	<b>Decision-making</b> Start with "Lost on an Island" or "Lost on the Moon" exercise where participants have to rank the importance of 20 items for their survival. Introduce criteria. Illustrate how consistent the ranking becomes if all use the same criteria. Introduce criteria to decide who makes the decision and the method used to make the decision. Explore decision-making under certainty, risk and uncertainty. Decision-trees and game theory. Practical examples. Coping with procrastination. Use of inventories to suggest style of decision-making. Example chart given in <b>HTGTM</b> Chapter 3, p. 3-16.	Interesting to see the change in the participants as the ranking of the list becomes more certain as the various elements of decision-making are introduced.  <b>Prerequisites:</b> goals and criteria. MPS Units 31 and 23.	2-4 h
27-28	<b>Group skills</b> Summarize characteristics of good groups; Task and Morale dimensions. Participants become familiar with a feedback form ( <b>HTGTM</b> p. 5-9 Chapter 5) through spiked-group role-playing or assessing videotape. Then group on group practice plus feedback with each individual client having an observer. Then roles switch so that	Extremely powerful workshop. A variety of versions are possible. My favourite is to combine this with MPS Unit <b>52</b> .  <b>Prerequisite:</b> perhaps MPS 52. Other workshops on Listening and responding, assertiveness and giving and receiving feedback	1½-4 h

	<p>each gets prompt feedback. Then each group opens up and the group as a whole is assessed. Enrich the activity with FIRO-B, evolution of the group. You can ask different group members to assume different roles: recorder (records the group's work), checker (ensures that all members of the group understand the solution to the problem), encourager (encourages all members to participate), elaborator (relates present to past learning), validator (who ensures that the group thinks critically), chairperson (who orchestrates and facilitates the process), calculator (to do any numerical calculations). Select roles that are important for your group. <b>HTGTM</b>, p. 5-19. Extend into team work. see <b>Resources Section B.5</b> and Woods (1989).</p>	<p>(MPS Units 26, 43, 44)</p> <p><b>Enrich</b> Add workshops on chairperson skills (MPS 29), coping with difficult behaviours (MPS 46) and coping creatively with conflict (MPS 45).</p>	
29	<p><b>Chairperson skills</b> Summarize characteristics of effective chairpersons. Agenda writing for different group tasks. Rotate each through the role of chairperson and establish norms for the group on Task and Morale. Then determine whether the group functioned above or below the norms while each person was chairperson. Each person gets feedback and sets goals for improvement. Chairperson feedback form available. Described in the McMaster SDL videotape. <b>HTGTM</b> Chapter 5.</p>	<p>This takes many meetings. Everyone should be chairperson for at least three meetings. Need to apply enough time between each meeting for each person to write a reflective report, receive feedback on the report, set goals and create an agenda. It is worth the effort. Dramatic improvements with all moving to be about 30% higher than initial norms of task and morale.</p> <p><b>Prerequisite</b> Group skills workshop, MPS 27-28. It also helps to have had MPS <b>52</b> on interpersonal skills and MPS <b>45</b> coping creatively with conflict.</p>	15 h
31	<p><b>Defining real goals: mission &amp; vision</b> Outline the 7 characteristics of goals and then systematically give practice in developing each: mission statement of what you do; a vision statement of how you do it; use of</p>	<p>Extension of define-the-stated problem so as to identify the <b>real</b> goal. Variation on this workshop is helpful in creating learning issues. see <b>Resources Chapter C.1</b>.</p>	1½-4 h

	asking Why? why? why?; separating symptom from cause, identifying owners and stakeholders; recasting goal statements as "results" not "actions;" making the goal "observable" and creating consistent, measurable criteria.	<b>Prerequisite</b> MPS <b>23</b> , criteria,	
36	<b>Self-directed learning</b> Explicit workshop to list objectives and criteria to explicitly develop lifetime learning skills. Major goals are a shift in attitude from Perry scale 3 to 5; a shift from dependent through independent to interdependent learning, a realization that people are the best resource for information and knowledge. Workshop includes completion of questionnaires on learning style, their implications, outline of management tactics to make SDL groups function accountably and some practice activities matching "learning style" with the "handout sheets" used by students in the <b>teach</b> meeting. This has been outlined in <b>HTGTM</b> Chapters 1, 6 and 7. see <b>Resources</b> Section <b>B.6</b>	This is a combination of attitude shifts, suggestions for group process management and sensitivity to the need to <b>teach</b> instead of <b>report back</b> to the group.  <b>Prerequisite</b> useful to have MPS <b>11</b> , unique you; MPS <b>12</b> , learning skills. However, it can be run on its own.	1½-3 h
45	<b>Coping creatively with conflict</b> participants clarify misconceptions about conflict and disagreements; sensitize participants to the types of causes of conflict; outline the seven criteria for selecting a response; identify their preferred style of responding to conflict, practice applying the criteria and selecting an option for coping with conflict. <b>HTGTM</b> Chapter 5	Extremely helpful workshop; can be extended to look at dealing with difficult behaviours. Can be extended to workshops on building consensus and getting a buy-in.  <b>Prerequisite</b> useful to have MPS <b>11</b> , unique you; and MPS <b>52</b> interpersonal skills, especially about anger.	1½-3 h
49	<b>Coping with change</b> participants learn the "grieving" process and relate the elements to their past experience, become familiar with Taylor's model for working your way through the process, learn how	Surprisingly effective. Also part of a workshop on Networking.  <b>Prerequisites</b> none	1-5 h

	the grieving process relates to stress and anger; and what to do about it, discover, via the use of inventories, what impact the change is likely to have, learn to see opportunities in the "new," learn commitment charting and its effectiveness, learn how to overcome their internal resistance to change. <b>HTGTM</b> Chapter 1.		
52	<b>Basics of interpersonal skills</b> Participants learn their 7 fundamental rights, and see how to apply several dozen principles to improve interpersonal relations, become familiar with a model for listening and responding, learn how to build trust and see how a relationship can be destroyed, learn principles of coping with anger. videotapes and practice sessions. <b>HTGTM</b> Chapter 5.	Challenging to present because of the many concepts and ideas. Lays the foundation for workshops on listening and responding, group process, dealing with conflict. Add variety by using videotapes Also part of a workshop on Networking  <b>Prerequisites</b> useful to have MPS <b>11</b> , unique you.	1-5 h

Table 3-2 The implications of developing the process skills

Process skills as an outcome of the program			
not important	20%	35%	50%
tutor needs to facilitate the problem solving process, the interpersonal process, the group process and the lifetime learning tasks.	1. Legitimize the skill development by making it part of the course/program/calendar description. Example, see <b>Resources</b> Section <b>D.2</b> .		
	2. Develop objectives for the process skills. Example, see <b>Resources</b> Section <b>D.3</b> .		
	3. Provide explicit activities plus feedback to give the students an opportunity to develop the skill. Examples, see <b>Resources</b> Chapters <b>B</b> and <b>C</b> .		
	4. Ask students to continually monitor the process; perhaps add journal writing (examples, see <b>Resources</b> Sections <b>F.2</b> , <b>F.3</b> and <b>F.4</b> .)		
	5. Help the students see progress by assessing the skill development. Example, see <b>Resources</b> Section <b>D.4</b> and Woods et al. (1995).		
Provide additional guidance/skill development over the difficult areas:			

- some students are seen as being "free riders"; they do not do their fair share of the work.
- coping with conflict and groups that are "breaking apart"
- attendance problems

Some suggestions are given by Woods et al. (1995).

The bridge and extending activities are illustrated in the student's reflective journal in **Resources** p. F-29. The building activities are done in context-independent detective stories, such as those given in **HTGTM**, p. 3-26. The bridging activities ask the students to apply the same skills in Terry Sleuth detective stories written in the subject discipline, see **Resources** p. A-7 to A-10 and p. F-36. The student's extending is done, for example, in **Resources** on p. F-37 and F-38. Here she describes how she uses the skills developed in the workshop in her ordinary homework problems, **Resources** p. F-37 and in her everyday life, F-38 and -39.

Increasing student's process skills is like sending students to a tennis pro. Their tennis game may be OK, but they wish to improve it. What happens? The pro takes their game apart. Here is how to hold the racket. Here is how to toss the ball. Here is where their feet should be. During this detailed look, their game initially goes to pot. They focus so much on each component that what went naturally for them before, no longer works. Their performance "dips". They may feel stress, impatience and anger. Later they may feel frustrated because their progress appears to be slow. But as they persist, their game improves and surpasses their previous skill. But it takes time and patience.

So it is with increasing their process skill. My estimate of the degree of challenge for these process skills is:

hardest- self-assessment (mainly because they have misconceptions, equate it to examinations and tend to look to us faculty as "the ones to do it").

easier- self-direct learning. (They can usually move from dependent to independent learning relatively quickly. Indeed, many may be there already. However, to develop "interdependent learning skill" is challenging. In a sense, we are giving them a crash course in "teacher-training".)

easy- problem solving skills. (These are more difficult than group skills because so much is intuitive, or metacognitive; it's hard to see. Students also have many misconceptions about their skill; they usually either greatly over-rate or under-rate their ability.)

easiest- group skills. (True, it is challenging to work by consensus and to handle conflict well, but most of these are related to developing trust and building self-confidence. These behaviours tend to be more visible.)

Probably one of the greatest challenges will be for you to help them to see personal growth and for them to develop confidence in their skill. My experience has been that we can do this by:

1. Providing explicit process skills objectives.
2. Explicitly including the development of these skills in the program with as much credibility and assessment as "subject knowledge acquisition".
3. Developing skill transferability by including the three stages of activity: build, bridge and extend.
4. Requiring journal writing and self-assessment of the process skills.

Examples objectives are given in **Resources**, Section **D.3**.

Examples of student's journal writing and self-assessments are given in **Resources** Sections **F.2**, **F.3** and **F.4**.

Unfortunately, I know of no instant way to improve all of process skills. I wish I could snap my fingers and all of the skills and attitudes would be improved. We use about 100 hours of workshop to develop about two dozen key skills before students move into PBL.

### 3.5 Summary

- PBL works because the student groups have strong process skills: managing change, problem solving, self-assessment, lifetime learning and group work.
- Process skills are **not** developed by giving students opportunities; skill development requires explicit activities plus feedback.
- The tutor needs these process skills. Tutors should also learn how to coach students so that the students develop the process skills. Ideally both the tutor and the students should receive process skill training.
- Process skills can be required for admission, developed before the PBL activities or developed concurrently. Examples are given of each option.
- I recommend that process skills be valued outcomes of any educational program. This means that the process skills should be described in the course objectives and should be assessment.
- Example MPS workshops illustrate how to develop the process skills. My experience has been that the development requires three-stages: skill building, bridging and then extension. Furthermore, initially, student's skill will decrease before the skill improves.

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Back to [PBL](#)