

Appendix 3: Detailed outcomes of problem-based learning versus traditional curricula (control) in 13 studies*

Study	Outcome of problem-based learning			Remarks	Study quality
	Positive	No difference	Negative		
Peters et al, ²⁸ 1994	Self-assessment Better than control group in humanism (careers in primary care or psychiatry, preparedness for practising humanistic medicine and managing patients with psychosocial problems) and social learning	Self-assessment No difference in lifelong learning (no. of hours per week spent reading textbooks or journals, no. of times per month spent searching for information electronically, consulting with peers and confidence using evidence-based medicine)		Curriculum changes, such as an emphasis on humanistic and psychosocial aspects of medicine, contaminated positive findings in both humanism and social learning	High
Hoffman et al, ²⁹ 2006	Supervisor assessment Better than control group in general knowledge, physical diagnosis and history-taking, patient management, written presentations, oral presentations, teaching medical students, communication with members of the health care team, level of maturity, willingness to accept responsibility, initiative, ability to accept criticism, and embodiment of the qualities of a good physician	Supervisor assessment No difference in medical judgment/ability to perform under pressure, effectiveness with patients, willingness to help others, self-confidence and sensitivity to psychosocial needs of patients		The significance level was set at $p < 0.01$ because of the study's large sample	High
Jones et al, ³⁰ 2002	Self-assessment Better than control group in communicating effectively; teamwork; recognition of social and emotional factors in illness and treatment; understanding the relation among primary, social and hospital care; attitudes toward personal health and well-being; understanding principles of evidence-based medicine; coping with uncertainty; understanding audit and peer review; cultural competence; use of informatics; awareness of legal and ethical issues; and 8 procedural skills (venipuncture, urinary catheterization, obtaining valid consent, electrocardiography, writing prescriptions, using a nebulizer, suturing and inserting a nasogastric tube) Supervisor assessment Better than control group in communication skills, coping with uncertainty, understanding audit and peer review, cultural competence, and awareness of legal and ethical issues	Self-assessment No difference in history-taking, clinical examination, selection and interpretation of diagnostic tests; awareness of personal limitations; accurate record-keeping; disease prevention and health promotion; time-management; use of laboratory and diagnostic services; diagnosis, decision-making and treatment including prescribing; and 5 procedural skills (cardiopulmonary resuscitation, arterial blood sampling, administration of oxygen therapy, control of hemorrhage and calculating accurate drug doses) Supervisor assessment No difference in understanding disease process; awareness of personal limitations; teamwork; recognition of social and emotional factors in illness and treatment; accurate record-keeping; disease prevention and health promotion; time management; use of laboratory and diagnostic services; understanding the relations among primary, social and hospital care; attitudes toward personal health and well-being; understanding the principles of evidence-based medicine; diagnosis, decision-making and treatment including prescribing; use of informatics; and all procedural skills	Control group rated itself better than problem-based learning graduates in understanding disease processes		High

Rolfe et al, ³¹ 1995	<p>Supervisor assessment</p> <p>Better than control group in fostering a relationship with patients and families, interprofessional relationships, self-directed learning, and reliability and dependability</p>	<p>Supervisor assessment</p> <p>No difference in clinical clerking, diagnostic skills, clinical judgment, procedural skills, management approach, understanding of basic mechanisms, communication skills, initiative, enthusiasm and teaching</p>	<p>Problem-based learning curriculum emphasized interpersonal skills, which contaminated positive findings related to graduates' abilities to foster relationships with patients and families, and with other professionals</p>	High
Watmough et al, ^{32,33} 2006	<p>Self-assessment</p> <p>Better than control group in teamwork; recognition of social and emotional factors in illness and treatment; understanding the relation among primary, social and hospital care; attitude toward personal health and well-being; understanding the principles of evidence-based medicine; understanding the purpose and practice of peer review; use of informatics; disease prevention and health promotion; awareness of legal and ethical issues; and 6 procedural skills (venipuncture, arterial blood sampling, electrocardiography, control of hemorrhage, calculating accurate drug dosages and suturing)</p> <p>Supervisor assessment</p> <p>Better than control group in effective communication; recognition of social and emotional factors in illness and treatment; time management; understanding the relation among primary, social and hospital care; understanding the principles of evidence-based medicine; diagnosis, decision-making and treatment including prescribing; coping with uncertainty; understanding the purpose and practice of peer review; cultural competence; use of informatics; and awareness of legal and ethical issues</p>	<p>Self-assessment</p> <p>No difference in effective communication; awareness of personal limitations; accurate record-keeping; time management; use of laboratory and diagnostic services; diagnosis, decision-making and treatment including prescribing; coping with uncertainty; cultural competence; and 7 procedural skills (cardiopulmonary resuscitation, administering oxygen therapy, urinary catheterization, obtaining valid consent, prescribing, using a nebuliser and inserting a nasogastric tube)</p> <p>Supervisor assessment</p> <p>No difference in teamwork, awareness of personal limitations, attitude toward health and well-being, use of laboratory and other diagnostic services, disease prevention and health promotion, accurate record-keeping and all procedural skills</p>	<p>Control group rated themselves better than problem-based learning graduates in understanding disease processes</p> <p>Curriculum changes included longer community attachments, portfolio assessments, special study modules on audits and formal procedural skills training. These changes contaminated positive findings related to both self-assessed and supervisor-assessed competency in understanding the relation among primary, social and hospital care and in understanding the purpose and practice of peer review. Positive findings related to self-assessed competency in procedural skills were also contaminated.</p>	High
Tamblyn et al, ³⁴ 2005	<p>Self-assessment</p> <p>Better than control group in mammography screening rates, coordinated visits and diagnostic accuracy</p>	<p>Self-assessment</p> <p>No difference in rate of prescribing for contraindicated drugs</p>	<p>Educational reforms such as a focus on social, preventive and community care contaminated positive findings related to mammography screening and coordinated visits</p>	High
Mennin et al, ³⁵ 1996	<p>Self-assessment</p> <p>Better than control group in clinical reasoning, coping with uncertainty, diagnostic skills, doctor-patient relationship, follow-up care, continuing education, patient education, preventive care issues, serving medically underserved areas, self-assessment, teamwork and overall preparation for medical practice</p>		<p>Control group rated themselves better in health economics, history-taking, interviewing, physical examination and therapeutic management†</p> <p>Curriculum included a community-based preceptorship, which contaminated positive findings related to preventive care and serving medically underserved areas</p>	High

Santos-Gomez et al, ³⁶ 1990	<p>Self-assessment Better than control group in communication with patients</p> <p>Supervisor assessment Better than control group in attention to health care costs</p>	<p>Self-assessment No difference in knowledge, independent thinking, teamwork, patient education, critical thinking, attention to health care costs and self-assessment</p> <p>Supervisor assessment No difference in knowledge, communication with patients, independent thinking, teamwork, patient education, critical thinking and self-assessment</p> <p>Nurse assessment No difference in any competencies</p>	Although the differences in knowledge between graduates of problem-based learning curricula and the control group were not significant, nurses felt the control group was more knowledgeable	Low
Prince et al, ³⁷ 2005	<p>Self-assessment Better than control group in expert knowledge, profession-specific skills and communication skills</p>	<p>Self-assessment No difference in computer skills, teamwork, planning and organizational skills, leadership skills, independence, creativity, initiative, dealing with change and accuracy</p>	Curriculum included a longitudinal 5-year communication skills program, which contaminated positive findings related to communication skills	Low
Shin et al, ³⁸ 1993	<p>Observed assessment Better than control group in adherence to hypertension management guidelines</p>		Multivariable analysis showed that only the type of curriculum was significant Study surveyed only primary care doctors, and results cannot be extrapolated to other specialties	Low
Schmidt et al, ³⁹ 2006	<p>Self-assessment Better than control group in problem-solving, collaboration, interpersonal skills, meeting management, written presentations, research, self-directed learning, use of information resources, professional skills (such as physical examination), identifying and proposing more efficient ways to work, helping colleagues, working independently, planning, and efficiency and time management</p>	<p>Self-assessment No difference in productivity and ability to work under pressure</p>	Control group rated itself better than problem-based learning graduates in possession of medical knowledge and writing reports or articles	Low
Tolnai et al, ⁴⁰ 1991		<p>Observed assessment No difference in participation rates in continuing medical education activities</p>	Control group comprised more family physicians and fewer held postgraduate certification	Low
Woodard, ^{41,42} 1990 and 1981	<p>Supervisor assessment Better than control group in global ratings and in professional responsibility, ability to relate, self-appraisal ability, clinical skills, group work, critical thinking, problem solving and independent learning</p>		Actual rating values and levels of significance were not given for each competency	Low

*An abridged version of this appendix appeared as Table 2 in the main article (*CMAJ* 2008; 178:xxx-x).

†Although graduates in the control group rated themselves better than problem-based learning graduates in these areas, these differences were statistically nonsignificant after Bonferroni adjustment.