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AUTHOR(S)

Aisling Kerr, Hannah O'Connor, Teresa Pawlikowska, Paul Gallagher, Judith Strawbridge

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A scoping review of health professional curricula: Implications for developing integration in pharmacy

Ms Aisling Kerr^a aislingkerr@rcsi.ie

Ms Hannah O'Connor^a hannahoconnor@rcsi.ie

Prof Teresa Pawlikowska^b tpawlikowska@rcsi.ie

Prof Paul Gallagher^c phapjg@nus.edu.sg

Dr Judith Strawbridge^a jstrawbridge@rcsi.ie

A: RCSI School of Pharmacy, 1st floor Ardilaun House Block B, 111 St Stephen's Green, Dublin 2, Ireland

B: RCSI Health Professions Education Centre, 123 St Stephen's Green, Dublin 2, Ireland

C: Department of Pharmacy, 18 Science Drive 4, National University of Singapore, Singapore 117559

Corresponding Author: Aisling Kerr, RCSI School of Pharmacy, 1st floor Ardilaun House Block B, 111 St Stephen's Green, Dublin 2, Ireland aislingkerr@rcsi.ie

1 **Abstract**

2 **Background**

3 Integrated undergraduate health professions curricula aim to produce graduates who are
4 capable of meeting current and future healthcare needs. This is reflected in pharmacy education
5 where integration is increasingly advocated by pharmacy regulators as the perceived optimal way
6 of preparing students for registration as pharmacists. There is, however, no definition of
7 integration. Integration can be described according to the model i.e. horizontal, vertical or spiral
8 integration. It can also be described by the themes used to integrate, such as a systems-based
9 approach or by integrative teaching and learning approaches. The level of integration can also be
10 described.

11 **Objective**

12 This scoping review aimed to explore health professions education literature to inform the
13 optimal design of integrated pharmacy curricula. This review asks: what is meant by integration
14 in health professions curricula?

15 **Methods**

16 The Arksey and O'Malley scoping review framework was utilised. Ovid MEDLINE, EMBASE,
17 Scopus, Web of Science and ERIC were searched. Models of integration, themes for integration,
18 integrative teaching and learning approaches, and level of integration were defined and
19 supported data extraction.

20 **Results**

21 There were 9696 records screened and of these 137 were included. The majority of studies (n=88)
22 described horizontal integration. Systems-based teaching (n=56) was the most common theme
23 reported. Various integrative teaching and learning approaches were described, including
24 experiential (n=43), case-based (n=42) and problem-based (n=38) learning. The majority of the
25 curricula could be classified as levels 5-7 on Harden's ladder (n=102). Perception outcomes were
26 reported for 81 studies, and only 3 reported outcomes beyond perception. Reported outcomes
27 were generally positive and included knowledge gains and increased motivation.

28 **Conclusions**

29 There is a need for integration to be explicitly defined by curriculum developers and researchers.
30 Attention should be given to describing the model, theme, teaching and learning approach and
31 level of integration. There remains a lack of evidence for integration.

32 **Keywords**

33 Curriculum Design, Curriculum Integration, Health Professions Education, Integration, Pharmacy,
34 Pharmacy Education

35 **Introduction**

36 Integrated undergraduate health professions curricula aim to produce graduates who are
37 capable of meeting current and future healthcare needs¹. Integrated health professions curricula
38 are becoming increasingly popular worldwide with the goal of promoting retention of knowledge
39 and acquisition of skills².

40 Healthcare education has been changing globally since the start of the 20th century in line with
41 changing healthcare practices. First generation curricula, based on the Flexner report³, were
42 predominantly knowledge-based. Around the middle of the 20th century, some institutions
43 introduced problem-based learning curricula, which promotes integration, aiming to promote
44 skill development⁴⁻⁷. The development of third generation curricula aims to produce change
45 agents. Integration is an important component of third generation curricula⁸. The 1988 Edinburgh
46 declaration by the World Federation for Medical Education called for integration of basic sciences
47 and clinical practice in various contexts in medical education ‘to produce doctors that will
48 promote the health of all people’⁹.

49 Although not often discussed in curriculum development, the underpinning concept or theory
50 should be considered. Some underpinning theories include complexity theory¹⁰⁻¹², constructivist
51 theory^{10, 13-15}, cognitivist theory^{2, 10, 13}, andragogy^{2, 10, 13} and situated learning theory¹⁶. Complexity
52 theory is embedded in institutional learning perspectives from staff and student perspectives¹⁰.

53 Davydov’s learning model, which aims to stimulate learners’ imagination as a vehicle for their
54 insight into seeing problems as an instance of a general relationship, also applies to integration¹⁷.

55 The constructivist learning theory applies to integration, as when students’ progress through the
56 programme they construct their own understanding based on who they want to be as a

57 professional and how they view the world. Integration encourages constructivism in that new
58 information is rooted and linked in previous knowledge¹³⁻¹⁵.

59 More recently, integrated pharmacy curricula have been advocated by pharmacy regulators¹⁸⁻²³.
60 Integrated pharmacy curricula aim to produce graduates who can adapt their skills and
61 knowledge to a variety of complex problems in various contexts^{13, 24}. Pharmacy regulators in
62 Ireland^{21, 25}, the UK¹⁸⁻²⁰, Singapore²⁶, USA²² and Canada²⁷ explicitly call for integration of practice
63 experience and curriculum content. The pharmacy regulator for Australia and New Zealand do
64 not require integration of curriculum content but stipulate an integrated period of workplace
65 learning²³. Integrated pharmacy curricula were introduced in Ireland following a national review
66 of pharmacy education: Pharmacy Education and Accreditation Reviews (PEARs) project²⁴. The
67 recommendation was that an integrated model of education and workplace-based learning was
68 regarded as ‘the optimum way of ensuring the achievement of a clearly defined set of common
69 educational outcomes at registration that will ensure patient and public safety’²⁴. The authors of
70 the PEARs report concluded there was pedagogic evidence that an integrated period of
71 workplace learning is necessary to contextualize learning and develop skills, knowledge and
72 values required to be a professional pharmacist²⁴. This was important in light of the increasing
73 clinical role of pharmacist and the requirement to maximize their contribution to health care²⁴.
74 Schools of Pharmacy in Scotland are also introducing a new integrated programme expected to
75 be commenced in 2020^{28, 29}. There is, however, only a limited evidence base for integrated
76 curricula and the drivers for integration mainly lie in international trends and stakeholders
77 opinions²⁴.

78 There has been debate in pharmacy education about the balance of science and practice in
79 pharmacy³⁰⁻³³. Some believe more emphasis should be placed on practical and clinical skills³²
80 while others feel that there should be greater scientific instruction to underpin practice³¹. What
81 is important for integrated curricula, however, is integration, rather than balance, of science and
82 practice³⁴.

83 Integration is, however, challenging to define³⁵⁻³⁷. It may be defined by model of integration;
84 horizontal, integration across time, within a year of study^{2, 13, 35, 38-43}; Vertical integration has been
85 described as integration between years of study^{2, 13, 35, 38, 39}. Integration may also be described as
86 spiral^{2, 13, 44, 45}. Bruner used the concept of a spiral to conceptualize how topics are introduced at
87 basic level and revisited throughout a programme with increasing depth^{2, 13}.

88 Integration may also be described through themes for integration including systems-based
89 teaching^{46, 47}, stages of life⁴⁷, cross-cutting themes and the use of a topic, such as anatomy⁴⁷.
90 Some teaching and learning approaches are integrative including, case-based learning^{2, 48}, team-
91 based learning⁴⁹⁻⁵⁴, problem-based learning^{5, 55, 56}, enquiry-based learning⁵⁶⁻⁵⁸ and through
92 experiential learning^{2, 21, 25}.

93 Harden described a complex continuum of 11 points between the extremes of discipline-based
94 teaching and transdisciplinary teaching known as Harden's ladder. At higher points on the ladder,
95 greater emphasis is placed on integration and less importance on discipline-based teaching with
96 greater central organisation. The integration ladder is useful to educators to select a pragmatic
97 starting point for integration and their desired balance between integrated and discipline-based
98 teaching⁴⁶. The General Pharmaceutical Council's (GPhC), the UK pharmacy regulator, education
99 standards^{18, 19} require all pharmacy curricula to be integrated and they have published additional

100 guidance on integration. In their guidance on integration, they have operationalized Harden's
101 ladder, through a pharmacy curricula design lens^{20, 46}. This operationalization of Harden's ladder
102 is a pragmatic effort to clarify what models of integration met the standards. The highest levels
103 of integration 'transdisciplinary', 'inter-disciplinary' and 'multidisciplinary' (levels 9-11) fully meet
104 the GPhC standards and are considered to be 'fully integrated'. The next levels, 'correlation' and
105 'complementary' (levels 7-8) are classified by the GPhC as 'partially integrated' and meet the
106 minimum standard. All other levels (6 and below) are classified as 'not integrated' and do not
107 meet the GPhC standard for integration^{20, 46}.

108 There still remains, however, a lack of clarity about what is meant by the term 'integrated' for
109 curriculum design. There is no clear guidance on how to describe and report on integration. This
110 scoping review has been designed to identify patterns of integration within the wider healthcare
111 literature to inform optimal integrated curriculum design through a pharmacy lens.

112 **Objective**

113 The purpose of this scoping review was to determine the extent, type and range of research
114 studies on integrated curricula in health professions education and to inform curriculum design.

115 This review asks: what is meant by integration in health professions curricula?

116 The objectives of this review were to:

- 117 • Review the different models of integration which are used in healthcare curricula
- 118 • Identify themes for curriculum integration used in healthcare curricula
- 119 • Identify the different types of integrative teaching and learning approaches used in
120 integrated curricula

121

- Classify the various levels of integration in courses/curricula described as integrated

122 **Methods**

123 **Design**

124 This review followed scoping review methodology⁵⁹⁻⁶². A scoping review was suitable for the
125 research question as integration had not yet, to our knowledge, been comprehensively reviewed
126 in the literature. The review had an exploratory focus, to determine patterns of integration in the
127 literature⁶². The Arksey and O'Malley scoping review framework was utilized^{59, 61}. The five steps
128 of the scoping review framework were as follows: Stage 1: identifying the research question,
129 Stage 2: identifying relevant studies, Stage 3: study selection, Stage 4: charting the data, Stage 5:
130 collating, summarizing and reporting the results. The process was iterative and each stage was
131 treated in a flexible manner and repeated, where necessary, to ensure comprehensive coverage
132 of the literature⁵⁹.

133 **Data Sources and Search Strategy**

134 Working with an information specialist, search terms were iteratively developed through piloting
135 and refinement to ensure a focus on the review question^{59, 61}. The final search terms used a
136 combination of subject headings such as free text terms using truncation, MeSH terms and
137 appropriate Boolean operators and keywords to capture studies of interest. Details of the search
138 strategy are included in supplementary information. The following databases were searched up
139 to February 2019: Medline (Ovid), EMBASE, ERIC (Educational Resource Information Centre),
140 Scopus, Web of Science. A scoping search used various health professions as keywords
141 (pharmacy, medicine, nursing/midwifery, physiotherapy, veterinary, dentistry and healthcare
142 professional) to determine the scope of literature on experience of integration in pharmacy and
143 other health professions. Based on these searches, searches with medicine and pharmacy as

144 keywords were used as these areas contributed the most to our specific focus on pharmacy
145 education by both search result volume and relevance. The inclusion criteria were adapted to
146 include any health professions curriculum that may have appeared in these searches. An
147 additional search in Scopus based on pharmacy education was included to ensure comprehensive
148 coverage of the literature. These searches were carried out with the same rigor as a systematic
149 review to ensure comprehensive coverage of the literature. An information specialist validated
150 the combined aggregation of the search strings across databases.

151 **Study Selection**

152 Research studies were eligible for inclusion in this review if they described curriculum integration
153 in undergraduate healthcare professions curricula. The scope was restricted to health professions
154 curricula to improve relevance of included studies. Only studies published in English were
155 included in this review, and no publication age-limit was placed on included studies. Reasons for
156 exclusion of studies are listed below:

- 157 • Published in a language other than English
- 158 • Postgraduate Health Professions Training
- 159 • Not related to curriculum integration
- 160 • Published only as a conference abstract
- 161 • Non-health professions curricula
- 162 • Books/Book Chapters
- 163 • Opinion/Editorials
- 164 • Lack of curriculum details provided in study

165 The titles and abstracts of all publications retrieved from database searching were screened
166 independently for eligibility for inclusion by two reviewers. Reviewers screening abstracts met at
167 the beginning, middle and end of screening to discuss any challenges or uncertainties to help to
168 reduce any potential ambiguity of inclusion or exclusion criteria⁶¹. If there was any disagreement
169 between reviewers as to whether or not a study was suitable for inclusion, this was referred to
170 the moderator for final decision. All potentially eligible studies at this stage were obtained as full
171 text articles and they were reviewed for inclusion. The reasons for excluding studies at full text
172 stage were recorded. Quality appraisal was not carried out, with reference to the heterogeneity
173 of the studies and the requirements of the Framework^{59, 62}.

174 **Charting the data**

175 The research team collectively and iteratively developed the data extraction form. AK extracted
176 data relating to model of integration, theme for integration, integrative teaching and learning
177 approaches and level of integration for all included studies. HOC carried out data extraction on
178 10% of the included studies in order to confirm accuracy of data extraction. All extracted data
179 pertaining to each study were summarized in the table of characteristics of included studies. Data
180 were mapped and charted to identify patterns and summarized numerically within the
181 categories⁶¹ of model of integration, theme for curriculum integration, teaching and learning
182 approaches and level of integration.

183 Due to the heterogeneity of included studies and in the use of the term 'integration', the
184 parameters for data extraction needed to be defined. As a known weakness of scoping reviews
185 is lack of information on how data was categorised⁶¹, operational definitions were used for data

186 extracted which are included below. The level of integration was charted according to the GPhC
187 integration standards²⁰ which are based on Harden's Ladder⁴⁶, see table 1 for details.

188 *Table 1 Operational definition of each category for data extraction: model of integration, themes*
189 *for integration, teaching and learning approaches and level of integration*

Model of Integration
Horizontal: Horizontal integration is integration within a year of study or finite period of time ^{2, 13, 35, 38-43} .
Vertical: Vertical integration is integration between years of study ^{2, 13, 35, 38, 39} .
Spiral: Spiral curricula combines integration across time and disciplines. In a spiral curriculum, topics are revisited with increasing depth building on prior knowledge ^{2, 13, 44, 45} .
Themes for Curriculum Integration
Cross-Cutting Theme: Material is covered across subjects and disciplines rather than in one particular subject connecting content across disciplines e.g. professionalism, communication ⁶³ .
Topic: Material is related to each other and brought together under a common theme or idea e.g. anatomy, end of life ⁴⁷ .
Systems-Based: Material centered around a body system (for example, the cardiovascular system) including physiology, anatomy, pathology, chemistry and therapeutics associated with the system ^{46, 47} .

Stages of Life: Material associated with stages of life from conception, birth, childhood, adulthood, later years and end of life⁴⁷.

Teaching and Learning Approaches

Team-Based Learning: Team-Based Learning (TBL) is an evidence-based collaborative learning strategy designed around units of instruction, that are taught in a three-step cycle: preparation, in-class readiness assurance testing, and application-focused exercise⁴⁹⁻⁵⁴.

Case-Based Learning: Case-based learning (CBL) is an approach that allows basic science details to be linked to clinical scenarios, even for students with little or no clinical exposure, using a clinical case to stimulate learning^{2, 48}.

Problem-Based Learning: Problem-Based Learning (PBL) is a learner-centered approach in which students use 'triggers' from the problem case to define their own learning objectives. PBL does not involve solving the problem but uses problems to stimulate learning^{5, 55, 56}.

Enquiry-Based learning: Enquiry-based learning (EBL) is an approach driven by a process of enquiry and students are allowed to pursue their own lines of enquiry beginning with a question followed by investigating solutions, creating new knowledge as information is gathered and understood, discussing discoveries and experiences, and reflecting on new-found knowledge⁵⁶⁻⁵⁸.

Experiential Learning: Experiential learning is workplace-based learning, which is integrated to the curriculum^{2, 21, 25, 64, 65}.

Interprofessional Education: Interprofessional education is education involving students from 2 or more health professions in a collaborative learning environment, learning about and from each other^{66, 67}.

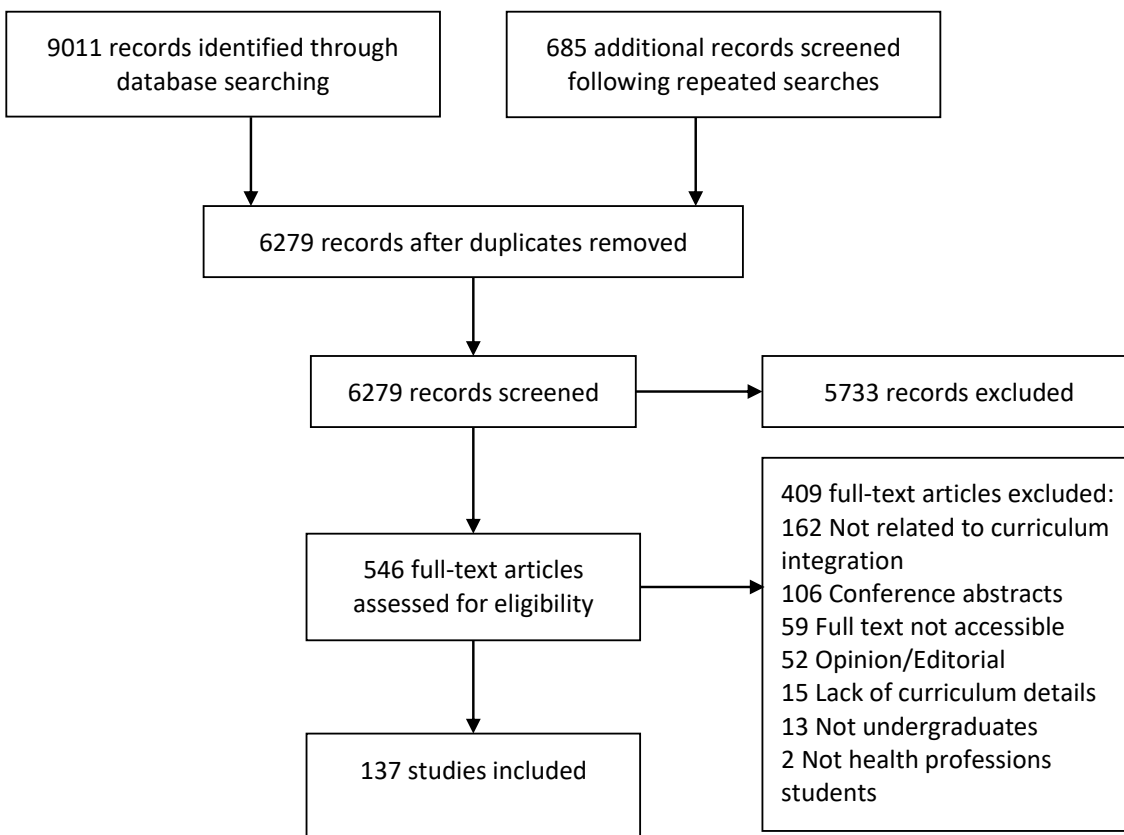
Level of Integration

The level of integration is defined based on the GPhC guidance on integration for pharmacy curricula²⁰. This has operationalized Harden's ladder⁴⁶ into a more easily classifiable manner. Where possible, Harden's Ladder was also applied. 'Not integrated' is defined as points 1-6 (isolation, awareness, harmonization, nesting, temporal co-ordination, sharing) on Harden's Ladder. 'Partially Integrated' is defined as points 7-8 (correlation, complementary) on the ladder and 'fully integrated' is defined as points 9-11 (multidisciplinary, interdisciplinary, transdisciplinary)^{20, 46}.

191 **Results**

192 **Search Results**

193 Initial database searches retrieved 9011 studies of which 131 met inclusion criteria. During title
194 and abstract screening, 5733 abstracts were excluded as they did not meet inclusion criteria and
195 80 conflicts were resolved by discussion between screening authors. Searches were repeated six
196 months after initial searches and prior to submission for publication to ensure up to date
197 coverage. A total of 685 additional results were retrieved and resulted in 6 additional studies for
198 inclusion.



199

200 Figure 1 PRISMA diagram of included and excluded studies for scoping review asking ‘What is
201 meant by integration in health professions curriculum design’

202 **Characteristics of Included Studies**

203 54 (39%) of included studies were published after 2010 and only 9 (7%) were published before
204 1995 with the earliest published study being in 1947⁶⁸ and the next included study not published
205 until 1974⁶⁹. See Table 2 for a summary of the year of publication of included studies.

206 *Table 2 Year of Publication of Included Studies*

Year of Publication	Studies (n)
<1989	6
1990-1995	3
1996-2000	15
2001-2005	23
2006-2010	26
2011-2015	41
2016-February 2019	23

207 The majority of studies were mixed methods (n= 55, 40%) Quantitative (n= 30, 22%) research was
208 more common than qualitative (n=11, 8%) and 30% (n=41) of included studies had no outcome
209 data.

210 61% (n=83) of included studies were conducted in the USA or Canada and 15% (n=20) were
211 carried out in Europe. Other settings each constituted less than 10% of the total: the Middle East
212 (n=12, 9%), Asia (n=10, 7%), Oceania (n=6, 4%), the Caribbean (n=3, 2%), Africa (n=2, 1%) and
213 South America (n=1, <1%).

214 The majority of studies (n=83, 61%) represented medical education and 28% (n=38) of studies
215 referred to pharmacy education. Dentistry and Nursing each accounted for 2% of studies (n=3).
216 Only 7% (n=10) of included studies involved more than one healthcare professions programme.

217 Table 3 Characteristics of Included Studies

Author	Year	Title	Course	Years	Duration	Type of Integration	Research Design	Location	GPhC rating
Abbott, A. et al ⁷⁰	2010	A 'medical student practice profile' as the foundation for a case-based curriculum revision	Medicine	1 st - 4 th	Multiple years	Systems-based, CBL, Spiral, PBL	Quantitative	USA (CA)	Partially Integrated
Abu-Hijleh, M. et al ⁷¹	2005	Integrating applied anatomy in surgical clerkship in a problem-based learning curriculum	Medicine	1 st - 6 th	Whole programme	Horizontal, Spiral, PBL, Topic (Anatomy), Systems-based	Quantitative	Bahrain	Fully Integrated
Adeniyi, K. and Sambo, D. ⁷²	1995	The role of pathophysiology in an integrated medical curriculum	Medicine	Pre-clinical years	Multiple years	Horizontal, CBL, Topic (Pathophysiology)	Narrative	Nigeria	Partially Integrated

Adibi, I. et al ⁷³	2007	Integrating physical examination and trunk anatomy; a new course for second year medical students	Medicine	2 nd	Module	Systems-based, Horizontal, Topic (Anatomy)	Quantitative	Iran	Not Integrated
Afaghi, A. et al ⁷⁴	2012	Effect of an integrated case-based nutrition curriculum on medical education at Qazvin University of Medical Sciences, Iran	Medicine	4 th - 5 th	Multiple Years	CBL, Horizontal, Vertical, Topic (Nutrition)	Quantitative	Iran	Not Integrated
Agrawal, C. and Karki, P. ⁷⁵	1999	Evolution of the second medical school in Nepal: A case study	Medicine	1 st - 2 nd	Multiple years	Systems-based, Horizontal, PBL, Experiential	Narrative	Nepal	Fully Integrated
Alrefaie, Z. et al ⁷⁶	2017	Effect of integrating research skills with basic sciences in an interdisciplinary integrated	Medicine	Pre-clinical and	Module	Systems-based, Horizontal	Quantitative	Egypt	Partially Integrated

		endocrine module on students' satisfaction and performance		clinical years					
AlSaggaf, S. et al ⁷⁷	2010	A model of horizontal and vertical integration of teaching on the cadaveric heart	Medicine	2 nd	N/A	Systems-based, Horizontal, EBL	Narrative	Saudi Arabia	Not Integrated
Alsharif, N. et al ⁷⁸	2001	The Structurally-Based Therapeutic Evaluation (SBTE) concept: An opportunity for curriculum integration and interdisciplinary teaching	Pharmacy	2 nd	Module	Horizontal, CBL	Narrative	USA (NE)	Partially Integrated
Arnold, L. and Willoughby T. ⁷⁹	1993	Curricular integration at the University of Missouri-Kansas City School of Medicine	Medicine	1 st - 6 th	Multiple years	Spiral, Experiential	Quantitative	USA (MO)	Fully Integrated

Azer, S. et al ⁸⁰	2013	Introducing integrated laboratory classes in a PBL curriculum: Impact on student's learning and satisfaction	Medicine	1 st - 2 nd	Multiple years	PBL, EBL, Systems-based, Horizontal	Mixed Methods	Saudi Arabia	Partially Integrated
Azzalis, L. et al ³⁸	2012	Integration of basic sciences in health's courses	Multiple	1 st	1 year	Horizontal, PBL	Quantitative	Brazil	Partially Integrated
Bahner, D. et al ⁸¹	2013	Integrated medical school ultrasound: Development of an ultrasound vertical curriculum	Medicine	1 st - 4 th	Multiple years	Vertical, Topic (Ultrasound)	Narrative	USA (OH)	Partially Integrated
Barlow, J. and Strawbridge, J. ⁸²	2007	Teaching and assessment of an innovative and integrated pharmacy undergraduate module	Pharmacy	4 th	Module	Horizontal, CBL	Mixed Methods	Ireland	Partially Integrated

Beleh, M. et al ⁸³	2015	Integrating a new medicinal chemistry and pharmacology course sequence into the PharmD curriculum	Pharmacy	1 st - 2 nd	Multiple years	Horizontal	Mixed Methods	USA (MI)	Partially Integrated
Besdine, R. et al ⁸⁴	2011	Integrating and Evaluating Geriatrics in Medical School: A Novel Approach for the Challenge	Medicine	1 st - 2 nd	Multiple years	Systems-based, Stages of life, Horizontal, Topic (Geriatrics), Experiential and Vertical	Qualitative	USA (RI)	Partially Integrated
Bouwer, H. et al ⁸⁵	2016	Current integration of dissection in medical education in Australia and New Zealand: Challenges and successes	Medicine	Various	N/A	Systems-based, PBL, Topic (Anatomy), CBL, Horizontal	Mixed Methods	Australia/N ew Zealand	Partially Integrated

Bowe, C. et al ⁸⁶	2009	Case method teaching: An effective approach to integrate the basic and clinical sciences in the preclinical medical curriculum	Medicine	1 st - 2 nd	Single session	Horizontal, CBL, Systems-based	Qualitative	USA (MA)	Partially Integrated (Harden's 10)
Brooks, S. et al ⁸⁷	2015	Integration of Gross Anatomy in an Organ System-Based Medical Curriculum: Strategies and Challenges.	Medicine	1 st - 2 nd	Multiple years	Systems-based, Horizontal, Topic (Anatomy)	Narrative	USA (AL)	Partially Integrated
Brown, B. et al ⁸⁸	2009	Learning across the curriculum: Connecting the pharmaceutical sciences to practice in the first professional year	Pharmacy	1 st	1 year	Horizontal, Cross-Cutting Theme (Professionalism), Experiential	Mixed Methods	USA (OH)	Not Integrated
Brunger, F. and Duke, P. ⁸⁹	2012	The evolution of integration: Innovations in clinical skills and ethics in first year medicine	Medicine	1 st	1 year	CBL, Vertical, Cross-Cutting	Qualitative	Canada (NL)	Not Integrated

						Theme (Communication)			
Cameron, A. et al ⁹⁰	2009	An Interprofessional Education Session for First-Year Health Science Students	Multiple	1 st	Single session	IPE, CBL, Horizontal	Mixed Methods	Canada (ON)	Not Integrated
Carpenter, C. ⁶⁸	1947	Integration and organization of the medical curriculum	Medicine	1 st - 4 th	Multiple years	Horizontal, Vertical	Narrative	USA (NC)	Fully Integrated
Chamberlain, L. et al ⁹¹	2008	Integrating collaborative population health projects into a medical student curriculum at Stanford	Medicine	1 st	1 year	Cross-cutting theme (Professionalism, Communication), CBL, Experiential	Qualitative	USA (CA)	Not Integrated

Chan, W. et al ⁹²	2008	Innovative 'Case-Based Integrated Teaching' in an undergraduate medical curriculum: development and teachers' and students' responses	Medicine	1 st - 5 th	Part of whole curriculum	Case-based, Spiral	Qualitative	Taiwan	Fully Integrated (Harden's 10)
Chin, J. et al ⁹³	2011	Evaluating the effects of an integrated medical ethics curriculum on first-year students	Medicine	1 st	Multiple years	Cross-cutting theme (Professionalism), Systems-based Horizontal, Vertical	Mixed Methods	Singapore	Partially Integrated
Collins, J. et al ⁹⁴	2002	Teaching radiology to medical students: An integrated approach	Medicine	3 rd	Module	Topic (Radiology), Experiential	Mixed Methods	USA (WI)	Partially Integrated

Connor, L. and Higginbotham N. ⁹⁵	1986	An integrated sociocultural curriculum for community medicine in Bali, Indonesia	Medicine	1 st - 4 th	Multiple years	Horizontal, Topic (Community health)	Narrative	Indonesia	Partially Integrated
Cooles, P. et al ⁹⁶	2014	Student performance and grading changes in a systems-based curriculum	Medicine	1 st - 2 nd	Multiple years	Systems-based, Horizontal	Quantitative	West Indies (Dominica)	Partially Integrated
Cordova, A. and Galigarcia J. ⁹⁷	1977	Place of social sciences in the medical curriculum. An integrated study plan for the teaching of medicine in the University of Havana	Medicine	1 st - 5 th	Whole programme	Horizontal, Vertical, Systems-based, Experiential	Narrative	Cuba	Fully Integrated
Cunningham, J. et al ⁹⁸	2001	Integration of neuroscience and endocrinology in hybrid PBL curriculum	Medicine	All years	Whole programme	PBL, Spiral	Narrative	USA (MO)	Fully Integrated

Day, C. et al ⁹⁹	2011	Early assessment of a new integrated preclinical musculoskeletal curriculum at a medical school	Medicine	1 st	Module	Systems-based, Horizontal	Quantitative	USA (MA)	Not Integrated
Di Prospero, L. et al ¹⁰⁰	2011	Teaching Collaboration: A Retrospective Look at Incorporating Teamwork into an Interprofessional Curriculum	Multiple	1 st	One year	IPE, TBL, Horizontal	Qualitative	Canada (ON)	Not Integrated
Dienstag, J. ¹⁰¹	2011	Evolution of the new pathway curriculum at Harvard medical school	Medicine	1 st - 4 th	Whole programme	PBL, CBL, Systems-based, Horizontal, Experiential, Topic (Pathophysiology)	Narrative	USA (MA)	Fully Integrated
Dircks, M. et al ¹⁰²	2017	Advances in clinical pharmacy education in Germany: A quasi-	Pharmacy	4 th	Module	Experiential	Mixed Methods	Germany	Partially Integrated

		experimental single-blinded study to evaluate a patient-centered clinical pharmacy course in psychiatry							
Dirks-Naylor, A. et al ³⁹	2015	Development and Assessment of a Horizontally Integrated Biological Sciences Course Sequence for Pharmacy Education	Pharmacy	1st	1 year	Horizontal, CBL	Narrative	USA (NC)	Partially Integrated
D'Souza, R. et al ¹⁰³	2018	Novel horizontal and vertical integrated bioethics curriculum for medical courses	Medicine	1 st - 5 th	Multiple years	Horizontal, Vertical, Cross-cutting theme (Professionalism)	Narrative	India	Partially Integrated

Dyrbye, L. et al ¹⁰⁴	2011	A model for integration of formal knowledge and clinical experience: the advanced doctoring course at Mayo Medical School	Medicine	2 nd	1 year	Horizontal, Systems-based, Experiential	Mixed Methods	USA (MN)	Partially Integrated
Eisenbarth, S., et al ¹⁰⁵	2016	Exploring the value and role of integrated supportive science courses in the reformed medical curriculum iMED: A mixed methods study	Medicine	1 st	1 year	Horizontal, Systems-based	Mixed Methods	Germany	Partially Integrated
Elangovan, S. et al ¹⁰⁶	2016	Integration of basic-clinical sciences, PBL, CBL, and IPE in U.S. Dental schools' curricula and a proposed integrated curriculum model for the future	Dentistry	1 st - 2 nd	Multiple years	Systems-based Horizontal, CBL, PBL	Mixed Methods	USA (Various)	Partially Integrated

Ellman, M. et al ¹⁰⁷	2016	Implementing and Evaluating a Four-Year Integrated End-of-Life Care Curriculum for Medical Students	Medicine	1 st - 4 th	Multiple years	Stages of life, Vertical, Experiential	Mixed Methods	USA (CT)	Partially Integrated
Emerson, M. ¹⁰⁸	2007	The central endocrine glands: Intertwining physiology and pharmacy	Pharmacy	1 st	Module	Systems-based, Horizontal, Vertical	Narrative	USA (AZ)	Partially Integrated
Faingold, C. and Dunaway, G. ¹⁰⁹	2002	Teaching pharmacology within a multidisciplinary organ system-based medical curriculum	Medicine	2 nd	Module	Systems-based, CBL, Horizontal	Quantitative	USA (IL)	Partially Integrated
Fazio, S. et al ¹¹⁰	2016	Blueprint for an Undergraduate Primary Care Curriculum	Medicine	1 st - 4 th	Multiple years	Vertical, Experiential, Topic (Pain)	Narrative	USA (MA)	Partially Integrated

Fields, S. et al ¹¹¹	1995	Principles of clinical medicine: an interdisciplinary integrated 2-year longitudinal course	Medicine	1 st - 2 nd	Multiple years	Horizontal, Systems-based, Experiential, PBL	Narrative	USA (OR)	Partially Integrated
Frank, D. et al ¹¹²	1996	An Integrated Curriculum for Teaching Preparatory Clinical Skills at a Traditional Medical School	Medicine	1 st - 4 th	Multiple years	Experiential, Stages of life, Cross-cutting theme (Ethics)	Qualitative	Canada (ON)	Partially Integrated
Frankl, W. and Roberts J. ⁶⁹	1974	Development of an integrated curriculum in clinical pharmacology	Medicine	1 st , 2 nd , 4 th	Multiple years	Systems-based, CBL, Vertical, Topic (Pharmacology)	Narrative	USA (PA)	Partially Integrated
Fuentes, D. G. ¹¹³	2012	Integration of pharmacotherapy topics across the curriculum using a 'Create-Your-Own-Patient Case' team project	Pharmacy	2 nd	Module	CBL, Horizontal, TBL	Mixed Methods	USA (IL)	Partially Integrated

Gallan, A. et al ¹¹⁴	2016	Vertical integration of biochemistry and clinical medicine using a near-peer learning model	Medicine	1 st	Module	PBL, Horizontal	Mixed Methods	USA (MA)	Partially Integrated
George, P. et al ¹¹⁵	2013	An Integrated Virtual Family Curriculum to Introduce Specialty-Specific Clinical Skills to Rising Third-Year Medical Students	Medicine	3 rd	Module	Horizontal, CBL	Mixed Methods	USA (RI)	Partially Integrated
Ghayur, S. et al ¹¹⁶	2012	Delivering endocrinology and reproduction in an integrated modular curriculum	Medicine	4 th	Module	Systems-based, Spiral, CBL	Mixed Methods	Pakistan	Partially Integrated
Giffin, B. and	2000	Gross anatomy of the head and neck and neuroscience in an	Medicine	1 st	Part of year	Horizontal, Systems-based, PBL	Narrative	USA (OH)	Partially Integrated

Drake, R. ¹¹⁷		integrated first-year medical school curriculum							
Goelen, G. et al ¹¹⁸	2006	Measuring the effect of interprofessional problem-based learning on the attitudes of undergraduate health care students	Multiple-Medicine, Nursing, Physiotherapy	2 nd , 3 rd	Module	IPE, PBL, Horizontal	Mixed Methods	Belgium	Partially Integrated
Gonzalez-Soltero, R. et al ¹¹⁹	2017	Work station learning activities: a flexible and scalable instrument for integrating across basic subjects in biomedical education	Medicine	1 st - 2 nd	Multiple years	Horizontal, Systems-based, TBL	Quantitative	Spain	Partially Integrated
Grady, R. et al ¹²⁰	2009	Using innovative group-work activities to enhance the problem-based learning experience for dental students	Dentistry	1 st - 5 th	Whole programme	PBL, Systems-based	Mixed Methods	UK	Partially Integrated

Griswold, T. et al ¹²¹	2012	Psychiatry in the Harvard Medical School-Cambridge Integrated Clerkship: An innovative, year-long program	Medicine	3 rd	1 year	Experiential, CBL, Horizontal	Mixed Methods	USA (MA)	Partially Integrated
Hall, J. et al ⁵²	2014	Team based learning: Preparing pharmacy students for an integrated curriculum during induction	Pharmacy	1 st	Module	TBL, Horizontal	Mixed Methods	UK	Partially Integrated
Hamilton, S. et al ¹²²	2008	Interprofessional Education in Gross Anatomy: Experience With First-Year Medical and Physical Therapy Students at Mayo Clinic	Multiple-Physical therapy, Medicine	1 st	Single session	IPE, Topic (Anatomy), Horizontal	Quantitative	USA (MN)	Partially Integrated

Hark, L. and Morrison, G. ¹²³	2000	Development of a case-based integrated nutrition curriculum for medical students	Medicine	1 st - 4 th	Multiple years	CBL, Horizontal, Vertical, Systems-based, Topic (Nutrition)	Narrative	USA (PA)	Partially Integrated
Hasnain, M. et al ¹²⁴	2012	Training Future Health Providers to Care for the Underserved: A Pilot Interprofessional Experience	Multiple-Medicine, Pharmacy	2 nd , 3 rd	Module	IPE, Experiential	Mixed Method	USA (IL)	Partially Integrated
Haspel, R. et al ¹²⁵	2012	Successful implementation of a longitudinal, integrated pathology curriculum during the third year of medical school	Medicine	3 rd	1 year	Topic (Pathology), CBL, Horizontal, Experiential	Mixed Methods	USA (PA)	Partially Integrated
Hayes, M. and Mitchell, R. ¹²⁶	1982	Psychology in an integrated undergraduate medical curriculum	Medicine	1 st - 5 th	Multiple years	Cross-cutting theme (Professionalism, Communication),	Narrative	Australia (NSW)	Partially Integrated

						Topic (Psychology), PBL, Systems-based, Stages of life, Experiential			
Ho, S. et al ¹²⁷	2009	An outcomes-based approach to curriculum development in pharmacy	Pharmacy	1 st - 3 rd	Multiple years	Experiential, Spiral, Systems-based	Mixed Methods	China	Partially Integrated
Hoppman n, R. et al ¹²⁸	2015	The evolution of an integrated ultrasound curriculum (iUSC) for medical students: 9-year experience	Medicine	1 st - 4 th	Multiple years	Topic (Ultrasound), Vertical, PBL and Experiential	Mixed Methods	USA (SC)	Partially Integrated
Hrubey, T. ¹²⁹	1996	An Integrated, Case-Based Curricular Model for the Entry-Level Doctor of Pharmacy Degree	Pharmacy	1 st - 6 th	Whole programme	CBL, PBL, Experiential,	Narrative	USA (NM)	Partially Integrated

						Vertical, Systems-based			
Husband, A. et al ¹³	2014	Integrating Science and Practice in Pharmacy Curricula	Pharmacy	1 st - 4 th	Multiple years	CBL, TBL, PBL, Vertical, Systems-based, Spiral, Horizontal	Narrative	UK	Partially Integrated
Islam, M. et al ¹³⁰	2016	Integration of Basic and Clinical Science Courses in US PharmD Programs	Pharmacy	N/A	N/A	Horizontal, Vertical, CBL, PBL, Systems-based, TBL, Spiral	Mixed Methods	USA (Various)	N/A
Ives, T. et al ¹³¹	1998	Integration of medicinal chemistry and pharmacotherapeutics courses: A case-based, learner-centered approach	Pharmacy	2 nd - 3 rd	Multiple years	Horizontal, CBL, PBL, Systems-based	Mixed Methods	USA (NC)	Partially Integrated

Jungsuwa dee, P. et al ¹³²	2017	A team-based assignment to integrate basic science and pharmacotherapeutic principles for anticancer agents	Pharmacy	Unclear	Module	TBL, Horizontal, CBL	Mixed Methods	USA (IL)	
Karimi, R. et al ¹³³	2010	Learning bridge: Curricular integration of didactic and experiential education	Pharmacy	1 st - 2 nd	Multiple years	Experiential, Vertical	Mixed Methods	USA (OR)	Partially Integrated
Katajavuo ri, N. et al ¹³⁴	2003	The development of excellence in pharmaceutical knowledge: New curriculum for the B.Sc. (Pharmacy) studies	Pharmacy	1 st - 3 rd	Whole programme	Experiential	Qualitative	Finland	Not Integrated
Katajavuo ri, N. et al ¹³⁵	2009	Curriculum reform in Finnish pharmacy education	Pharmacy	1 st - 5 th	Whole programme	Experiential, Horizontal, Vertical	Narrative	Finland	Partially Integrated

Khan, A. et al ¹³⁶	2004	Teaching of an integrated human nervous system course in the Sultanate of Oman	Medicine	1 st - 4 th	Multiple years	Systems-based, Horizontal, Vertical, PBL	Narrative	Oman	Partially Integrated
Klement, B. et al ¹³⁷	2011	Anatomy as the backbone of an integrated first year medical curriculum: Design and implementation	Medicine	1 st	1 year	Horizontal, Topic (Anatomy), Systems-based	Mixed Methods	USA (GA)	Partially Integrated
Kolluru, S. et al ¹³⁸	2012	A multi-instructor, team-based, active-learning exercise to integrate basic and clinical sciences content	Pharmacy	1 st - 3 rd	Multiple years	Horizontal, TBL	Quantitative	USA (TX)	Fully Integrated
Krebs, N. and Primak, L. ¹³⁹	2006	Comprehensive integration of nutrition into medical training	Medicine	1 st - 4 th	Multiple years	Topic (Nutrition), Vertical, Systems-based, Experiential	Narrative	USA (CO)	Partially Integrated

Kullgren, J. et al ¹⁴⁰	2013	An integrated course in pain management and palliative care bridging the basic sciences and pharmacy practice	Pharmacy	Unclear	Module	Horizontal and topic (Pain)	Mixed Methods	USA (NV/UT)	Not Integrated
Lazarus, D. et al ¹⁴¹	2014	Anatomy Integration Blueprint: A Fourth-Year Musculoskeletal Anatomy Elective Model.	Medicine	4 th	Module	Horizontal, PBL, Topic (Anatomy)	Quantitative	USA (PA)	Partially Integrated
Lim, A. and Honey, M. ¹⁴²	2006	Integrated undergraduate nursing curriculum for pharmacology	Nursing	1 st - 3 rd	Multiple years	Vertical, Topic (Pharmacology), CBL	Narrative	New Zealand	Partially Integrated
Lim-Dunham, J. et al ¹⁴³	2016	A Vertically Integrated Online Radiology Curriculum Developed as a Cognitive Apprenticeship:	Medicine	3 rd	Online module	Vertical, Topic (Radiology), CBL	Mixed Methods	USA (IL)	Not Integrated

		Impact on Student Performance and Learning							
Lloyd Jones, G. et al ¹⁴⁴	1997	Integrating clinical pharmacology in a new problem based medical undergraduate curriculum	Medicine	1 st - 4 th	Whole programme	PBL, Horizontal, Stages of life, Experiential, Vertical, Cross-cutting theme (Professionalism)	Narrative	UK	Fully Integrated
Loewen, P. et al ¹⁴⁵	2016	Design and implementation of an integrated medication management curriculum in an entry-to-practice doctor of pharmacy programme	Pharmacy	1 st - 3 rd	Multiple years	Systems-based Spiral	Narrative	Canada (BC)	Fully Integrated (Harden's 10)

Marshall, L. and Nykamp, D. ¹⁴⁶	2010	Active-learning assignments to integrate basic science and clinical course material	Pharmacy	3 rd	Module	Horizontal, Systems-based, CBL	Mixed Methods	USA (GA)	Partially Integrated
Mawdsley, A. and Willis, S. ¹⁴⁷	2017	Exploring an integrated curriculum in pharmacy: Educators' perspectives	Pharmacy	N/A	N/A	Horizontal, Vertical, Spiral, PBL	Qualitative	UK	N/A
McNair, A. et al ¹⁴⁸	2011	How we implemented an integrated professionalism curriculum to 2nd year medical students at the National University of Ireland Galway Medical School, with examples from students' final output	Medicine	2 nd	Single session	Horizontal, Topic (Professionalism), CBL	Narrative	Ireland	Not Integrated

Miller, A. et al ¹⁴⁹	2000	'Systems Integration': A middle way between problem-based learning and traditional courses	Medicine	2 nd - 3 rd	Multiple years	Horizontal, CBL, Systems-based	Quantitative	New Zealand	Partially Integrated
Miller, L. and Mercer, S. ¹⁵⁰	2017	Drugs of Abuse and Addiction: An integrated approach to teaching	Pharmacy	3 rd	Single session	Horizontal, Topic (Addiction)	Mixed Methods	USA (TN)	Not Integrated
Nelson, M. et al ¹⁵¹	2013	The regis model for pharmacy education: A highly integrated curriculum delivered by team-based learning™ (TBL)	Pharmacy	1 st - 3 rd	Whole programme	Horizontal, Vertical, Systems-based, TBL	Mixed Methods	USA (CO)	Fully Integrated
O'Neill, P. et al ¹⁵²	2000	Evaluation of an integrated curriculum using problem-based learning in a clinical environment: The Manchester experience	Medicine	1 st - 4 th	Whole programme	PBL, Horizontal, Vertical, Experiential, Systems-based	Mixed Methods	UK	Fully Integrated

Patel, V. et al ¹⁵³	2005	Knowledge integration and reasoning as a function of instruction in a hybrid medical curriculum	Medicine	2 nd - 4 th	Multiple years	PBL, Horizontal, Vertical	Mixed Methods	USA (NY)	Partially Integrated
Pearson, M. and Hubball, H. ³⁵	2012	Curricular Integration in Pharmacy Education	Pharmacy	1 st - 4 th	Multiple years	Horizontal, CBL, Vertical, Experiential	Narrative	Canada (BC)	Not Integrated (Harden's 5)
Pereira, J. and Murzyn, T. ¹⁵⁴	2001	Integrating the 'new' with the 'traditional': An innovative education model	Pharmacy	Final year	One semester	Horizontal, Topic (Pain), Experiential	Mixed Methods	Canada (AB)	Partially Integrated
Pitka, K. et al ¹⁵⁵	2014	Integrating Internships with Professional Study in Pharmacy Education in Finland	Pharmacy	2 nd - 3 rd	Multiple years	Experiential	Narrative	Finland	Partially Integrated

Pittenger, A. et al ¹⁵⁶	2013	An Interprofessional Diabetes Experience to Improve Pharmacy and Nursing Students' Competency in Collaborative Practice	Multiple	2 nd - 4 th	Module	IPE, Horizontal, CBL	Mixed Methods	USA (MN)	Partially Integrated
Poirier, T. et al ¹⁵⁷	2016	Survey of Pharmacy Schools' Approaches and Attitudes toward Curricular Integration	Pharmacy	Multiple	N/A	Horizontal, CBL, PBL, TBL, Experiential, Systems-based	Mixed Methods	USA (IL)	N/A
Puthuchery, J. et al ¹⁵⁸	2009	Body and disease 2008: An integrated course teaching pathology, pharmacology, immunology and microbiology	Medicine	1 st	Module	Horizontal, TBL	Quantitative	Singapore	Partially Integrated

Quill, T. et al ¹⁵⁹	2003	An integrated biopsychosocial approach to palliative care training of medical students	Medicine	1 st - 4 th	Whole programme	PBL, topic (Pain), Experiential, Spiral	Narrative	USA (NY)	Partially Integrated
Ryden, M. et al ¹⁶⁰	1989	Multi-course sequential learning as a model for content integration: ethics as a prototype	Nursing	1 st - 3 rd	Multiple years	Vertical, Cross-cutting theme (Professionalism)	Narrative	USA (MN)	Partially integrated
Saleh, K. et al ¹⁶¹	2004	Development and evaluation of an integrated musculoskeletal disease course for medical students	Medicine	2 nd	1 year	Horizontal, Systems-based, CBL	Mixed Methods	Pakistan	Partially Integrated
Sandila, M. et al ¹⁶²	2001	An Integrated Curriculum for MBBS	Medicine	1 st - 2 nd	Multiple years	Horizontal, Systems-based	Narrative	Pakistan	Partially Integrated
Schapiro, R. et al ¹⁶³	2011	Integrative cases for preclinical medical students: Connecting	Medicine	1 st - 2 nd	Multiple years	CBL, Horizontal	Qualitative	USA (WI)	Partially Integrated

		clinical, basic science, and public health approaches							
Scheffer, C. et al ¹⁶⁴	2012	Integrative medical education: Educational strategies and preliminary evaluation of the Integrated Curriculum for Anthroposophic Medicine (ICURAM)	Medicine	1 st - 6 th	Whole programme	Cross-cutting theme (Communication, Professionalism), PBL, Topic (CAM)	Quantitative	Germany	Partially Integrated
Schmidt, H. et al ¹⁶⁵	1996	The development of diagnostic competence: comparison of a problem-based, an integrated, and a conventional medical curriculum	Medicine	3 rd - 6 th	Whole programme	Horizontal, PBL, Systems-based	Quantitative	Netherlands	Partially Integrated

Schmidt, H. ¹⁶⁶	1998	Integrating the teaching of basic sciences, clinical sciences, and biopsychosocial issues	Medicine	Whole programme	Whole programme	Horizontal, PBL, Systems-based, Vertical, Experiential	Qualitative	USA (NY)	Partially Integrated
Shaffer, K. et al ¹⁶⁷	2009	An Integrated Model for Radiology Education. Development of a Year-long Curriculum in Imaging with Focus on Ambulatory and Multidisciplinary Medicine	Medicine	3 rd	1 year	Experiential, Horizontal, Topic(radiology)	Quantitative	USA (MA)	Partially Integrated
Shafi, R. et al ¹⁶⁸	2010	Experience with a theme-based integrated renal module for a second-year MBBS class	Medicine	2 nd	Whole programme	Vertical, Horizontal, Spiral, PBL, Systems-based	Mixed Methods	Pakistan	Partially Integrated

Sharp, D. et al ¹⁶⁹	2003	The 'virtual family': An evaluation of an innovative approach using problem-based learning to integrate curriculum themes in a nursing undergraduate programme	Nursing	1 st , 3 rd	Multiple years	PBL	Mixed Methods	UK	Partially Integrated
Shimura, T. et al ¹⁷⁰	2004	Implementation of Integrated Medical Curriculum in Japanese Medical Schools	Medicine	All years	Whole programme	Systems-based Horizontal	Mixed Methods	Japan	Partially integrated
Snyman, W. et al ¹⁷¹	2005	Vertical and horizontal integration of knowledge and skills - a working model	Dentistry	All years	Whole programme	CBL, Systems-based, Horizontal	Narrative	South Africa	Partially Integrated
Sookanekun, P., et al ¹⁷²	2009	Health promotion integrated into a Thai PharmD curriculum to improve pharmacy practice skills	Pharmacy	Unclear	Module	Experiential, Topic (Health promotion)	Mixed Methods	Thailand	Partially Integrated

Sprague, J. et al ¹⁷³	2000	Development and implementation of an integrated cardiovascular module in a PharmD curriculum	Pharmacy	4 th	Part of year	Horizontal, Systems-based, CBL	Mixed Methods	USA (OH)	Partially Integrated
Stalburg, C. et al ¹⁷⁴	2002	An interdisciplinary course in women's health integrating basic and clinical sciences: Clinical anatomy and women's health	Medicine	4 th	Module	Horizontal, Topic (Obstetrics, Gynecology)	Quantitative	USA (MI)	Partially Integrated
Steele, D. and Susman, J. ¹⁷⁵	1998	Integrated clinical experience: University of Nebraska Medical Center	Medicine	1 st - 2 nd	Multiple years	Cross-cutting theme (Communication, Professionalism), Experiential	Mixed Methods	USA (NE)	Not Integrated

Steele, G. and Greenidge, E. ¹⁷⁶	2002	Integrating medical communication skills with library skills curricula among first year medical students at the University of the West Indies, St. Augustine	Medicine	1 st	One assignment	Cross-cutting theme (Communication)	Quantitative	West Indies (St. Augustine)	Not Integrated
Stevenson, T. and Brackett, p. ¹⁷⁷	2011	A novel approach to Introductory Pharmacy Practice Experiences: An integrated, longitudinal, residence-based program	Pharmacy	1 st - 3 rd	Multiple years	Vertical, Experiential	Mixed Methods	USA (AL)	Partially Integrated
Stewart, A. et al ¹⁷⁸	2011	A shared assignment to integrate pharmaceuticals and pharmacy practice course concepts	Pharmacy	1 st	One assignment	Horizontal	Mixed Methods	USA (MA)	Not Integrated
Stott, M. et al ¹⁷⁹	2016	Improving medical students' application of knowledge and	Medicine	Clinical Years	Module	Vertical, CBL	Mixed Methods	UK	Partially Integrated

		clinical decision-making through a porcine-based integrated cardiac basic science program							
Stull, R. and Carter, R. 180	2002	Integrating the pharmacy curriculum: More to consider than improving learning	Pharmacy	1 st - 3 rd	Multiple years	Systems-based	Narrative	USA (VA/MN)	Partially Integrated
Sturmberg, J. et al ¹⁸¹	2002	A longitudinal, patient-centered, integrated curriculum: Facilitating community-based education in a rural clinical school	Medicine	4 th	Part of year	Experiential	Narrative	Australia (WW)	Partially Integrated
Supiano, M. et al ¹⁸²	2007	A vertically integrated geriatric curriculum improves medical student knowledge and clinical skills	Medicine	3 rd	Module	Topic (Geriatrics), Experiential	Quantitative	USA (MI)	Partially Integrated

Taylor, J. et al ¹⁸³	2012	Warren Alpert Medical School's Doctoring program: a comprehensive, integrated clinical curriculum	Medicine	1 st - 5 th	Whole programme	Cross-cutting Theme (Professionalism, Communication), Experiential, Vertical	Narrative	USA (RI)	Partially Integrated
Thom, K. et al ¹⁸⁴	2016	Advancing interprofessional patient safety education for medical, nursing, and pharmacy learners during clinical rotations	Multiple (Medicine, Nursing, Pharmacy)	4 th	Module	IPE, CBL, Experiential, Horizontal	Quantitative	USA (MD)	Partially Integrated
Tobin, B. et al ¹⁸⁵	2003	Longitudinal and horizontal integration of nutrition science into medical school curricula	Medicine	1 st -4 th	Whole programme	Horizontal, Vertical, PBL, Systems-based, Topic (Nutrition)	Narrative	USA (GA)	Partially Integrated

Tofovic, S. et al ¹⁸⁶	1998	Teaching clinical pharmacology and therapeutics: Selective for fourth-year medical students	Medicine	4 th	Module	PBL, horizontal, Topic (Pharmacology)	Quantitative	USA (PA)	Partially Integrated
Van Weel-Baumgarten, E. et al ¹⁸⁷	2013	Bridging the gap: How is integrating communication skills with medical content throughout the curriculum valued by students?	Medicine	3 rd - 6 th	Multiple Years	Vertical, Cross-cutting theme (Communication), Experiential	Mixed Methods	Netherlands	Partially Integrated
Varkey, p. ¹⁸⁸	2007	Educating to improve patient care: Integrating quality improvement into a medical school curriculum	Medicine	1 st - 4 th	Multiple years	Vertical, Topic (Quality improvement), CBL, Experiential	Narrative	USA (MN)	Partially Integrated
Vogler, C. et al ¹⁸⁹	2017	Interprofessional education involving medical and pharmacy	Multiple	3 rd	Single session	IPE, Experiential	Quantitative	USA (IL)	Not Integrated

		students during transitions of care							
Waldrop, B. and Thomason, A. ¹⁹⁰	2016	Design and implementation of pharmacy morning report: An adaptation of medical morning report for case-based instruction in the pharmacy curriculum	Pharmacy	1 st - 3 rd	Single Session	Horizontal, CBL	Mixed Methods	USA (AL)	Partially Integrated
Warren Beach, J. et al ¹⁹¹	1998	An integrated infectious disease course for an entry-level doctor of pharmacy curriculum	Pharmacy	2 nd	One semester	Horizontal	Mixed Methods	USA (GA)	Partially Integrated
Watt-Watson, J. et al ¹⁹²	2004	An integrated undergraduate pain curriculum, based on IASP curricula, for six Health Science Faculties	Multiple	2 nd , 3 rd	Module	Horizontal, Topic (Pain), IPE	Mixed Methods	Canada (ON)	Partially Integrated

Wensel, T. et al ¹⁹³	2014	Design, implementation, and assessment of an Integrated Pharmacy Applications course series	Pharmacy	1 st - 3 rd	Multiple years	Horizontal, CBL	Mixed Methods	USA (AL)	Partially Integrated
Whelan, A. et al ¹⁹⁴	2002	Outcomes-based integrated hybrid PBL curriculum	Pharmacy	1 st - 4 th	Whole programme	PBL, Systems-based, Horizontal	Mixed Methods	Canada (NS)	Partially Integrated
Wilkerson, L. et al ¹⁹⁵	2009	No content without context: Integrating basic, clinical, and social sciences in a pre-clerkship curriculum	Medicine	1 st - 2 nd	Multiple years	Spiral, Systems-based, PBL	Narrative	USA (CA)	Partially Integrated
Wilkins, K. et al ¹⁹⁶	2017	Integration of Basic and Clinical Science in the Psychiatry Clerkship	Medicine	3 rd , 4 th	Module	CBL, Horizontal	Quantitative	USA (CT)	Partially Integrated

Woodman, O. et al ¹⁹⁷	2004	Teaching pharmacology to medical students in an integrated problem-based learning curriculum: An Australian perspective	Medicine	1 st - 3 rd	Multiple years	PBL, Horizontal, Systems-based, Topic (Epilepsy)	Narrative	Australia (Vic)	Partially Integrated
Yamini, T. et al ¹⁹⁸	2015	Developing a fully integrated tobacco curriculum in medical colleges in India Curriculum development	Medicine	2 nd , 3 rd , 4 th	Multiple years	Topic (Tobacco), Systems-based, Horizontal	Quantitative	India	Partially Integrated
Yaqinuddi n, A. et al ¹⁹⁹	2016	The Integrated Clinical Anatomy Program at Alfaisal University: An Innovative Model of Teaching Clinically Applied Functional Anatomy in a Hybrid Curriculum.	Medicine	1 st -5 th	Whole Programme	Systems-based, Spiral, TBL, PBL Topic (Anatomy)	Quantitative	Saudi Arabia	Partially Integrated

219 **Outcomes**

220 Perception outcomes were reported for 81 studies. The majority of studies with perception
221 outcome data had Kirkpatrick level 2A (attitudes or perceptions)²⁰⁰ or 2B (modification of
222 knowledge or skills) outcomes (n=64). 14 studies had level 1 (learners' views on the learning
223 experience²⁰⁰) outcomes. Only 3 studies went beyond perception to Kirkpatrick level 3 (behavior
224 change)²⁰⁰ outcomes. No studies had level 4 (benefit to patients or clients) outcomes²⁰⁰. There
225 did not appear to be any clear pattern in the approach to evaluation of integration or of tools
226 used to evaluate integration.

227 In general, positive perceptions of integration and satisfaction with educational experience.
228 Specifically improved attendance¹⁰⁹, and knowledge gains or improved exam performance were
229 reported^{73, 76, 79, 96, 102, 115, 127, 128, 132, 133, 137, 138, 141, 149, 158, 161, 165, 174, 176-179, 182, 190, 192}. Students
230 reported feeling empowered to be self-directed learners and critical thinkers^{88, 131, 133, 168, 194},
231 increased understanding of relevance of knowledge to career^{52, 76, 102, 131, 150, 190}, increased
232 confidence^{70, 93, 107, 131, 138, 141, 161} and motivation⁷⁶. Those studies with level 3 outcomes indicated
233 positive changes in improved communication skills¹⁵¹, greater uptake of specialty¹²¹ and
234 improved performance in clinical placements¹⁷². Some negative perceptions and disadvantages
235 were also reported. These included struggling with basic concepts in some areas¹⁹⁴, increased
236 stress levels²⁰¹, and decreased motivation to learn over the year¹⁵². Some students expressed
237 concern about insufficient time for content^{116, 140} and about module organization and structure^{83,}
238 ¹⁶⁸. Shaffer et al found that students who completed an integrated clerkship had significantly
239 lower scores in the final multiple choice question exam than those who completed the traditional
240 clerkship¹⁶⁷. Cooles et al found increased failure rates in microbiology and pharmacology

241 following introduction of a systems-based curriculum⁹⁶. Others found no significant differences
242 in exam performance by students from traditional and integrated teaching^{143, 146} Some reported
243 that faculty expressed concern about the time commitment for integrated activities^{133, 167}.

244 **Classification of Integration**

245 Only 17 (12.4%) included studies defined what they meant by integration or included a definition
246 of integration in their publication^{13, 35, 38, 39, 68, 77, 114, 145, 147, 150, 157, 171, 179, 180, 191, 197}.

247 **Model of Integration**

248 The most commonly described model of integration was horizontal integration (n=88). Vertical
249 (n=38) and spiral (n=15) integration were described more frequently in more recent years. Some
250 studies described more than one integration model, varying for different aspects of the
251 curriculum or as the curriculum developed.

252 **Themes for Curricular Integration**

253 Various themes for curricular integration were described by included studies and it was very
254 common for more than one theme to be used. Systems-based teaching was the most common
255 theme for integration used (n=56). The use of a topic (n=37) to integrate teaching was also
256 employed. The topics covered were quite heterogeneous, for example, anatomy (n=6), pain (n=5)
257 or nutrition (n=4). Stages of life (n=5) teaching and cross-cutting themes (professionalism n=12,
258 communication n=8) were each described by less than 10% of included studies.

259 **Teaching and Learning Approaches**

260 Various teaching and learning approaches to support integration were described. As with the
261 themes of curricular integration, many studies described the use of more than one approach.
262 Experiential learning (n=43, 32%), case-based learning (n=42, 31%) and problem-based learning
263 (n=38, 28%) were most commonly described. All three of these approaches are favored for
264 integrated curricula. Other approaches identified were described by less than 10% of studies
265 each; team-based learning (n=12, 9%), inter-professional education (n=9, 7%) and enquiry-based
266 learning (n=2, 1%).

267 **Level of Integration**

268 It proved difficult to assign a numerical level using the ladder based on details included in the
269 studies. Harden's ladder was reported explicitly on 4 studies^{35, 86, 92, 145}. The level of integration
270 was classified, where possible, using the GPhC integration guidance, which operationalized
271 Harden's ladder. The majority of curricula were classified as 'partially integrated' (n=102, 74%)
272 which means that integration extended beyond a single session or minimal integration of content
273 towards modules or multiple years, or had some content integrated throughout the whole
274 programme. Curricula classified as 'fully integrated' generally had full content integration over
275 multiple years and often included experiential learning; see Table 4. The curricula classified as
276 'fully integrated' demonstrated evidence of vertical integration or thorough horizontal
277 integration, often including experiential learning and extending across the whole programme.
278 Those that were classified as 'not integrated' were single sessions or components of a module or
279 did not appear to have sufficient impact on the overall design of the curriculum to meet
280 requirements for 'partially integrated'; see Table 4. The level of integration was not classified for

281 6 included studies due to the nature of the paper. This highlights the inconsistent use of the term
 282 integration in relation to curriculum and highlights the need for definitions and guidance for
 283 integrated curricula.

284 *Table 4 Level of Integration*

Level of Integration	Harden's Ladder	Studies (n)
Not Integrated	1-6 (Isolation, Awareness, Harmonization, Nesting, Temporal co-ordination, Sharing)	16
Partially Integrated	7-8 (Correlation and Complementary)	102
Fully Integrated	9-11 (Multidisciplinary, Interdisciplinary or Transdisciplinary)	13

285

286 **Duration of Integration**

287 The duration of integration within each programme was highly heterogeneous and the majority
 288 did extend across multiple years towards a whole programme (n=74, 54%). 35 studies described
 289 integration from one module or a part of a year and 12 studies described integration in one year
 290 of the programme. 10 studies described integration of a single session.

291 **Discussion**

292 This scoping review has confirmed there is an increasing trend towards integration as illustrated
293 by the increased number of publications since 2000, and the global geographical spread of
294 included studies. This supports findings by Brauer and Ferguson that integration as a concept has
295 spread worldwide and is supported by many national healthcare education organizations².

296 Horizontal integration was the most commonly designed model of integration but vertical and
297 spiral integration increasingly feature in more recent studies. The lack of definition of integration,
298 and insufficient descriptions of integration, created some complexities when classifying by
299 integration model. This illustrates the need for clearer definitions of each model of integration
300 and for more consistent use of the term integration.

301 The variation in the themes for curricular integration further highlights the various ways of
302 integrating modules and programs. Systems-based teaching was the most commonly described.
303 It lends itself to integration through teaching more than one science topic and combining clinical
304 and basic sciences^{11, 120}. Systems-based teaching, however, appeared to be mainly connected
305 with horizontal integration. This may reflect the challenge in revisiting topics between years, and
306 at increasing depths, in a systems-based approach making vertical and spiral integration less
307 likely to occur^{2, 202}.

308 Experiential learning, problem-based learning and case-based learning were the most commonly
309 described integrative teaching and learning approaches. Integrated periods of workplace-based
310 learning are believed to enhance competency development and achievement of learning
311 outcomes^{2, 24, 28, 203-206}. Problem-based learning is often used to support horizontal and vertical
312 integration¹⁹⁵ and is believed to promote deeper learning than conventional teaching

313 methods²⁰⁷. Case-based learning helps to prepare students for practice through application of
314 knowledge and linking theory and practice. Health professions educators value learning based on
315 cases, as cases can illustrate relevance of learning materials and help develop critical-thinking
316 skills⁴⁸.

317 Harden's ladder is a useful tool for curricular developers. There are, however, difficulties in
318 operationalizing Harden's ladder⁴⁶. Ideally, the level of integration should be described by
319 Harden's ladder or as 'fully', 'partially' or 'not integrated' as described in the GPhC guidelines²⁰,
320 ⁴⁶. The majority of studies described 'partially integrated' curricula. This is influenced by the
321 requisite time, financial, staff and other resources for curriculum integration^{35, 40, 151}. The
322 duration of integration, ranging from a single session to a topic extending to the whole
323 programme relates to varying levels of integration described. This supports the findings of Brauer
324 and Ferguson that integration may include that of discrete topics within a programme or year of
325 study, earlier clinical experience or full integration of once individual modules². The development
326 and delivery of an integrated curriculum is complex and staff must integrate content and
327 collaborate to plan, design and assess effectively³⁴.

328 A significant number of included studies did not have any outcome data, therefore, evidence for
329 integration remains sparse. There did not appear to be any consistent means of evaluating
330 integrated curricula and the majority of included studies had Kirkpatrick level 2A or 2B outcomes,
331 highlighting the limited evidence for integrated curricula beyond perception data. There is
332 evidence, however, of generally positive perceptions of integration from students and faculty,
333 although there is also evidence of some disadvantages to integration. There is some evidence

334 supporting integration through knowledge gains and exam performance but there is a lack of
335 trials and detailed comparative studies.

336 Few included studies compared different types of curricula^{165, 208}. Schmidt et al¹⁶⁵ compared an
337 integrated, a problem-based and a conventional medical curriculum. It was found that students
338 taught in an integrated curriculum had better diagnostic skills than those trained in a
339 conventional curriculum. They found no differences in students from problem-based and
340 integrated curricula¹⁶⁵. Al-Damegh et al had similar findings with better examination
341 performance by students in the integrated, problem-based curriculum than the traditional²⁰⁸.
342 Some other studies that compared integrated to traditional curricula were not included in this
343 review due to lack of integrated curriculum descriptions but findings often favored integration²⁰⁹⁻
344 ²¹¹.

345 There are no notable or significant differences in the models of and themes for curricular
346 integration between other healthcare professions and pharmacy. There are a greater number of
347 medical integrated curricula, which may reflect student numbers or a more established research
348 field of medical education.

349 **Strengths and Limitations**

350 Key strengths of this review are the comprehensive search of published literature and the use of
351 a recognized scoping review framework⁵⁹. The inclusion of multiple study designs, within defined
352 inclusion and exclusion criteria, improved the robustness of this study.

353 As the focus of this review was what is meant by integration, some studies which attempted to
354 evaluate integrated curricula or compared with other curricula designs were excluded from this

355 review as they lack details of the model and themes of integration. Grey literature was not
356 consulted and studies published in a language other than English were excluded, therefore, there
357 is a possibility than some relevant studies were not included.

358 **Conclusion**

359 The literature describing integrated curricula has been mapped and a number of potential areas
360 for further research have been identified. Integration is difficult to define, and enact, and means
361 different things to different people. Integration is a complex term and should not simply be
362 described as horizontal, vertical or spiral as it is multifaceted and needs to be treated as such.
363 Numerous themes and integrative teaching and learning approaches lend themselves well to
364 integration. These, and the desired level of integration, need to be considered when developing
365 integrated curricula.

366 Whilst there is no right or wrong way to integrate, limited details describing integrated curricula
367 is an issue and there is a clear need for all aspects of integration to be explicitly defined by
368 curriculum developers. Those developing and researching integrated curricula, should define
369 what is meant by integrated, consider and specify which model of integration to employ, what
370 themes and integrative teaching and learning approaches will be used. The models, themes,
371 teaching and learning approaches, and the levels of integration which have been mapped and
372 summarized in this review can serve as a menu for curriculum developers. It is proposed that the
373 definitions listed for each component of integration in methods are used and applied for each
374 aspect selected. The desired extent and level of integration should be considered in light of all
375 options and resources available. All information pertaining to definition of integration, model,
376 theme and teaching and learning approaches used should be clearly reported.

377 Integrated curriculum design in pharmacy education needs to take the desired balance of science
378 and practice into account, given the complex knowledge and skill requirements of the profession.
379 There is scope for increased use of integrated experiential learning in pharmacy education.
380 Experiential learning as a block within the course, with no links to course content, is insufficient
381 to be defined as integrated. Increased experiential learning linked to course content may also aid
382 the desired balance of science and practice through contextualizing science in practice.

383 The level of integration must be carefully considered and implemented. Increased faculty stress
384 levels have been reported following introduction of integrated curricula^{133, 167, 201}. Resources and
385 supports available and required should be factored into a decision about level of integration to
386 help minimize the stress impact of the curriculum transition. Partially integrated curricula may
387 not necessarily be less optimal than fully integrated curricula.

388 Stress can also impact on students, as reported in dentistry by Ahmad et al²⁰¹. It is, therefore,
389 important to seek student feedback and monitor student wellbeing on introduction of an
390 integrated curriculum.

391 Integration is a multi-faceted, complex term and significant efforts are required to achieve
392 consistency in the use of the term. A working definition, based on the results of this scoping
393 review, is proposed as 'Integration is multi-faceted term describing a curriculum design which
394 may be defined by model (horizontal, vertical, spiral), theme (systems-based, stages of life, topic,
395 cross-cutting theme) and integrative teaching and learning approach (problem-based, case-
396 based, experiential, enquiry-based, team-based learning, inter-professional education) and level
397 of integration.' It is proposed that definitions for each component are specified, and those
398 included in this review may be useful as a guide.

399 There remains a lack of evidence to support integration and further research to determine if
400 integration really does work for pharmacy education. It is important to make efforts to gain
401 higher-level evidence. Evidence is building that students enjoy integrated curricula and
402 knowledge gains. However, there is a sparsity of higher-level evidence. There is a need for clear,
403 explicit definitions of integration, before it would be possible to begin to accurately answer the
404 question if integration really does work.

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412 None

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414 Not applicable

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