Curriculum integration within the context of veterinary education[*]

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Abstract

Curriculum integration has been applied across a range of educational levels as a means of attempting to improve learning outcomes, but there is a paucity of information that has defined and explored curriculum integration as it relates to the teaching of veterinary science. A definition of curriculum integration in the teaching of veterinary science is suggested, which places the student as life-long learners at the centre of the educational model. Learning activities are designed to help students see connections among disciplines and topics thus reinforcing their relevance and helping them to apply their knowledge to different contexts. Curriculum integration at James Cook University in the first three years of the program has been promoted through the design of assessment, use of case studies, imaging, palpable anatomy, learning of clinical skills, a research project, animal handling, and a personal professional development program. Advantages and disadvantages of curriculum integration are discussed. Further work is needed to determine if this mode of curriculum design is able to produce veterinary graduates who are better able to meet the challenges of a changing workplace in the 21st century.

Key words: Curriculum integration, education, interdisciplinary studies, life-long learning.

Introduction

Changes within the national and international community are likely to affect the way that veterinary science is practiced in the 21st century.[1,2] Some of these changes include rapid advances in knowledge and technology,[3] globalization and internationalization of the profession, changing social, trade and economic constraints, changes in consumer expectations, and greater availability of technicians to perform routine procedures.[4,5] If educational institutions are to avoid any disparity between the knowledge and skills required by veterinarians and what they learn, students will need to be equipped with the knowledge and skills that are relevant to a constantly changing workplace. They will need to be lifelong learners who can adapt to a changing knowledge base and be able to search and construct knowledge from a variety of sources. As practices expand and deliver a greater range of services to the public, students will also need to develop social and communication skills, and work effectively in teams.[6,7] These evolving educational needs will present new challenges to the development of curricula for education in veterinary science which may require a different approach to traditional educational practice.

The use of curriculum integration in veterinary education represents one approach to delivering a learning experience that aims to mimic more closely the way information and problems are encountered in the workplace, and to deliver an authentic learning experience which attempts to meet the educational needs of veterinarians in the 21st century. There, however, appear to be few reports addressing the topic of holistic curriculum integration within veterinary science education programs although a number of reports detail experiences with elements of integration, for example integration of communication and problem solving skills,[8,9] specific disciplines[10-12] and technologies.[13] The aims of this report are to develop a definition and a holistic model of integration that could apply to veterinary education, as well as to examine some of the advantages and disadvantages of curriculum integration. Some of the methods that are being used to promote integration within a veterinary science degree program at James Cook University are also outlined.

Historical development of curriculum integration

The concept of curriculum integration is not new. As early as the 1880's separation of knowledge into discrete subjects was criticized as being unnatural and responsible for causing a fragmentation of knowledge.[14] In the early 1900's a number of various forms of curriculum integration were practiced and by 1930 teaching of school subjects in an integrated manner, based on student's needs was advocated.[14] Over the years there has been a fluctuating emphasis on integration

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within primary and secondary education. More recently there has been a renewed effort to incorporate elements of integration into all levels of education.[15,16] This has been encouraged by an exponential increase in knowledge, the need for individuals to solve complex problems which rely on a broad knowledge base, and pedogical reform linked to greater appreciation of the educational value of a more integrated mode of teaching and learning.[15] Renewed efforts to incorporate integration within medical curricula are also apparent. For example, the latest recommendations of the General Medical Council which oversees the standards and assessment of undergraduate medical education in the United Kingdom are that, "the clinical and basic sciences should be taught in an integrated way throughout the curriculum".[7] Examples, however, of more holistic attempts to include curriculum integration within veterinary education are lacking.

Integration in relation to veterinary education

"A variety of perspectives on curriculum integration have been suggested. These frequently incorporate concepts of students building connections between different topics and disciplines, and the application of knowledge to real world scenarios and problems.[15,18] Within the context of veterinary education, instead of veterinary science being divided into a series of subjects and disciplines, with an integrated curriculum, students are immersed in a transdisciplinary learning environment that attempts to reflect the complexities of life.[19] Ingram[20] refers to integration as a way of organizing knowledge that counteracts the tendency for knowledge to become fragmented and irrelevant and which assists students to develop a coherent view of life. In explaining the differences in emphasis placed within an integrated compared with a discipline-based curriculum it has been suggested that the "application of knowledge takes precedence over acquisition and mastery of facts alone, activating a dynamic process of question posing, problem posing and solving, decision making, *and* higher-order critical thinking".[15]

The primary philosophical justification for an integrated curriculum comes from the fact that problems are rarely encountered in professional practice that are exclusively presented and solved within the context of a single discipline. More often problems present in the context of requiring knowledge and skills from a range of disciplines. For example, a case of pyometra in a dog requires knowledge of anatomy, physiology, pathology, imaging, medicine, and surgery to solve, while managing the case requires the application of communication and business skills which are all overseen by a code of professional practice and ethics. An integrated curriculum may help students see connections between disciplines, the relevance of material being studied and may enable them to connect and apply their knowledge to a variety of applications.

Harden[21] outlines different degrees of integration in medical teaching. For example, in courses with the least amount of integration these courses are taught in isolation and instructors are largely unaware of what is being taught in other courses. With increasing integration teachers become more aware of what is being taught in other courses ("awareness"), and communicate with other disciplines to ensure that curriculum objectives are achieved ("harmonization"). Common themes may be linked between courses ("nesting"), or topics taught in different subjects are aligned in time with similar subjects taught in other subjects ("temporal integration"). Further integration occurs when teaching is jointly planned and delivered by different disciplines ("sharing"). For example, teaching sessions on lameness could involve planned delivery from the disciplines of anatomy, imaging, medicine and surgery. Integration sessions may be run to highlight areas which are shared in common among subjects which are studied separately ("correlation") or greater emphasis may be placed on themes which can be explored concurrently with subject-based teaching ("complimentary program"). Alternatively, themes can be developed and explored through the disciplines ("multi-disciplinary"), for example the use of a body systems-based approach to teaching. High levels of integration operate when courses are taught in an environment of collective planning and teaching where teachers from a number of disciplines collaborate to plan and deliver courses. Individual subject content can be combined into a new course which lacks divisions according to disciplines, and where subject content may be delivered according to appropriate themes ("inter-disciplinary"). Further integration can be achieved by immersing students in a learning environment that enables them to construct knowledge as part of a real-world, authentic learning experience ("transdisciplinary integration"). Given this graduated approach to curriculum integration, it is apparent that elements of

integration are included in many undergraduate veterinary degree programs although high level transdisciplinary integration appears to be less common.

In attempting to contextualize a definition for the teaching of veterinary science, the author suggests that integration of a veterinary science curriculum involves:

- Organizing of student learning in an authentic way that is linked to what veterinarians do.
- Designing the curriculum to reflect how problems are encountered in real life.
- Promoting linkages between disciplines and topics allowing students to connect and construct their learning across fields, thereby promoting deeper learning and reinforcing greater relevance.
- Encouraging the development of skills to assist students to be able to locate, assess and use a variety of sources of information. This may help to equip students to be lifelong learners.
- Enhancing communication, self-management and interpersonal skills, recognizing their critical importance in professional life and the application of knowledge and skills.
- Acknowledging and embracing the contribution of academic disciplines but limiting their contribution to what is needed in the application of knowledge and sees their place in the context of a more holistic view of knowledge.
- Interrelating of different subjects and topics, both horizontally between parallel disciplines such as anatomy, physiology and biochemistry, and vertically between different disciplines traditionally taught in the early or latter years of the curriculum, for example, physiology and medicine.

In this model, the development of skills is viewed as a tool to reinforce knowledge learnt across disciplines, and is an important component linking knowledge with application. Learning activities are designed to help students see connections among disciplines and topics, thus reinforcing their relevance and helping them to apply their knowledge to different contexts. Skills learnt within an integrated context may also help students to build new knowledge when problems are encountered where immediate solutions are not known.

Advantages and disadvantages of an integrated curriculum

A number of advantages and disadvantages of curriculum integration are summarized in Table 1.

Advantages associated with an integrated curriculum

a) Improvements in learning outcomes.

A wide body of knowledge supports the value of curriculum integration for improving learning outcomes for students. [22-25] Vars[23] in summarizing results from over 100 studies spanning 60 years of research concluded that students participating in integrative programs have performed as well or better on standardized achievement tests compared with students enrolled in the more traditional, subject-based disciplines. Evidence also exists that integrated learning improves critical thinking, problem solving, retention of knowledge, and relationships with peers and teachers. It also is suggested to help improve motivation, and fosters more positive attitudes to learning.[23,24] A number of reports also suggest that graduates are better prepared for their chosen vocations.[9,26-29] It is argued that integrative learning requires higher cognitive function through the application of knowledge from a range of disciplines and problem solving, rather than simply knowledge recall.[22] Dahle et al.[24] concluded that vertical integration between clinical medicine and basic sciences within medicine "motivated the students, and stimulated profound rather than superficial learning, a better understanding of important biological principles and better retention of knowledge."

In contrast to an integrated curriculum, traditional, discipline-based curricula, artificially divide and fragment knowledge, often leaving the students to make the necessary connections on their own.[30] Separation of areas of knowledge may restrict students' thinking, and it represents an artifice of life that does not reflect true life experiences. Lane[9] compared problem based learning with a traditional approach to teaching in veterinary and medical science, and cited evidence to suggest that a

traditional approach is more likely to result in superficial rather than deep learning, poor recall of knowledge, and frequent student dissatisfaction with their learning experience.

b) Use of authentic learning

Benefits of integration are attributed to presenting information and problems that mimic how they are encountered in the real world, and presenting facts in relevant, meaningful[31] and connected ways.[32] Use of authentic learning, connecting knowledge to application in the world beyond the classroom, can stimulate student's interests, and promote student participation, engagement and satisfaction.[33] It can also be argued that learning of basic facts is far easier when those facts are connected with a clinical case, application, or clinical skill. Contextualization of knowledge into clinical presentations and problems with integrated learning may be one way that it assists with knowledge retention compared with the learning of knowledge in isolation.

c) Learning outcomes are focused on specific graduate attributes and competencies

Veterinary and medical education accreditation bodies have placed increasing emphasis on competencies and essential skills for veterinary practice.[34-35] In order to achieve accreditation veterinary educational schools need to demonstrate that students achieve the core knowledge and skills and attributes that are required to achieve the required standards. This has lead to the development of an outcomes-based model of educational practice in some veterinary and medical schools. With this model of education curriculum development is focused on what students should be able to do at the end of their course.[36] Curriculum integration should facilitate the achievement of an outcomes-based model of educational development by focusing content on what graduates need and accreditation bodies require. It should also enable greater streamlining of course content to what is most relevant for graduates. Irrelevant or redundant material can be removed from the curriculum, making learning outcomes clearer to both teachers and students. This should also enable the flexible development of the curriculum as the needs of graduates change enabling the strategic development of subject content that is better aligned with students' interests and needs, and helps prevent curriculum crowding or overload as knowledge grows. This dynamic approach to curriculum development with changing graduate needs should be better placed to adapt to changes associated with tracking, limited licensure, and increased emphasis on specialization, compared to a more traditional discipline-based curriculum.

Ingram[20] suggests that there is an innate resistance for curriculum to change while knowledge continues to expand. An integrated approach to curriculum delivery is less constrained by narrowly organized subjects; it is more dynamic and can more rapidly assimilate changes in the workplace and society. With a discipline-based educational model, maintaining too tight a focus on disciplines may lead to a tendency for the self perpetuation of subject disciplines, rather than educating students for the world that they will face. Integration should provide a framework to adapt our educational practice to a rapidly changing world and facilitate the implementation of outcome-based education.

d) Promotion of interpersonal and communication skills

An appreciation for the relevance of communication, self management, team skills, and ethical reasoning in professional practice has naturally lead to the inclusion of the teaching of personal and professional development within a number of veterinary schools, including James Cook University.[8] Within an integrated curriculum, opportunities can be provided for illustrating and developing personal and professional skills through the solving of problems, management of various scenarios and collaborative exercises. Some authors have suggested that benefits of integrating elements of the curriculum within veterinary science include the development of problem solving skills, communication, and team skills, social competence, and life-long learning skills.[9,10]

e) Improvement in student motivation

Building connections and establishing relevance may promote greater student interest, motivation, and improve student retention, particularly in the early years of a veterinary science course.[24,37] Rigorous training in foundational sciences without connection to application may result in a dwindling of initial enthusiasm and motivation early in a course, concerns about relevance, and self doubt as to whether students may want to pursue a career in veterinary science.[9] Setting knowledge,

skills and attitudes within the context of how it is applied as veterinarians may provide a degree of emotional appeal to students and encourage motivation. For example, embryological developments can be linked to functional or surgical problems. Aspects of anatomy can be explored through discussions concerning surgical approaches to particular anatomical regions or specific physical conditions, highlighting anatomy during physical examination of live animals and by the use of various imaging modalities. Physiological processes can be explored using case studies, patient monitors, clinical pathology and pharmacological alteration of function. An advantage of improving student motivation include improved learning outcomes by enhancing deeper learning.[24] Venville et al.[33] argue that some of the main benefits of integrating curricula in relation to secondary school students included improvement in student motivation and interest. The critical importance of motivating students for successful learning outcomes[38,39] would suggest that curriculum integration can play an important educational role for students.

Disadvantages associated with an integrated curriculum

A number of potential disadvantages associated with developing and delivering an integrated curriculum are outlined. Many operate at the organizational level and so with appropriate leadership, support and a shared vision for change potential problems could be minimized. Some of the disadvantages include:

a) Challenges for staff

A number of organizational, teaching and personal challenges confront institutions and staff that are involved in developing an integrated curriculum. Delivering an integrated curriculum requires teachers to collaborate and work closely together to design and deliver course content and assessment tasks. Resourcefulness and creativity is required by staff as they strategically select which topics are most relevant and how they can be integrated. Delivering of learning sessions and assessing integrated content may also require a number of staff from a variety of disciplines to attend simultaneously, which can make scheduling difficult and place more demands on staff time. A high level of cooperation and time to plan and deliver the integrated content is therefore required. Greater time demands associated with delivering integrated learning modules has been previously been identified as a potential disadvantage associated with curriculum integration.[40] Staffing formulas may also need to be revised which could impact on the cost of veterinary education. If staffing issues are not fully met, it could negatively impact on staff morale and research output.

Teachers may feel less comfortable to deliver integrated teaching.[22] Educators planning and delivering an integrated curriculum may need to contribute to areas with which they are relatively unfamiliar and to change from the more familiar discipline-based system.[22] They may need to revaluate their discipline areas and remove material that may be redundant or irrelevant within the context of an integrated curriculum. It is also conceptually more difficult to prepare integrated teaching materials and it may require staff to downsize individual discipline content. Downsizing of content and shift to a different, more collaborative approach to teaching could create a degree of insecurity and anxiety for staff. This may require additional investment in support via training to more smoothly transition the curricula and pedagogical change. Curricula drift towards a more familiar discipline-based program could occur as staff are unable to make the transition to an integrated curriculum.[33]

b) Challenges for students

Students unfamiliar with an integrated learning program need to adjust to the changes in their learning environment. Assessment is designed in an integrated manner and students must be fully prepared when undertaking each assessment task and draw upon their entire knowledge base. Reference points for solving problems or answering questions are blurred, not constrained by the boundaries of disciplines as students draw upon information learnt across disciplines to answer questions. This may increase the difficulty of assessment tasks which could result in lower academic scores, higher failure rates, and a perceived reduction in student performance if student scores are compared among institutions. Greater emphasis on problem solving and application of knowledge and skills requires a higher level of cognitive function than simply factual recall. The need for appropriate standard setting, evaluation, and revising of learning and assessment tasks will be needed

to ensure that the desired learning outcomes are being achieved and that students are not overwhelmed by the greater challenges presented with an integrated model of learning and assessment.

c) Omission of important topics

Potential trivialization of some areas of knowledge with a failure to engage key aspects of specific disciplines[30] and a deficiency of knowledge of the basic sciences have been criticisms of moves to integrate curricula.[9] Careful monitoring and mapping of the course content, feedback from graduates and employers should, however, help to ensure that essential knowledge and skills are taught and not overlooked.

Implementation of curriculum integration within a veterinary teaching program

At James Cook University, a new Bachelor of Veterinary Science degree program was commenced in 2006. An attempt is being made to model the 5-year curriculum on an integrated learning program. Traditional science based courses at the university involve completing four, 3-unit subjects per semester. Each subject consists of a maximum of approximately 80 to 100 student contact hours over a 13-week study period. Accumulation of set numbers of unit points is used to qualify for the earning of various degrees. In the first year of the veterinary science program, students undertake eight equally-weighted, three-unit subjects: chemistry, cell biology and biochemistry, biological principles for agriculture and veterinary science, plant biology, animal biology, physiology and pharmacology, and veterinary professional life 1 and 2.[41] The latter two subjects include an introduction to animal industries, animal behavior, ethics, and animal handling, and it is within these two subjects that students are introduced to elements of integration. The second and third years of the program involve a fully integrated curriculum where students study only one, 12-unit subject in the first and second study periods of each year. Each12-unit subject consists of about 320 to 380 student contact hours, taught over a 13 to 14 week study period.[41] Each 12-unit, integrated subject taught in the second and third year of the program consists of a number of themes that are outlined in Table 2. Themes within the integrated curriculum represent an interdisciplinary concept that provides an organizational framework for developing learning activities that enhance integration between disciplines.[42] Use of themes offers the advantage of promoting greater connections between disciplines that might not occur when providing instruction in disciplines separately.[42] For example, anatomy and physiology are both taught within the theme entitled, Structure and Function as both anatomical structure and physiological function are intimately connected.

The fourth and fifth years of the program are still under development. In the fourth year, integration is being focused within individual species and it will follow a two-tiered, problem-based approach to veterinary science. Problems are first presented within species-contexts in which they are normally encountered, for example, companion animals, intensive livestock industries, small and large ruminants, exotic animals and equine. Secondly, within these species contexts, problems will be presented in a way which reflects their usual presentation, for example, problems with respiratory symptoms, problems causing reduced production or sudden death, musculoskeletal problems or problems associated with different body systems. These problem themes may be further divided into subthemes. The emphasis remains, however, on the context in which problems are most commonly encountered. In the fifth and final year of the program, students will be able to apply their knowledge to solving clinical problems and scenarios within the fields of veterinary practice, teaching, and government service provision. In addition, they will continue to develop their technical and interpersonal skills.

Learning activities designed to promote integration

Activities that are designed to promote integration within the first three years of the program have included the use of case studies, imaging, palpable anatomy, learning of clinical skills, a research project, animal handling, and a personal professional development program. The curriculum is designed in a way to promote both horizontal and vertical integration between topics and disciplines. Design of the curriculum around a single,12-unit subject in each study period reduces boundaries between disciplines, reinforces connections, and supports the multidimensional way that problems are encountered in society. Assessment includes a range of on-course and supervised assessment tasks. Examinations include questions that relate to the entire subject content and examine knowledge,

skills, and the application of knowledge. Use of scenarios enables questions relating to a number of disciplines to be asked within the same question. Item recognition questions, simulated consultations, multiple station assessment tasks, and objective structured clinical examinations (OSCEs) will feature in various parts of the course and be used as instruments to foster integration by including questions directed towards a number of disciplines.

Multi-disciplinary case studies are used throughout the course to assist students to see how knowledge, skills, and attitudes that they are developing at each stage of the course can be applied in the real world. For example, first year students working in small groups may examine an outbreak of an exotic disease, plant poisoning, or a terminally ill patient. During such an exercise, students learn research and writing skills, learn how to work in teams, and improve their knowledge of the foundational sciences such as biology and chemistry as they relate to the case. In addition, students can be directed to discuss a range of ethical, financial, and communication issues. In this way, students can begin to see how their current knowledge can be applied, but also the wider context in which knowledge and skills are applied in practice. Cases can also be used as framework for introducing new knowledge and skills enabling a degree of scaffolding.

Clinical skills are introduced early in the course to help students see how knowledge can be applied, to enable skills to be progressively developed throughout the course, and also to improve student motivation. For example, while students in their second year of the course are learning aspects associated with the anatomy and physiology of the nervous system, students participate in a practical class that involves assessment of the function of peripheral nerves of dogs and horses and also modify and assess nerve function by performing an inverted-L nerve block on a cow.[37] While gross anatomy, histology, and physiology associated with cardiac muscle are taught, exercises in cardiac auscultation or examination of the clinical pathologic findings associated with cardiac injury can be conducted. Imaging and palpable anatomy are used to complement didactic lectures, dissections, and prosections in anatomy, but also to link knowledge to application and also to foster the development of clinical skills associated with imaging and physical examination of animals.

Competence in handling a range of animal species is an essential skill for veterinary graduates.[34,43] Animal-handling classes also provide an opportunity for integration. Topics that are integrated into the animal-handling course include occupational, health and safety, animal welfare, dosage calculations, meat safety, zoonoses, anthelmintic and antiparasitic treatments, regional anatomy, knowledge of the animal industries, and physical examination. Similarly, when clinical skills are taught with animals they also reinforce animal handling skills.

Students within the third year of their program undertake a research project within teams. Members of each team are awarded the same mark for the assessment pieces they complete as a team. Integration with biometrics, epidemiology, ethics, and welfare is also an advantage of this project. It also enables them to build upon their team, writing, reviewing, and research skills, but also introduces some new knowledge as they research their topics, consider experimental design and management, and write experimental proposals and applications for ethics approval.

Personal and professional development

Personal and professional development (PPD) is a theme that is embedded in all stages of the course. Emotional intelligence is viewed as one of the key determinants of longevity and success in the workplace,[44] so inclusion of learning activities to promote social skills and emotional intelligence is seen as integral to the objective of producing competent veterinarians. The aim of the PPD program is to foster the development of skills that are needed for managing self, improving performance in teams, enhancing communication skills across a range of areas including written and oral communication, and communication in groups, including to the public, clients, and staff. It also aims to promote skills that will enable students to be life-long learners. This includes skills in analysis, reflection, and researching for information. Components of the PPD program are therefore integrated with many of the activities that students undertake: oral and written reports; time, self, and group management; and communication across a range of circumstances.

An integrated learning model

An integrated learning model is illustrated in Figure 1. At the center of the model are life-long learners that are able to adapt to the needs of an evolving workplace. Knowledge, skills, and

attitudes transcend the limitations of specific disciplines as students make connections within a transdisciplinary environment. During the course, knowledge, skills, and attitudes are continually developed through learning promoted from the foundational, paraclinical, and clinical sciences. A range of skills are developed including clinical, analytical, and communication skills, information literacy, problem solving, and reflective practice. Development of emotional intelligence and social competence as well as an understanding of ethics are viewed as being important for successful functioning within the community,[44,45] and are therefore an integral component of the educational model. The learning environment is also influenced by a number of learning communities that operate within the educational institution or workplace as well as on national and international scales. Professional associations, conferences, literature, and virtual forums and websites all provide important links to the ongoing educational development of the veterinary learner. This illustration conveys the broad educational environment in which an integrated curriculum aims to embed veterinary students.

Conclusion

Curriculum integration in a veterinary context refers to the design of the curriculum in such a way that a) enables students to make connections among topics and disciplines, b) reduces boundaries among disciplines, c) is guided by what veterinarians do and are required to do, and d) reflects how problems are encountered in the real world. Advantages and disadvantages of this form of curriculum design are apparent, and further work is needed to determine if an integrated curriculum results in improved workplace performance and longevity. Curriculum integration at James Cook University has been promoted by directed curricular design, methods of student assessment, a personal professional development program, and use of multi-disciplinary case studies, imaging, palpable anatomy, clinical skills, a research project, and animal handling opportunities.

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Figure 1. Diagrammatic representation of an integrated learning environment which is emulated within an integrated curriculum in which veterinary students are embedded.

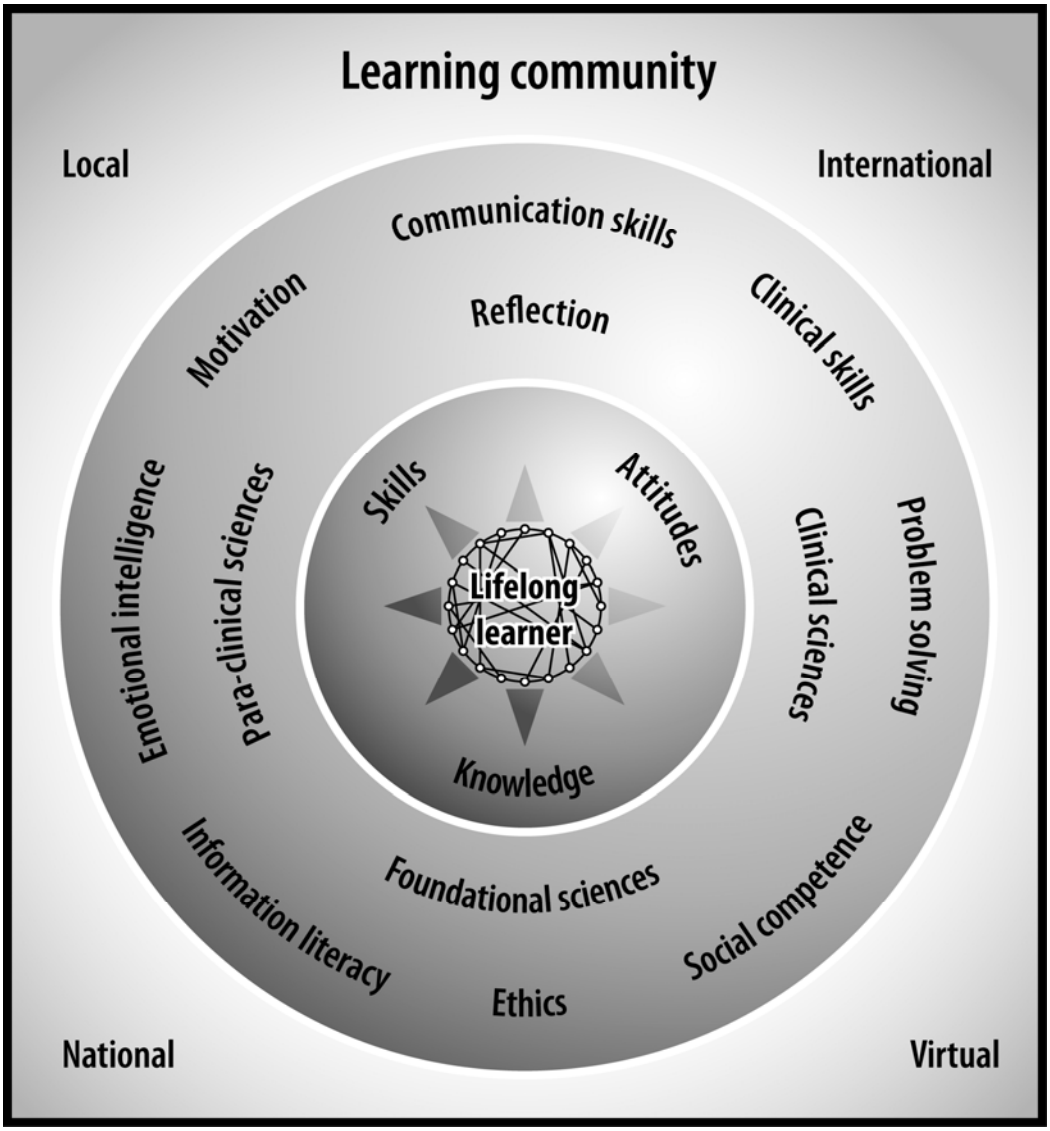

Table 1. Advantages and disadvantages of curriculum integration.

Advantages of curriculum integration	Disadvantages of curriculum integration
• Integrative learning improves learning outcomes, promotes deeper learning and a broader perspective on topics	• Greater difficulty for students. Students must be prepared to be examined on all the learning material
• Authentic learning connects knowledge to application in the world beyond the classroom potentially improving student's motivation, participation, engagement, retention and satisfaction	• Problem and application focus requires a higher level of cognitive function as students solve problems and apply knowledge rather than simply recalling facts
• Contextualization of knowledge into clinical presentations and problems may assist with knowledge retention compared with the learning of knowledge in isolation	• Cooperation among staff from different disciplines is required as they plan, implement and assess learning activities
• Provides emotional appeal, motivating students, encouraging engagement and deeper learning	• Collaborative, planning, preparation, delivery and assessment can be time consuming. Staffing formulas will need to be revised
• An emphasis on outcome-based learning focuses learning on achieving specific knowledge, skills and attitudes, and helps remove irrelevant or redundant material from the curriculum	• Comparisons of student performance with less integrated courses may not be valid
• Curriculum can be more readily adapted to the changing needs of students and the profession	• A deficiency of knowledge of the basic sciences or overlooking of important topics can more easily occur
• Forces staff to critically evaluate and revise their content. Relevance takes precedence over coverage	• Staff insecurity and anxiety could occur associated with preparation of integrated material, and downsizing of individual discipline content
• Collaborative learning promotes team and interpersonal skills.	• Staff training and support required in association with curricula and pedagogical change and the preparation of integrated learning activities
• Collaborative teaching promotes greater communication and cooperation among staff across disciplines	• Curricula drift towards a discipline-based program may occur in the face of difficulties associated with a revised curriculum. Staff may default to a more familiar approach
• Integration of personal and professional development promotes life-long learning, moral and ethical reasoning, team, professional and communication skills	• A shared vision is required by staff and students to facilitate the change to an integrated curriculum. Appropriate leadership is critical for both inspiration and guidance
• Draws from, but is not bounded by the constraints of traditional disciplines	• Some staff may not model integrative thinking with their teaching, denying students visible models of integrated learning

Table 2. Thematic structure of subjects undertaken by students in years 2 and 3 of the veterinary science degree program at James Cook University.[37,41]

Theme	Focus
Structure and function	Diversity of living organisms Structure and function of plants and animals Techniques that are available to study plants and animals
Disease, defence and chemical agents	Molecular and cellular basis of disease processes, organisms and bodily defence Diversity of organisms that cause disease Pharmacology
Animal production, management and behaviour	Animal production, welfare and behaviour
Veterinary services	Epidemiology and public health
Veterinary practice	Knowledge, skills and attitudes required for veterinary practice
Professional life	Self understanding, management and personal development Team skills Communication skills Conflict resolution Information literacy and lifelong learning skills Practice management/business skills