

Update in Anaesthesia

Anesthesia curriculum design for the global setting

Patricia Livingston*, Gaston Nyirigira and Adam Mossenson

*Correspondence email: plivings@dal.ca

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Abstract

A stepwise process for curriculum design is presented. This begins with considering the context, resources and skills required for program graduates. The stepwise approach requires identification of broad outcomes to be achieved, selecting and organizing content, choosing active teaching methods, developing assessment tools and considering a plan for program evaluation. The authors share experience with the Rwandan anesthesia curriculum as an illustrative example of a multi-year curriculum and the Vital Anaesthesia Simulation Training (VAST) Course as an example of curriculum development for a short course.

Key words: curriculum design; medical education; spiral curriculum

"Medical education is not about the transmission of information but about the transformation of the learner"

INTRODUCTION

The Lancet Commission on Global Surgery highlighted disparities in the numbers of trained healthcare providers between low- and middle-income (LMICs) and high-income countries (HICs), setting a goal of 20 surgery, anesthesia and obstetric specialists per 100,000 population by 2030². The WFSA Global Anesthesia Workforce Survey details these discrepancies as they apply to anesthesia. The survey identified the wealthiest countries as having an average of 17.96 physician anesthesia providers (PAP) per 100,000 population while 77 countries reported a PAP density of <5 per 100,000 and 43 countries reported a PAP density of <1 per 100,000³. Effective educational initiatives are essential to developing leaders and teachers who can build the anesthesia workforce⁴. The purpose of this article is to outline principles of robust curriculum design that apply to developing a single teaching session, a short course or a full anesthesia academic curriculum. We share our experience with the Rwandan anesthesia curriculum and development of the Vital Anaesthesia Simulation Training (VAST) Course^{5,6} as illustrative examples. The authors have been associated with the Rwandan anesthesia residency training program as the co-designer of the curriculum (PL, with input from Rwandan anesthesia educators), a learner and later a

teacher (GN) and a teacher and the founder of VAST (AM).

There was only one anesthesiologist in Rwanda following the Genocide against the Tutsi in 1994. In 2006, a partnership was established with the Canadian Anesthesiologists' Society International Education Foundation (CASIEF)⁷ to send volunteer North American anesthesiologists, for a month at a time, to teach in Rwanda. The intention from the start was to educate residents to become future teachers and leaders in anesthesia with the goal of self-sufficiency by the end of the program.

In the early years of the program, there was a topic list for visiting volunteer teachers but no comprehensive curriculum. Anesthesia residents were educated in medical school through a traditional passive approach that relied on lectures and observation. The basic science background, particularly in physiology and pharmacology, was inadequate and residents struggled to apply book learning into clinical practice. Additionally, there were shortages of equipment and medications needed for safe conduct of anesthesia and few local role models and teachers. Cognizant of these issues, the need was apparent for a comprehensive curriculum for anesthesia resident education that would prepare future leaders, educators and clinicians. This required a deep exploration of principles of curriculum design.

The VAST Course arose from recognition that safe anesthesia care requires well-functioning perioperative teams. This 3-day course uses immersive, low-cost

Patricia Livingston MD
Associate Professor
Department of Anesthesia,
Pain Management and
Perioperative Medicine
Dalhousie University
Halifax
Nova Scotia
CANADA

Gaston Nyirigira
MD, MMED, FCA (ECSA)
Department of Anesthesia,
Critical Care and Pain
Management
University Teaching
Hospital of Butare
University of Rwanda
Huye
RWANDA

Adam Mossenson
MBBS, MPH, FANZCA
SJOG Midland Public and
Private Hospitals
Curtin University
PO Box 8691 Perth BC
Perth
WESTERN AUSTRALIA
and Department
of Anesthesia, Pain
Management and
Perioperative Medicine
Dalhousie University

simulation, focusing on safe anaesthesia and resuscitation for obstetrics, paediatrics, trauma, general surgery, and pre- and post-operative care. In addition to role play in 15 simulated scenarios, there are case-based discussions and skills stations covering non-technical skills e.g., situation awareness, team working, trauma primary survey, difficult airway management, neonatal resuscitation, pain management, and complex decision-making.

The following discussion provides an overview of curriculum, outlines a stepwise approach to curriculum design and discusses the Rwandan anesthesia curriculum as an example. Appendix 1 demonstrates application of these principles to the VAST Course.

Curriculum overview

A curriculum describes the planned learning experiences of an educational institution⁸. It is much more than a syllabus. A properly designed curriculum guides teachers, learners and administrators in offering transformative experiences so that learners achieve the desired outcomes of a program. A curriculum encompasses everything from what learners must be able to do after the course of study (learning outcomes) to identifying how well the stated goals have been achieved (program evaluation). In between, it specifies what is taught, how it is taught, who teaches and how learning is assessed. The best curricula are never considered “final”, rather they are strengthened by being reassessed and refined.

Anesthesia training includes both mentorship in clinical practice and formal academic curricula. Some programs have clearly specified clinical rotations (e.g., regional anesthesia, pediatric anesthesia) while others are less structured. In both cases, learning experiences will be “opportunistic”, meaning that encounters with patients having various pathology cannot be predicted. A well-designed academic curriculum complements opportunistic clinical learning by providing standardized learning experiences in core topics and exposure to areas that are less common but important. For example, malignant hyperthermia is rarely encountered clinically but recognition and management of the condition can be well taught through academic curricula.

Stepwise approach to curriculum design

Many models for curriculum design exist⁸⁻¹⁰ but they usually agree on core elements (Figure 1). The following discussion describes the curriculum design process as applied to training of anesthesia providers. Principles outlined are equally relevant to design of a short 2-hour teaching session or an entire specialty training program, to design of de novo curriculum or to modification of existing programs. While written here in a linear manner, the actual curriculum design process is iterative by working back-and-forth through these stages.

Build the curriculum design/renewal team

The ideal curriculum design team includes educators, learners and administrators who are enthusiastic about medical education. Build a team of keen, engaged people who are committed to medical education.

Consider the context

An anesthesia provider working in a remote district hospital with minimal resources will need a different skill set than a practitioner in a well-resourced tertiary care centre. While many requirements for each setting are common (e.g., all need airway management skills), graduate anesthesia providers must meet the needs of their own patients, learners and society. Contemplate the skills that are required to practice safely and effectively by considering the likely end destination where graduates of the program will practice.

Consideration of the context also requires reflecting on the available resources. Some questions to ask early on are:

- Who are the teachers?
- What resources and equipment are already available?
- Is there a simulation lab or space for a basic one?
- What avenues are there for sourcing additional resources?

Prior to embarking on curriculum design, the team should carefully assess their circumstances, requirements and resources, as these contextual factors influence all aspects of the curriculum.

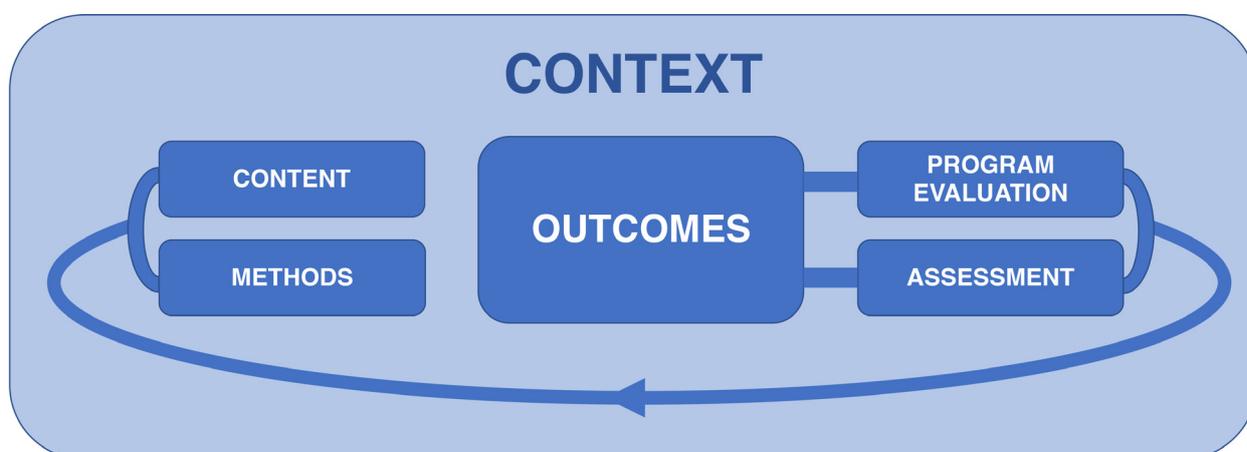


Figure 1: Key components of curriculum design. This visually represents to the key features of curriculum design. All aspects are embedded in and informed by a particular learning context. Broad outcomes are at the centre, as achieving these is the purpose of the curriculum. Content and teaching methods are designed with these outcomes in mind. Assessment measures learners’ progression to achieving the stated goals. Program evaluation occurs on a continuous basis. Learner assessment and program evaluation inform the ongoing refinement of the curriculum.

Identify broad outcomes

Having reflected on the context, the next step is to identify what learners will be required to do by the end of training. A curriculum is designed by keeping the end goals in mind. Broad outcomes are higher level goals rather than specific knowledge, skills and attitudes (learning objectives). For example, an anesthesia provider in a remote district hospital must be able to recognize and manage obstetric emergencies. Knowing this is an essential outcome, the curriculum should be designed to achieve this goal.

A recent trend in healthcare training is competency-based medical education (CBME)¹¹. This involves describing what a learner can be entrusted to do by the end of training (entrustable professional activities)¹² and the competencies to be achieved at each level of training (milestones). CBME is labour intensive as it requires frequent assessment and feedback for learners to identify where they are on their trajectory of achieving the stated goals. While CBME has potential advantages, it is not the only way to arrange a curriculum. Even when CBME is not employed, best practice is to begin by considering broad outcomes to be obtained by the end of training and to design the remaining elements to ensure these goals are achieved⁹.

Select and sequence content

Having identified broad outcomes, the next step is to select content needed to achieve those goals. Content overload is a common pitfall, as inevitably the volume of material exceeds what is realistic and manageable. Rather than attempting to include everything known on a topic, the focus should be on selecting the core knowledge, skills and attitudes the graduate practitioner will require to ensure that broad outcomes are accomplished.

The concept of “spiral curriculum”¹³ is useful in sequencing content. In a spiral curriculum, topics are revisited throughout the program but each time with increasing depth to enrich understanding. In the example of “recognize and manage obstetric emergencies”, early anesthesia trainees may learn about physiology of healthy pregnancy and various diseases of pregnancy. Later they may learn details of the clinical presentation and treatment of conditions such as severe pre-eclampsia. Still later they may be required to demonstrate management of a sick pre-eclamptic patient in simulation or clinical practice.

When possible, look for existing content that is suitable for the local needs. The World Federation of Societies of Anaesthesiologists (WFSA) website¹⁴ has a host of resources and links to established courses. The Anesthesia Tutorial of the Week has well-developed content intended for worldwide use. Other short courses, such as SAFE Obstetric, SAFE Pediatrics, Essential Pain Management and VAST, have been well-designed and tested. Including these international courses in anesthesia training is a strength. If considering a more longitudinal curriculum, the VAST Foundation Year is a one-year simulation-based curriculum for first year anesthesia. This curriculum is available for teachers who have trained as VAST facilitators and expands upon the foundations established in the VAST Course. Finally, select textbooks that are appropriate for the needs and not overly complex. Morgan and Mikhail’s Clinical Anesthesiology¹⁵ is a clearly written fundamental anesthesia textbook.

Match teaching methods with desired outcomes

Select teaching methods to promote transfer of learning¹⁶ from the context in which learning occurs (e.g., classroom, simulation lab) to the context in which learning is applied (patient care). Transfer of learning is most effective when circumstances for learning resemble circumstances where new learning is implemented. If trainees have only read about pre-eclampsia in a book, it is more difficult to treat real patients with this condition than for trainees who have rehearsed management of pre-eclampsia in simulation. Effective transfer of learning does not require teaching methods to be complex but rather that they be thoughtfully selected to achieve the desired outcomes. For example, if a desired outcome is safe selection for and performance of spinal anesthesia, teaching methods could include preparation reading with guiding questions, watching a video, hands on practice with a part-task trainer and, finally, supervised mentorship in clinical practice. Learning is facilitated by active methods where the learners are engaged, and experiences are vivid. Problem solving, case-based discussions, skills labs and simulation promote greater retention of learning than passive lectures. Anesthesia providers work with surgeons, nurses, colleagues, and trainees. Consider incorporation of inter-professional education, to help prepare anesthesia trainees for effective team function in future practice.

In selecting teaching methods, also consider the teachers:

- Can they be freed up from clinical service to be available for formal teaching?
- Are teachers able to establish a safe and supportive learning environment or are they accustomed to “shame-based” teaching methods?
- Is faculty development needed?
- How will teachers be oriented to teaching topics?
- Is teaching valued and rewarded by the institution?

It is essential to advocate for protected time for teachers to ensure the formal curriculum can be implemented.

Choose appropriate assessment methods

Assessment, along with meaningful feedback, is vitally important for helping learners reflect on behaviour and develop strategies for improvement. Assessment is a means for programs to determine how well learners are progressing on the trajectory to achieving the desired outcomes. Having a variety of assessment tools allows selection of those that most closely align with the required knowledge, skills and attitudes. For example, if recall of basic knowledge is being assessed, a written examination would suffice. If teamwork is being assessed, a 360 evaluation where various team members (nurses, surgeons, colleagues, mentors) provide anonymous feedback would be suitable. If complex synthesis of knowledge and behaviours is being assessed, an Objective Structured Clinical Examination (OSCE) or standardized simulation scenario may be best suited. The CanMEDS Assessment Tools Handbook provides a comprehensive survey of assessment tools and where they are best used¹⁷.

Consider how the curriculum will be evaluated

Just as assessment and feedback help learners improve, program evaluation looks at the degree to which the program achieves the broad outcomes of the curriculum. As with assessment tools, optimal evaluation uses a variety of methods. The Kirkpatrick model¹⁸ includes four levels from basic to most robust: reactions (learner, teacher and administrator impressions of the program), learning (exam scores for groups of learners), behaviour (workplace performance assessments for groups of learners) and results (impact of the program on patient outcomes). As much as possible, programs should endeavour to capture data from all four categories, recognizing the demonstration of results on patient care is difficult.

Collaborate with other similar programs

Curriculum design can be complex and laborious. There is no need to “reinvent the wheel”. Collaboration and resource sharing amongst programs in similar contexts should be highly encouraged.

Development of the Rwandan anesthesia curriculum

The Rwandan anesthesia curriculum (Figure 2) was developed in 2012 by Rwandan and CASIEF partners. The initial focus was on academic sessions, which could be controlled, rather than the clinical setting, which is more complex. The academic curriculum has improved significantly with the establishment of a simulation and skills centre in 2013¹⁹.

The Rwandan curriculum identifies broad outcomes and includes specific learning objectives for each session. Spiral design is used

so that topics are revisited with increasing depth, starting with Foundations and later in Core. There is one full academic day each week where active teaching methods are employed. Prior to each session, learners are assigned preparation reading and asked to submit answers to guiding questions. This allows teachers to gauge understanding and primes residents for deeper learning. Reading is from selected textbooks^{15,20} and articles shared by teachers. Classroom time may include collaborative problems solving, case-based discussions, videos, debates, games, quizzes, oral exams, skills stations and simulation. To build teaching skills, a resident teacher leads the session each week, with mentorship by the visiting or local teacher. Resident teachers are given feedback to help improve teaching skills. Each academic day also includes resident-led problem rounds to discuss management of clinical challenges.

To address challenges in clinical practice and the shortage of local teachers, selected residents have been offered clinical electives at Dalhousie University in Canada for periods of 3-6 months. The goal of this program is to strengthen clinical skill and to expose residents to Canadian practices of teamworking and patient care. Since 2010, 11 residents have participated in this program which was unfortunately paused due to the global pandemic.

Successes

Anesthesia was previously considered one of the least attractive specialties to medical students and the program struggled to recruit candidates. That is no longer the case; it is now a highly desirable program able to recruit excellent medical graduates. Where once

Year 1: Foundations										
Academic curriculum	Anesthesia fundamentals		Preoperative assessment			Pharmacology				
Academic curriculum	Equipment			Physiology						
VAST Foundation Year	Introduction to simulation & preoperative assessment		Theatre preparation	Airway management	Induction of anaesthesia	Essential pain management	Obstetrical anesthesia & neonatal resuscitation			Pediatric anesthesia
VAST Foundation Year	Pediatric anesthesia (cont.)		Trauma & burns	Recovery	Cardiac arrest management	Sepsis	Ethics	Invasive monitoring	Teaching & Learning Course	
Year 2: Core										
Academic curriculum	Cardiovascular				Respiratory			Neurologic		
Academic curriculum	Neurologic (cont.)	Renal			Hepatic		Gastrointestinal & metabolic	Endocrine		
Simulation and skills	There is a bank of simulated scenarios for use. Specialty skills workshops depend on visiting/local faculty (e.g., regional anesthesia, airway techniques, POCUS)									
Case presentation	Assigned topics that correspond to the Core subject taught that day									
Year 3: Core										
Academic curriculum	Hematologic & Musculoskeletal		Infectious disease & Immunologic		Pediatric		Obstetric	Critical care		
Academic curriculum	Critical care (cont.)		Recovery & Perioperative	Regional & pain			Trauma & burns	Airway		
Simulation and skills	There is a bank of simulated scenarios for use. Specialty skills workshops depend on visiting/local faculty (e.g., regional anesthesia, airway techniques, POCUS)									
Case presentation	Assigned topics that correspond to the Core subject taught that day									
Year 4										
Teaching & research	Senior residents are involved in teaching junior residents and preparing their final research dissertations in addition to clinical duties									

Figure 2: Overview of Rwandan anesthesia academic curriculum. This overview of the curriculum shows the topics with allotted time approximately indicated by the size of the box where the smallest box represents two weeks. Year 1, Foundations, includes: the academic curriculum, which focuses on anesthesia fundamentals, pharmacology, physiology and equipment and the VAST Foundation Year, a simulation-based curriculum. Years 2 and 3 continues with the academic curriculum, exploring body systems and their interaction with anesthesia. Across each year, relevant skills workshops, simulations and resident led case presentations occur. Year 4 is less structured but includes time for residents to complete their research projects and teach junior learners.

there were 0-2 applicants per year, recent intake has been 15 candidates per year.

Program graduates are increasingly capable of bridging the gap between “book knowledge” and clinical practice. Additionally, residents demonstrate improved confidence and capability at effective teaching. Residents are involved in teaching colleagues, non-physician anesthesia providers, updating the curriculum and teaching at international courses endorsed by the WFSA.

Challenges

The overwhelming challenge to achieving the CASIEF vision of autonomy has been the shortage of local teachers due to the attraction of work outside Rwanda²¹. Migration of skilled anesthesiologists is a massive loss to the people of Rwanda and demoralizing for colleagues and learners who remain. The Rwandan Ministry of Health is endeavouring to address the root causes of migration, but it is difficult to compete with well-paying non-governmental organizations and high-income countries. As a result of migration, high clinical demands and the attraction of private work within Rwanda, a scarcity of available teachers remains. For local teachers, an additional barrier may be significant travel required between the work and teaching locations. Retention of anesthesiologists is slowly improving but government, academic and clinical leaders need to strive for better working conditions and salaries that encourage anesthesiologists to remain in Rwanda to practice and teach.

Language has been another challenge for the Rwandan anesthesia program as most of the early learners were educated in French. In 2009, the official language of instruction was changed to English. In the early years of the CASIEF-Rwanda program, communication between Anglophone volunteer teachers and learners was difficult. This is gradually improving as the younger generation is more comfortable with English.

While assessment tools were included in the initial curriculum, comprehensive program evaluation was not. This weakness has led to an unstructured approach to ongoing curriculum renewal. Despite this limitation, significant informal learning from the curriculum has occurred.

CONCLUSION

Curriculum design does not need to be complex, but it should include the core elements previously described. Each training program is situated in its own unique context and reflection on the local needs helps to ensure the curriculum is designed so that graduates have the knowledge, skills and attitudes required for that particular setting. Begin with the end in mind so that broad outcomes are defined for the curriculum and the remaining elements are coordinated to ensure these outcomes are met. Select content carefully to achieve the learning goals while avoiding content overload. Sequence content to ensure topics are revisited with increasing depth. A range of active teaching techniques is ideal. Simulation is an especially strong modality as vivid, experiential learning in simulation fosters transfer or learning to clinical practice. Assessment and feedback help teachers and learners gauge progress. Evaluation is often overlooked – as it was in Rwanda –

but necessary for continuous refinement of the curriculum.

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Appendix 1: Stepwise approach to the VAST Course curriculum design

STEP	PROCESS UNDERTAKEN
Build the curriculum design team	Co-authors of VAST collaborated with the colleagues from the WFSA, the Scottish Center for Simulation and Clinical Human Factors ²² and partners from diverse contexts to identify needs and steer VAST's direction. Anesthesia trainees from Canada and Rwanda were actively engaged in course development.
Consider the context	VAST needed to be easily delivered, without reliance on a simulation centre, and clinically relevant in contexts ranging from remote hospitals in resource-limited settings to tertiary care hospitals.
Identify broad outcomes	Course graduates need to provide safe anaesthesia and peri-operative care for the most common clinical challenges and essential surgery (Bellwether procedures ²³) seen in first-level hospitals. This requires both safe clinical practices and effective non-technical skills ²⁴ .
Select and sequence content	Clinical content was selected to focus on the main case mix seen at district hospitals in resource-limited settings. In addition to the Bellwether procedures, content includes pediatric and obstetric emergencies, trauma, pain management and ethical decision making. Recognizing the key role non-technical skills play in effective team function for patient safety, non-technical skills are embedded throughout. Spiral design ¹³ is used so that scenario "patients" are first introduced in case discussions before appearing in simulated scenarios that follow stages of their hospital stay.
Match teaching methods to desired outcomes	Since a key learning outcome is practice of non-technical skills, the predominant teaching method is immersive simulated scenarios followed by reflective debriefing. Course participants are optimally prepared to manage scenarios by pre-course reading with guiding questions, introduction of systematic frameworks, case-based discussions and skills stations that cover core clinical content and technical skills.
Choose assessment methods	The VAST Course is designed to promote behaviour change amongst healthcare providers, rather than to assess performance according to standard benchmarks. Assessment happens in self-reflection during scenario debriefing and in commitment-to-change discussions at the end of the course, whereby participants consider their learning and contemplate practice changes they plan to make post-course. For research purposes, the impact of VAST on performance has been assessed ⁶ using the Anaesthetists' Non-Technical Skills framework ²⁴ .
Consider curriculum evaluation	End-of-day evaluations are collected from participants and facilitators to gain information on aspects of the course that have gone well and to identify areas for improvement. This feedback is integrated into an ongoing process of iterative refinement of VAST's teaching methods and content.
Collaborate with other programs	During development, course authors collaborated with the leads of existing programs such as Essential Pain Management, Safer Anaesthesia from Education, Helping Babies Breathe and Primary Trauma Care to build a curriculum that integrates consistent clinical content from these programs with the goal of complementing and reinforcing learning across courses. Likewise, in developing simulation methodology, VAST's design principles and debriefing framework were adapted from an established model used at the Scottish Centre for Simulation and Clinical Human Factors.