Longitudinal assessment: A strategy to improve continuing professional certification

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ABSTRACT

Healthcare certification organizations carefully balance a commitment to bring value to their membership through programs that support lifelong learning and professional growth, while protecting the public by ensuring competent certified practitioners. These certifying bodies are challenged with remaining current with their maintenance of certification programs while keeping pace with the growing breadth of knowledge, industry standards and guidelines, innovative advances, and rapid technological gains in testing and assessment. Within the context of process innovation, the National Board of Certification and Recertification for Nurse Anesthetists (NBCRNA) evaluated the current landscape of Longitudinal Assessment (LA) as a potential strategy for the assessment of core knowledge as part of their Continued Professional Certification Program for Certified Registered Nurse Anesthetists. This manuscript details the evaluation of LA using a Logic Model as the tool to scaffold inquiry, a review of LA literature, an environmental scan of current LA programs with identification of LA program elements available, and the results of a LA feasibility study. The findings substantiate that continued professional certification which incorporates a LA strategy can augment lifelong learning, but is not an assessment strategy that can be implemented without thoughtful planning, customization and continuous maintenance.

Certified Registered Nurse Anesthetists (CRNAs) have been demonstrating their proficiency of anesthesia knowledge and in practice throughout the history of the profession. In 1945 the national CRNA organization approved a standardized evaluation strategy known as a National Certification Exam to be taken upon completion of CRNA training; all certified members would have to successfully pass this test in order to practice anesthesia. Recognizing that one initial test was not sufficient to demonstrate their lifelong commitment to their practice and patients, CRNAs furthered their commitment to safe anesthesia in 1976 by self-mandating that all certified members of the profession complete a continued certification process known as recertification. Over the years, both the name and steps required for recertification have evolved for this group of Advanced Practice Registered Nurses because of myriad changes to clinical anesthesia, safety standards and guidelines, technological advancement and assessment innovation.

Continued Professional Certification, as recertification is now known for CRNAs practicing in the United States, has been an integral component of maintaining licensure and promoting patient safety. As the national entity responsible for the Continued Professional Certification Program, the National Board of Certification and Recertification for Nurse Anesthetists (NBCRNA) believes that lifelong learning is a vital part of the certification process and essential for promoting patient safety. As such, the NBCRNA continually monitors innovative assessment strategies that are based on empirical evidence which support lifelong learning for its CRNA members, while accommodating the rapidly changing technological advancements in healthcare, the

importance the public places on credentialling standards and skills evaluation, and the needs of its CRNA members.

The NBCRNA develops its programs to account for the necessary requirements that promote patient safety by enhancing provider quality and meet strict standards set by certification organization accreditors. To meet these demands, the NBCRNA took six years (2010–2016) to gather professional, member and industry expertise and feedback to design and roll out the current Continued Professional Certification Program for CRNA continued certification (recertification); a process that consists of two, four-year cycles that requires CRNAs to complete various activities to demonstrate continued engagement with professional education or practice improvement, four online modules and a 150-item Continued Professional Certification Assessment (National Board of Certification and Recertification for Nurse Anesthetists, n.d.-a)

While many other healthcare certification boards utilize some form, or combination of a similar process, various healthcare organizations have been trialing newer innovative appraisal strategies for their recertification process or maintenance of certification (Spence et al., 2021). One strategy, based in educational theory that has been favorably received by certification organizations and healthcare practitioners alike is known as Longitudinal Assessment (LA). LA can be described as a maintenance of certification process that uses modern technology to administer shorter assessments of specific content (such as medical and nursing knowledge) with immediate feedback, repeatedly over a defined period of time. Longitudinal Assessment is based on adult learning principles to promote learning, retention, and transfer of knowledge to the clinical setting. A majority of the member boards of the American Board of Medical Specialties, National Commission on Certification of Physician Assistants, and The National Board for Respiratory Care are examples of certification organizations that are piloting or implementing LA into their continued board certification exams, or maintenance of certification process (American Board of Medical Specialties, 2019b; National Board for Respiratory Care, 2020; National Commission on Certification of Physician Assistants, n.d). One reason these boards moved away from their high-stakes recertification examination is because their certificants felt the high-stakes assessment was burdensome, not relevant to their practice, and did not support lifelong learning (American Board of Medical Specialties, 2019b). As part of the NBCRNA's commitment to patient safety and promotion of lifelong learning, and to improve the recertification experience for the CRNA members it serves, LA is one of the strategies the NBCRNA chose to explore as a possible element to incorporate into its Continued Professional Certification Program as an alternative to, or replacement of, the 150-item assessment.

This manuscript will illustrate the process a professional certification organization undertook to examine and explore LA as a substitute or supplement to continuing board certification requirements for nurse anesthetists, within the purview of supporting lifelong learning and promoting patient safety. This manuscript is novel because it serves as an exemplar and guide for other organizations considering a LA program. To date, there are no known process publications that outline the methods a credentialing organization undertook to investigate LA, summarize the program elements, as well as operational considerations to develop, implement, evaluate, and maintain a LA program from the approach of process innovation. The authors' approach utilized process innovation that can help organizations develop products or programs based on principles of design thinking: feasibility (technologically feasible), viability (economically viable) and desirability (desirable from an end-user perspective) (IDEO Design Thinking, n.d.)

Background

LA can be described as using current technology to administer shorter evaluations of specific content, repeatedly over a defined period of time. Through a recurring examination process, concepts and information are reinforced so that knowledge of the exam taker is retained

and accumulated gradually. Knowledge gained in this fashion can be more readily retrieved and applied to various situations. Within the context of healthcare in the United States, LA offers an innovative means of pivoting from a traditional examination and evaluation of a practitioner's post-certification knowledge every five to ten years, to more frequent assessments. The frequent evaluations utilized in LA models reinforce current knowledge of emerging evidence-based topics (Larson et al., 2008) with a goal of assuring public safety through adequately informed, relevant and highly qualified healthcare providers.

LA fosters lifelong learning and retention by offering spaced learning educational experiences on a broad range of professional topics repeatedly, periodically, and frequently at intervals determined by the needs of industry, profession, practitioners, and public. LAs have been designed based on adult learning principles (Bernstein et al., 2016; Price et al., 2018) that leverage modern technological innovations. LAs offer the opportunity to shift the balance from an assessment of learning only, to one that amalgamates the assessment *for* learning (Kelley & Whatson, 2013). One of the most powerful features of LA is providing immediate feedback to a practitioner and the rationale(s) for correct or incorrect answers. For example, in a traditional exam, a test-taker is usually provided only summative information on the test as a whole (i.e., "You received 80 out of 100 questions correct"). By contrast, in LA, each question becomes a "teachable moment": The practitioner is given immediate feedback explaining each answer choice, as well as references or resources that transcends their testing encounter and can also offer a learning experience.

LA offers the advantages of incorporating more frequent, recurring assessments with immediate performance feedback and follow-up evaluations to identify and address any knowledge gaps. This can also assist in developing an improvement plan with targeted educational remediation, along with the delivery of real-time information, all of which further supports and augments lifelong learning for the practitioner. Furthermore, LA platforms (online or app-based technological programs that structure the LA) can be conveniently accessed from a desktop, tablet or mobile device, thus removing the need to take time off from work to complete a continuing board certification exam at a testing center.

Historically, once a CRNA has passed the National Certification Exam and obtains licensure in the state(s) of practice, a CRNA can administer anesthesia in a number of operative, pain management, dental or podiatry settings. To maintain the highest standards of the profession and to ensure public safety, the NBCRNA first proposed the criteria for the Continued Professional Certification Program and presented it to the CRNA community in August 2011 (National Board of Certification and Recertification for Nurse Anesthetists, n.d.-a) The Continued Professional Certification was then disseminated nationwide in August 2016. Since 2016, the current Continued Professional Certification components are composed of two four-year cycles totaling an eight-year program period. The Continued Professional Certification requires completion of 60 Class A continuing education credits (typically comprised of approved educational or professional meeting and conference attendance hours) and 40 Class B professional activity credits (i.e., presentations, publications, research, teaching, etc.); Core Modules examining four core domain areas of nurse anesthesia practice[1] each cycle or every four years; and a 150-item assessment (called the Continued Professional Certification Assessment), which is a performance standard[2] assessment, in the second four-year cycle (Fig. 1). To

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[1] This core knowledge has been organized into four content domains: (a) Airway Management; (b) Applied Clinical Pharmacology; (c) Applied Physiology and Pathophysiology; and (d) Anesthesia Equipment, Technology, andSafety.

[2] Performance does *not* affect certification, it is not a pass/fail exam; additional Class A continuing education is required in any area of weakness (Ferris et al., 2021)
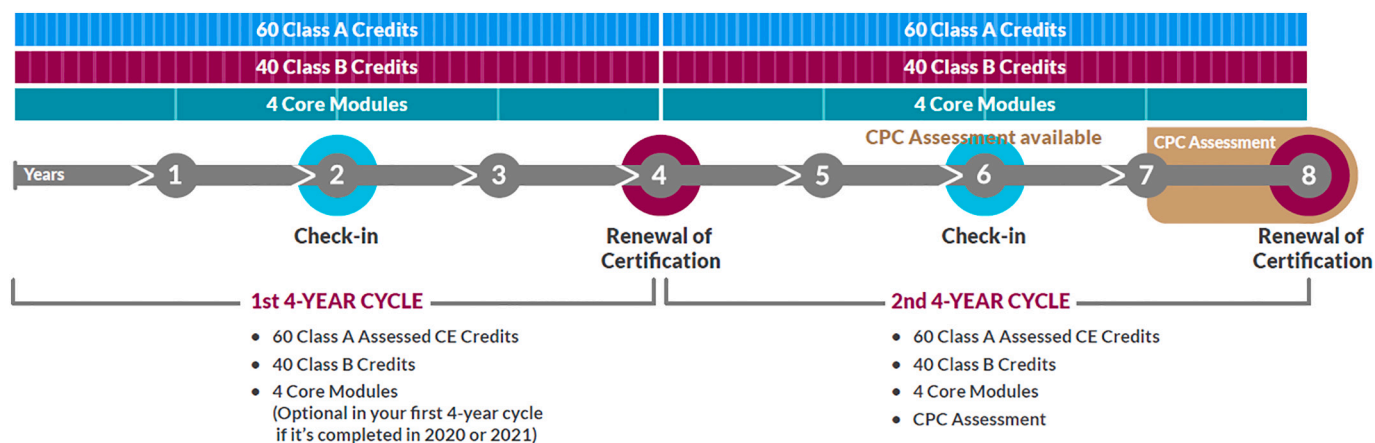
Fig. 1. Continued professional certification program components and timeline.

continue practicing anesthesia and maintain licensure, CRNAs must seek out approved educational opportunities (i.e., 60 Class A and 40 Class B credits), complete the Core Modules (which are optional in the first four-year cycle if the member completes their recertification cycle in 2020 or 2021, mandatory thereafter) and meet a Continued Professional Certification Assessment performance standard.

Integral to the development and dissemination of the described Continued Professional Certification Program, the NBCRNA committed to a continuous evaluation plan of their credentialling process in order to maintain a relevant and current recertification strategy that would encourage lifelong learning and promote patient safety. An Evaluation and Research Advisory Committee was formed to investigate prominent, evidence-based assessment strategies that could enhance their credentialing programs through the lens of their key guiding question: What are optimal[3] ways to assess and maintain knowledge needed for initial and continued board certification over time in CRNA practice?

Investigation into the feasibility, viability, and desirability of designing a LA program for CRNAs to augment the current Continued Professional Certification Program, either as an alternative or supplement to the Continued Professional Certification Assessment started in 2019. The Evaluation and Research Advisory Committee: LA Subcommittee was formed and charged by the NBCRNA Board of Directors with evaluating current and innovative methods of LA to gauge how to measure and assess the crucial, clinical decision-making knowledge of CRNAs. A logic model was utilized to scaffold, guide and focus the investigation process, and a LA literature review and environmental scan of other certification organizations was completed. Other health-care standards and models were inspected, and a comparative matrix of their LA program elements was assembled. Based on the cumulative findings, a feasibility study was conducted to trial an existing LA program using test questions from the Continued Professional Certification Assessment practice exam.

Therefore, this manuscript describes the initial process and the methodology the NBCRNA undertook to investigate if LA is an optimal method to assess and maintain core knowledge needed for continued board certification over time in CRNA practice.

Methodology

Logic models

The goal of the LA Subcommittee work was to examine and explore how LA might be used as an alternative or complementary option within the Continued Professional Certification Program to support lifelong learning. To investigate process-driven changes within the existing recertification program, the authors utilized the logic model tool to help conceptualize the activities needed to achieve intended results. Because a logic model links both short and long-term results with program activities and processes, it can help an organization systematically illustrate and describe how to perform its work effectively during program planning, implementation, and evaluation (W. K. Kellogg Foundation, 2004). The LA program planning logic model tool was developed to summarize the issues, needs, desired results, influential factors, strategies to implement and assumptions considered to determine the feasibility of adding LA into an existing recertification program. (Fig. 2).

The first step in developing the logic model was to identify the focus areas or list the issues that needed to be addressed. After in-depth exploration of the maintenance of certification processes, the LA Subcommittee pinpointed three primary concerns: 1) A single-point-in-time assessment administered every 8-years may not promote lifelong learning (current Continued Professional Certification Assessment model, see Fig. 1); 2) The optimal assessment method that will maintain the CRNA's core knowledge must be identified; and 3) A determination must be made as to whether LA is to be an alternative or a supplement to the current Continued Professional Certification Assessment.

Next, as part of the LA Subcommittee, NBCRNA staff, and Subject Matter Experts collaborated to define the needs of the CRNA community and determine available assets. The LA Subcommittee conducted an extensive literature review and attended conferences with other credentialing bodies (such as the American Board of Medical Specialties) who currently incorporate LA in their credentialing requirements, to identify best practices and lessons learned (American Board of Medical Specialties, 2019a). From these explorations, an assessment of feasible, viable and desirable platform features for CRNAs, as well as associated costs, was created. Then, a timeline with short- and long-term goals was developed.

Short-term results included conducting a literature review that would help to better understand the current evidence body supporting LA. Additionally, performing an environmental scan of the current LA landscape and developing a comprehensive list of program elements. Furthermore, a feasibility test would then yield results to be reported to the NBCRNA Board of Directors with a recommendation to conduct a pilot study to better understand the operational implications of developing a LA program. The long-term goal was to support the NBCRNA
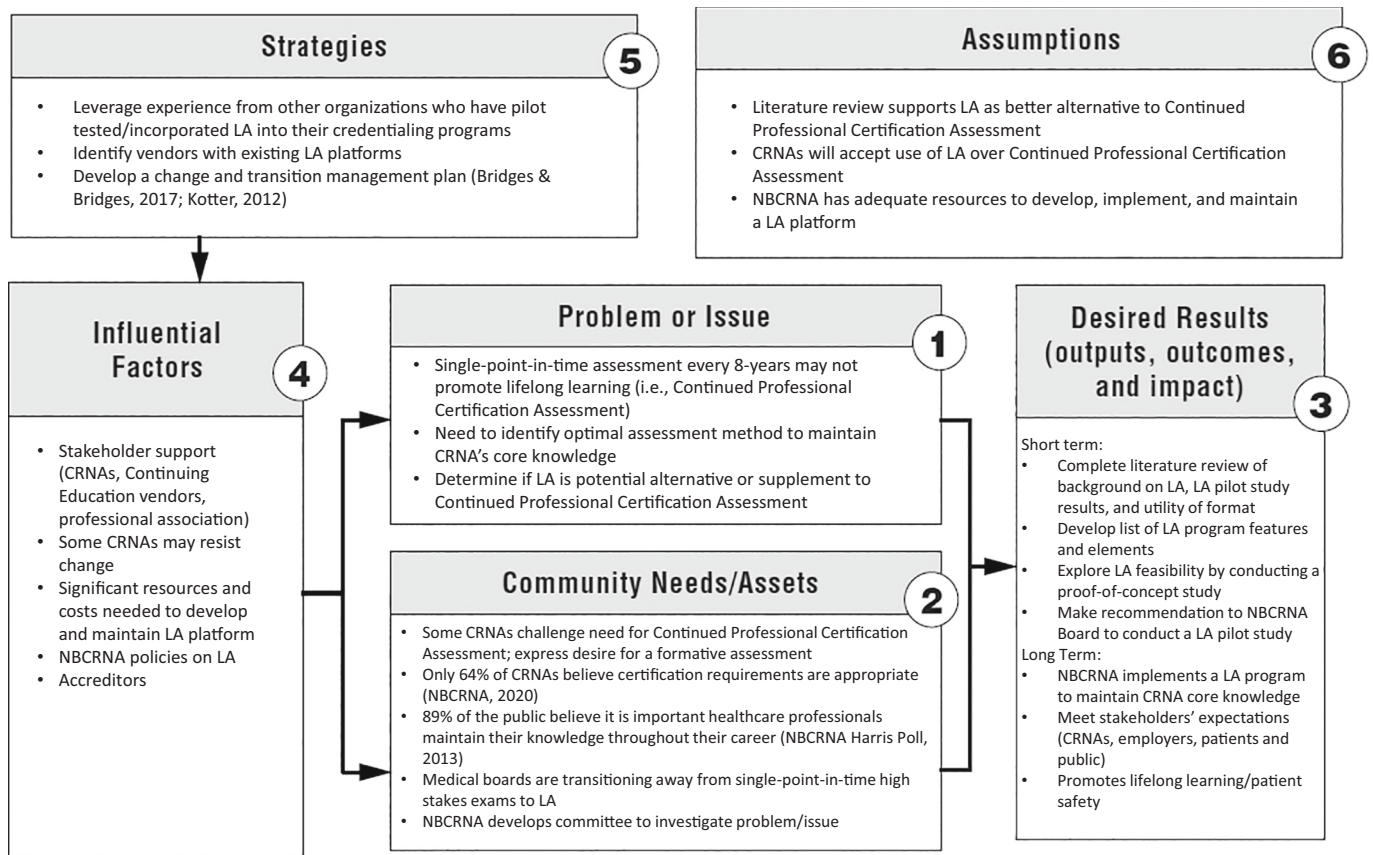
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[3] Optimal in this context is defined by the NBCRNA as being evidence-based, valid, reliable, feasible, viable and desirable to the NBCRNA both in terms of meeting certification standards and to CRNAs being evaluated (NBCRNA, n.d.-b)

Fig. 2. Longitudinal assessment program planning logic model adapted from the W. K. Kellogg Foundation, 2004. Supplemental references from Figure 2 include The National Board of Certification and Recertification of Nurse Anesthetists, 2013 & 2020.

organizational mission to improve patient safety through high quality credentialing programs, by offering a LA program for continued board certification.

Influential factors for LA implementation were then considered. These include communication to stakeholders, such as the CRNA members and the NBCRNA Board of Directors, regarding desirability for a LA option, as well as identifying those current continuing education vendors that might support transition to the LA learning platform. Strategies for successful implementation of the LA program were also included, leveraging salient information from medical boards who have already piloted or adopted LA, a strong communication plan to involve the stakeholders (i.e., CRNAs), as well as developing a change management and transition plan (Bridges & Bridges, 2017; Kotter, 2012). Lastly, assumptions were identified and included whether the literature review supports LA for lifelong learning, that using LA was best practice, and that financial, technological, and human resources were available.

Review of the literature

To inform on the exploration of LA as a method that buttresses lifelong learning, an extensive literature review was conducted (Ward et al., n.d.). The overall goal of this literature review was to inform the theoretical underpinnings, as well as an understanding of the healthcare professions utilizing LA. There were three foundational questions guiding this literature review: 1) What are feasible, desirable, viable models of LA for lifelong learning that can be adopted or adapted for CRNAs? 2) What innovative testing alternatives are currently utilized by healthcare professionals and non-healthcare communities to assess knowledge, judgement, skills, abilities, and performance over time for the purpose of continued professional certification or maintenance of certification? and, 3) Is there merit in considering LA by this

credentialing body at this time? Furthermore, the literature review aimed to determine the purpose of a LA program and explore whether this method could be used as a supplement or an alternative option to the current Continued Professional Certification Assessment. To answer these questions, the literature was examined for the advantages, opportunities, and disadvantages or limitations that may be inherent in a LA undertaking, as well as to identify other credentialing program implications in the literature that may warrant consideration.

Search terms for the review of literature included "longitudinal assessment," "competence," "certification," "recertification," "learn," "teach," "test enhanced," and "education." Medline, CINAHL, Embase, PsycINFO, Scopus, Nursing@Ovid, and grey literature identified 791 potentially relevant articles. Twenty-two articles published between 2011 and 2021 were identified for inclusion that addressed the research questions and were included in the literature review: Fourteen publications were descriptive studies, seven were background articles/expert reports/opinions, and one was a systematic research report. While the literature review was a vital part of the process of informing on LA and is summarized here, it is not the intended purpose of this manuscript. The reader is referred to Ward et al. (n.d.) for a more detailed review of LA literature.

The literature represented various medical specialties including anesthesia, general surgery, cardiology, pediatrics, and veterinary medicine. There was also international representation from the United Kingdom reflecting dental and dental hygienists' continual assessment (Hatala et al., 2019). The most prolific evidence on LA was found to come from the pediatric and anesthesia medical specialties, both of whom have successfully incorporated LA platforms in the recertification of their members (Leslie et al., 2018; Sun et al., 2016). Of these, one study presenting pilot results of anesthesiologists participating in LA, MOCA® Minute, found they performed better on the high-stakes

cognitive examination compared to those not participating (Sun et al., 2016).

Findings from this literature search clarified the process of actualizing LA as a continual tool that could be utilized in recertification. The literature provided evidence of buy-in and value from the healthcare professional's perspective, signaling that it is desirable to those practitioners already taking LAs: The literature details the theoretical foundation underlying LA programs, the utility of the LA concept and participant experience based on pilot studies conducted by several member boards of the American Board of Medical Specialties. These reports indicate that LA platforms are well received by their member physicians, are perceived as being more convenient and less anxiety-provoking overall, and are preferred over a high-stakes point-in-time recertification exam. It also highlighted that LA is an advantageous tool to effectuate lifelong learning, an indispensable objective in achieving the Institute of Medicine's identified core competencies of the healthcare professional (Advisory Committee on Interdisciplinary, Community-Based Linkages, n.d.) LA provides an opportunity to identify knowledge gaps and helps to keep practitioners current on emerging topics and clinical guidelines. Overall, the findings from the literature review indicate that LA can be deemed an appropriate and useful method that helps support healthcare providers' maintenance of knowledge and critical thinking over time, as reflected by both certification bodies and participating healthcare providers. (Ward et al., n.d.)

Synopsis of program elements

The LA Subcommittee conducted an environmental scan from December 2019 to May 2020 of the 24 American Board of Medical Specialties member boards, and one other healthcare organization (the National Commission on Certification of Physician Assistants), that were known at the time for either offering, piloting or planning a LA program based on the American Board of Medical Specialties Board Certification Report and the Benchmarking Study on Continuing Certification in Healthcare (Spence et al., 2021). To conduct the environmental scan, members of the LA Subcommittee visited the websites of each American Board of Medical Specialties member board and other healthcare organizations to garner information about their LA programs. Specific data on the LA system features, number of questions per LA cycle, time allowed per question, etc. were then entered into a comparative matrix that was created using Microsoft Excel®. This comparative matrix was then used to inform on the development of a comprehensive list of various LA program elements. If there was a distinct program element present for one organization, then that new system feature was entered into the comparative matrix as a new datapoint.

Based on the data available, the comparative matrix indicated that 87% ($n = 21$) of American Board of Medical Specialties member boards were offering, piloting, or planning a LA. Of those 21 American Board of Medical Specialties participating member boards, 67% ($n = 14$) continued to offer a traditional continuing certification exam option alongside their LA. The most common frequency for the delivery of LA questions was a quarterly administration, with the average number of questions administered being 21 with four to five minutes as the average time allowed per question. Seventy-one percent ($n = 15$) of member boards, indicated the allowance of outside reference resources to be used when answering questions.

After the LA Subcommittee presented their results to the NBCRNA Board of Directors, the National Board for Respiratory Care was identified as offering LA as part of their Credential Maintenance Program. Respiratory Therapist certificants have the option of participating in the LA program, retaking the credentialing exam, or earning a new credential. The National Board for Respiratory Care LA platform consists of 5 to 10 questions per quarter with up to 5 min to complete each question. After each question, the certificant rates their confidence and relevance, and then is provided with immediate feedback (NBRC, 2019).

Additional datapoints collected and entered in the comparative matrix included information on security, scoring/performance standards and remediation plans. Once the comparative matrix was completed, a comprehensive list of LA program elements or options were grouped into broader domains such as features (i.e., specific characteristics/traits about the LA program that are required for development and maintenance of a LA platform that will interface the user and the LA) and collated by: 1) functional requirements (the general behavior of what the LA program does according to features that if not met will render the platform unusable and thus impacts functionality), 2) non-functional requirements (requirements that specify how the LA program should perform and thus defines the behavior or product properties that affect the user experience but does not impact functionality), and 3) technical requirements (the technical performance and operating systems that must be considered pertaining to hardware and software requirements) (Table 1). This comprehensive list of program elements could be utilized to inform the potential design considerations of a LA prototype and pilot program, as well as determine the resource implications to consider for development and maintenance should an organization decide to pursue a LA program.

LA feasibility/proof of concept study

A LA feasibility study, or proof-of-concept exploration, was undertaken in collaboration with the National Commission on Certification of Physician Assistants to ascertain the feasibility, functionality, desirability and utility of their existing LA platform (National Commission on Certification of Physician Assistants, n.d.) from June to July 2020. Twenty-five test items from the Continued Professional Certification Assessment practice assessment were placed in a test environment, which emulated the National Commission on Certification of Physician Assistants' existing LA platform. Members of the NBCRNA Board of Directors, and volunteer members of the Evaluation and Research Advisory Committee, Value & Satisfaction and LA Subcommittees were invited to participate in the feasibility study to trial the emulated LA platform. It should be noted that these participants included Subject Matter Experts in the fields of assessment strategy that serve as external advisors, as well as NBCRNA staff liaisons. Participants were then asked to complete a post-survey evaluating their overall user experience, as well as the platform's usability that was measured based on several attributes from the User Experience Questionnaire[4] presented in parentheticals next to the associated findings (User Experience Questionnaire [UEQ] Team, 2018).

Thirty-one participants responded to the survey with nearly even representation across the groups: Members from the NBCRNA Board of Directors ($n = 6$), Evaluation and Research Advisory Committee ($n = 7$), the Value & Satisfaction Subcommittee ($n = 5$) and LA Subcommittee (n = 6) volunteers, and NBCRNA staff (n = 7). The average age of participants was 55 years, and the median years of practice was 11–20 years. About half of respondents (48%) hold a PhD, 32% have a practice doctorate, and 13% have a master's degree.

After excluding any non-CRNA participants, the CRNA's who reviewed the emulated LA platform rated it 4.5 out of 5 stars (attractiveness). They found the platform to be user-friendly (perspicuity) and liked the immediate feedback (novelty). In terms of technology, the vast majority did not experience any technical issues (efficiency) and found the platform easy to use and navigate (efficiency and dependability).

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[4] LA Feasibility/Proof of Concept Study Pilot Questionnaire Attributes to Determine Usability adapted from the UEQ: Attractiveness (What is the overall impression/rating of product?); Perspicuity (Is the product easy to get familiar with? Is it easy to learn how to use?); Efficiency (Can users solve their tasks without unnecessary effort?); Dependability (Does the user feel in control of the interaction? Is it secure and predictable?); Stimulation (Is it exciting and motivating to use the product? Is it fun/engaging to use?); Novelty (Is the design of the product creative? Does it catch the interest of users?).

Table 1

LA program functional, non-functional, and technical requirements, domains and elements/options matrix.

LA Program Requirements, Domains and Elements/Options					
Functional Requirements		**Non-Functional Requirements**		**Technical Requirements**	
Domain	Elements/Options	Domain	Elements/Options	Domain	Elements/Options
Feature	Attestation in the beginning and/or when submitting a response to each question	Scoring	If repeat items, count first item, second item or both?	Platform	Build own/"off-the-shelf" from a vendor
Feature	Algorithm for selecting/displaying items (e.g., responsive/adaptive testing/machine learning/AI-driven)	Scoring	Standard setting (i.e., performance standard, pass/fail, etc.)	Web-based	Preferred browsers
Feature	Immediate feedback for each item (rationale, critique, references, etc.)	Development/ Maintenance	Subject Matter Experts individually develop Items and/or use automated item generation	Operating system	Preferred operating systems
Feature	Rationale for each item	Enhancements/ Maintenance	Expand/increase item-writing committee sizes if Subject Matter Experts develop items	Mobile optimization	Platform usable on computer and mobile devices
Feature	Reference(s) for each item	Enhancements/ Maintenance	Addition of emerging topic items	System performance check	Platform system performance check
Feature	Post-question evaluations about confidence/relevance/difficulty and/or if resources used	Enhancements/ Maintenance	Shortened rationales		
Feature	Progress bar/progress to date by content/domain area	Enhancements/ Maintenance	Simplified reference format		
Feature	Due date/days left to complete	Enhancements/ Maintenance	Process for article identification/selection		
Feature	Question history/review/bookmark question to access later	Enhancements/ Maintenance	Increased data forensics (i.e., collusion detection analysis)		
Feature	Normative data (self-performance vs. other participant performance for comparison)	Enhancements/ Maintenance	Platform improvements/enhancements		
Feature	Dashboard with key information displayed (i.e., core knowledge gap/gain analytics)	Enhancements/ Maintenance	Addition of featured readings/items (i.e., articles, clinical guidelines)		
Feature/ Scoring	Skip/decline question(s)	Feature	Reference/resources allowed		
Feature/ Scoring	Repeat test question(s)/incorrect question(s) and/or similar/clone item	Feature	FAQ, video on how to use, etc.		
Feature/ Scoring	Ability to change answer before submitting	Frequency of Assessment	Frequency of engagement: quarterly, semi-annually, annually		
Structure	Questions timed (i.e., 2, 3, 5, 10 minutes/per question)	Security	Participant identity confirmation (i.e., unique username and password, multi-factor ID, biometrics, proctor video of candidate/ID or AI observation, etc.)		
Structure	Number of questions per frequency assessment (i.e., 25 questions per quarter)	Security	Proctored administration vs. remote proctoring (live, recorded, AI) or no proctoring		
Security	Welcome/attestation screen to agree on policy and procedures	Security	Browser blocks use of copy and print screen		
		Security	Each item is tagged with a representation of the user's name, the current date/time, and the question ID. The tag is replicated on a watermark repeated underneath the question and critique content		
		Security	Connectivity checks (i.e., 'heartbeat' every 10 seconds—while viewing a question—the system sends a 'heartbeat' to the user's device to detect if they are still connected		
		Security	Transactional logging—Every event is logged for tracking and support purposes, along with time and session information		
		Structure	Traditional secure exam option offered (yes/no/available as an option)		
		Structure	Content based on job analysis on testing core and/or new knowledge		
		Structure	Test "time-sensitive/current" questions		
		Structure	Cycle length, items/quarter, drop lowest quarter each year, etc.		
		Structure	Remediate if below the passing standard		
		Customization	Platform customization		
		Technical support	Platform technical support		
		Registration	Participant registration/authentication		

Ninety-four percent found the platform easy to log into (efficiency/dependability) and no participant needed to perform a system check to launch the exam (efficiency). CRNA participants further expressed that they appreciated certain aspects of the platform, including the ability to visualize progression of the assessment (novelty), receive immediate feedback and the opportunity to review missed questions along with references (stimulation and novelty). Ninety-six percent of CRNA volunteers reported that they would utilize this type of platform again (stimulation), while 88% of CRNA volunteers indicated that they would prefer LA as an option for continuing certification (stimulation and novelty).

This initial exploration of an emulated LA platform was promising as it allowed CRNA volunteers to trial, and therefore learn more about LA, with the majority indicating it a desirable option. It provided actionable user input on platform features that would or would not be helpful to adopt for a larger-scale trial or real-time LA program. Additionally, the process of identifying test questions from the Continued Professional Certification Assessment practice assessment offered insight as to whether LA was feasible from a technological perspective, since each item pulled from the item bank had to be configured according to the platform's specifications based on an item template and blueprint. Furthermore, it helped glean if it was viable from an operational perspective to generate items with references, rationales, and feedback for correct or incorrect responses.

However, there are limitations to this feasibility study secondary to the fact that other LA platforms were not trialed or emulated for comparison. Additionally, although the preliminary data were promising, it is not considered generalizable to be representative of the entire CRNA population's sentiments regarding LA or the use of an LA platform. Piloting such a platform with a larger, randomized sample of CRNAs would garner more generalizable feedback, and trialing other available LA platforms would allow for a better understanding of the different capabilities currently available. Although the NBCRNA first conducted this small feasibility study with promising results, a larger pilot study is still warranted to further examine the full capabilities of other LA available platforms as well as evaluating participant's performance on the LA versus a point-in-time examination, and to collect data on their perceptions of usability with the LA platform.

Advantages to LA

Through the work of the LA Subcommittee, many advantages to utilizing LA were brought to light. In many cases, these advantages appear to surpass what can be achieved through more traditional point-in-time testing methods. One such advantage is more frequent touchpoints between the certifying body and the certified population. The continuous nature of LAs allow for potentially better insight into how well the certified individuals are staying current on emerging healthcare information. Additionally, the increased frequency in touchpoints may allow for faster identification of knowledge gaps and the opportunity to provide individualized remediation plans, which better aligns with promotion of lifelong learning. In many cases, LAs more closely mirror the certified individuals' practice, in relation to traditional point-in-time

testing.

Other advantages that LAs provide include the ability to offer immediate feedback on testing topics. In many cases, the test taker is presented with feedback after each question explaining why the answer is correct and why the distractors are incorrect. This aspect of LA provides an immediate learning opportunity. LA programs also provide the ability to offer real-time scoring and normative or peer-comparison data.

Flexibility, accessibility, and relevance are other advantages of LAs noticed in the literature. The findings from the environmental scan conducted by the LA Subcommittee also revealed that the majority of existing LAs provided the test taker flexibility in how they responded to a question set. For instance, test takers could respond to an entire set of questions in one sitting, or space out their questions over a given timeframe. The remote nature of LAs allow for greater accessibility, in that internet access is often all that is needed to participate. To account for life events, some LAs offered by American Board of Medical Specialties medical boards allow certificants to skip several quarters of questions (i.e., for personal events, short-term healthcare issues, military deployment, etc.).

Additionally, some certifying organizations that utilize LAs collect confidence and relevance ratings for individual questions that can then be used by an algorithm to deliver a more tailored exam experience to each test taker's individual clinical practice. For example, most LA platforms ask certificants to rate their confidence and relevance in their responses, prior to seeing the answer and rationale. Algorithms are then used to select repeat or cloned items. For example, if a certificant said they were highly confident and that the item was highly relevant to their clinical practice, but got the item wrong, then the algorithm would prioritize presenting a repeat or cloned item in the future. This novel methodology may help in the measurement of learning and help certificants recognize their gaps in knowledge.

Disadvantages to LA

The work of the LA Subcommittee also uncovered potential disadvantages to LAs. One such disadvantage is that the examination content is often less secure compared to traditional brick-and-mortar testing centers. This can potentially lead to exposed examination content that could threaten the validity of scores. As a result, increased security protocols are often warranted (i.e., web crawling services, social media monitoring, data forensic techniques).

The continuous nature of LAs can also lead to an increased burden on content development. Such an increase in development workload can be a substantial stressor for both certifying body staff and volunteers alike to develop new items, along with providing references with any associated feedback. The increased content development burden can also have a negative financial impact to set up the infrastructure and pipeline needed to be consistently developing new examination content.

The financial aspect of developing, administering, and scoring a LA should not be overlooked. There are substantial costs associated with developing and maintaining a LA program. These costs can include but are not limited to research, staffing, outreach/communication, platform development/procurement/maintenance, content development, and

technical support.

Recommendations

While the process of investigating LA as a viable replacement or supplement to the current Continued Professional Certification Program offered to CRNAs by the NBCRNA yielded a substantial amount of evidence surrounding this tool, recommendations for how to proceed with exploring LA were also cultivated. Based on the experience and results of this initial systematic LA exploration, it was felt that LA should be investigated further both operationally and holistically. It is recommended that when planning such an organizational change (such as implementing LA) and transition management, any and all results should be presented both within the certification organization and through dissemination strategies to the certificant population and professional association. This recommendation would improve transparency of the certification organization and their objectives, while fostering awareness and buy-in from certificants. Not surprisingly, focus groups were identified as one means of gathering themes on how best to communicate such a change or how to roll-out such a process (Dwyer & Turner, 2019; Leslie et al., 2019). Within an organization there must be a solid consensus built on the fundamental and strategic considerations of planning and implementing LA. Multiple LA platforms should be trialed; vendors should be consulted for information and proposal comparisons to adjust for user and industry preferences, technological enhancements, and best practices, as well as functional, non-functional and technical requirements. In addition, a list of feasible, viable and desirable program elements for a LA platform prototype need to be garnered from stakeholders, including an organization's membership and with consultation with Subject Matter Experts in test administration. Likewise, a full analysis by a psychometrician is recommended to develop a clearer understanding of how scoring, standards, feedback and administration of a LA program would function and behave. Financially, this may necessitate a conjoint analysis to better estimate and clarify the value and pricing of such a new assessment.

The results, culminating from the process described in this manuscript, of the LA Subcommittee were presented to the NBCRNA Board of Directors in October 2020, with the recommendation that the board consider exploring the operational considerations and development of a pilot study. The NBCRNA Board of Directors formed a task force and are currently exploring the possibility of conducting a pilot study.

Conclusion

For any organization considering strategies to improve their membership's lifelong learning, or an avenue to supplement or replace their current maintenance of certification, LA is a potential pathway that requires strategic and operational considerations before implementation. Ultimately any group or organization investigating this process is encouraged to tailor their exploration using any of the methods, tools and the program elements collated by the NBCRNA LA Subcommittee. It should be noted, however, that this venture is not a simple undertaking, and an encompassing process will be required by any group looking at instituting LA. LA may take time to develop, as with any new product development process. It is resource intensive both financially and in the time invested for the initial investigative/discovery phase, development and in the maintenance of a worthwhile assessment program. Certification organizations are encouraged to consider the process the NBCRNA took to initially investigate LA, as the findings substantiate that continued professional certification which incorporates a LA strategy can augment lifelong learning. However, it is not an assessment strategy that can be implemented without thoughtful planning, customization and continuous maintenance to sustain.

Declaration of competing interest

We have no known conflict of interest to disclose.

References

Advisory Committee on Interdisciplinary, Community-Based Linkages (ACICBL). (n.d.) Continuing education, professional development, and lifelong learning for the 21st century health care workforce 11th annual report to the Secretary of Health and Human Services and the U.S. Congress. https://www.hrsa.gov/sites/default/files/hrsa/advisory-committees/community-based-linkages/reports/eleventh-2011.pdf.
American Board of Medical Specialties. (2019a). Innovations in assessment, learning and improvement. In *ABMS Conference 2019, Chicago, Illinois* (September 23-25).
American Board of Medical Specialties. (2019b). Longitudinal assessment balances learning and assessment. https://www.abms.org/news-events/longitudinal-assessment-balances-learning-and-assessment/.
Bernstein, D. I., Wasserman, S. I., Thompson, W. P., & Freeman, T. M. (2016). ABAI's MOC assessment of knowledge program matures: Adding value with continuous learning and assessment. *American Academy of Allergy, Asthma & Immunology, 5*, 80–83. https://doi.org/10.1016/j.jaip.2016.11.017
Bridges, W., & Bridges, S. (2017). *Managing Transitions: Making the Most of Change.* Da Capo Press.
Dwyer, A., & Turner, A. (2019). Longitudinal assessment for recertification: Striking the balance between assessment and learning. In *Slide Presentation at: Virtual Exchange 2020.* Austin, TX: Institute for Credentialing Excellence (November 9–11).
Ferris, M., Gill, C., Preston, J., & Browne, M. (2021). Validity evidence for the Continued Professional Certification Assessment: Professional practice analysis of the National Board of Certification and Recertification for Nurse Anesthetists. *Journal of Nursing Regulation, 11*(4), 51–62. https://doi.org/10.1016/S2155-8256(20)30172-1
Hatala, R., Gutman, J., Lineberry, M., Triola, M., & Pusic, M. (2019). How well is each learner learning? Validity investigation of a learning curve-based assessment approach for ECG interpretation. *Advances in Health Sciences Education: Theory and Practice, 24*(1), 45–63. https://doi.org/10.1007/s10459-018-9846-x
IDEO Design Thinking (n.d.) Design Thinking Defined. Retrieved August 29, 2021, from https://designthinking.ideo.com/.
Kelley, P., & Whatson, T. (2013). Making long term memory in minutes: A spaced learning pattern from memory research in education. *Frontiers in Human Neuroscience, 7*, 1–9. https://doi.org/10.3389/fnhum.2013.00589
Kotter, J. (2012). *Leading change.* Harvard Business Review Press.
Larson, D. P., Butler, A. C., & Roediger, H. L. (2008). Test-enhanced learning in medical education. *Medical Education, 42*, 959–966. https://doi.org/10.1111/j.1365-2923.2008.03124.x
Leslie, L. K., Olmsted, M. G., Turner, A., Carraccio, C., Dwyer, A., & Althouse, L. (2018). MOCA-Peds: development of a new assessment of medical knowledge for continuing certification. *Pediatrics, 142*(6), Article e20181428. https://doi.org/10.1542/peds.2018-1428
Leslie, L. K., Turner, A. L., Smith, A. C., Dounoucos, V., Olmsted, M. G., & Althouse, L. (2019). Pediatrician perspectives on feasibility and acceptability of the MOCA-Peds 2017 pilot. *Pediatrics, 144*(6), Article e20192303. https://doi.org/10.1542/peds.2019-2303
National Board for Respiratory Care. (2020). Credential maintenance program: Maintaining your respiratory care credentials. Retrieved August 29, 2021, from https://www.nbrc.org/wp-content/uploads/2020/02/NBRC-CMP-Brochure.pdf.
National Board for Respiratory Care. (2019). Credential Maintenance Program (CMP) instructions for users. Retrieved August 29, 2021, from https://www.nbrc.org/wp-content/uploads/2019/11/CMP-Assessment-Instructions.pdf.
National Board of Certification and Recertification for Nurse Anesthetists. (2013). Health care survey – Harris Poll 2013. Retrieved August 29, 2021, from http://www.nbcrna.com/publications/press-releases-and-statements-archive/release-3.
National Board of Certification and Recertification for Nurse Anesthetists. (2020). NBCRNA Value of Credential Survey. https://www.nbcrna.com/docs/default-source/research-files/voc-full-report.pdf?sfvrsn=7178cb6a_6.
National Board of Certification and Recertification for Nurse Anesthetists. (n.d.). Background and history of the CPC program. Retrieved August 29, 2021, from https://www.nbcrna.com/continued-certification/background-history.
National Board of Certification and Recertification for Nurse Anesthetists. (n.d.). NBCRNA focus on research. Retrieved August 29, 2021, from https://www.nbcrna.com/research.
National Commission on Certification of Physician Assistants. (n.d.). Alternative to PANRE: A pilot program. Retrieved August 29, 2021, from https://www.nccpa.net/alternative-to-panre.
Price, D. W., Swanson, D. B., Irons, M. B., & Hawkins, R. E. (2018). Longitudinal assessments in continuing specialty certification and lifelong learning. *Medical Teacher, 40*(9), 917–919. https://doi.org/10.1080/0142159X.2018.1471202
Spence, D., Wicks, T., Wojnakowski, M., & Plaus, K. (2021). Benchmarking study on continuing certification in health care: Program variables, commonalities and trends. *Journal of Nursing Regulation, 12*(2), 34–40. https://doi.org/10.1016/S2155-8256(21)00054-5
Sun, H., Zhou, Y., Culley, D. J., Lien, C. A., Harman, A. E., & Warner, D. O. (2016). Association between participation in an intensive longitudinal assessment program and performance on a cognitive examination in the Maintenance of Certification in Anesthesiology Program®. *Anesthesiology, 125*(5), 1046–1055. https://doi.org/10.1097/ALN.0000000000001301

User Experience Questionnaire Team. (2018). User Experience Questionnaire. https://www.ueq-online.org/.

W. K. Kellogg Foundation. (2004). Logic model development guide. Retrieved on August 29, 2021, from https://www.wkkf.org/resource-directory/resources/2004/01/logic-model-development-guide#back=https://www.wkkf.org/resource-directory#pp=10&p=1&q=logic%20model.

Ward, R., Spence, D., Leonard, C., Barnhill, G., Sapp, A. & Choudhry, S. (n.d.). Evaluating continued certification and lifelong learning in healthcare: A literature review of longitudinal assessment [unpublished manuscript]. The National Board of Certification and Recertification of Nurse Anesthetists.