RESEARCH

Identifying the Presence of Cognitive Apprenticeship in the Layered Learning Practice Model

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Objective. To identify the presence of cognitive apprenticeship themes in the layered learning practice model (LLPM).
Methods. Attending pharmacists who had implemented an LLPM completed an individual 90-minute face-to-face semi-structured interview. Three researchers independently reviewed transcripts to identify cognitive apprenticeship themes according to the framework's dimensions and sub-dimensions.
Results. Of 25 eligible attending pharmacists, 24 (96%) agreed to participate. All core dimensions of the cognitive apprenticeship framework emerged during the interviews; however, preceptors varied in how they used the framework in the training of pharmacy learners at different levels. This variability was especially apparent within the sub-dimensions of the content and method domains.
Conclusion. This study demonstrates that all four cognitive apprenticeship principles are being used in the clinical environments operationalizing the LLPM. These findings suggest that cognitive apprenticeship is an applicable and relevant educational framework when engaging multiple learners in clinical education environments.

Keywords: layered learning practice model, cognitive apprenticeship, experiential education, clinical education, student pharmacists

INTRODUCTION

Preparing postgraduate pharmacy residents and student pharmacists to assume direct patient care roles is vital to improving patients' outcomes, as well as the future of pharmacy practice. The pharmacy residency accreditation standards of the American Society of Health-System Pharmacists for a postgraduate year 1 pharmacy residency program has a required competency that all graduates need to be able to "provide safe and effective patient care to a diverse range of patients."[1] Pharmacy curriculum accreditation standards have recently been refined to "ensure graduating student pharmacists are practice-ready and team-ready, that is, prepared to directly contribute to patient care working in collaboration with other health care providers."[2] Interestingly, the Practice Advancement Initiative (PAI), formerly the Pharmacy Practice Model Initiative (PPMI), also addresses the education and training of student pharmacists recommending "curricular changes are required in schools of pharmacy to prepare students for a significantly larger role in drug therapy management than is currently achieved in most hospitals and health systems."[3] Thus, pharmacy learners at different levels of their professional training must have intentional experiential learning opportunities within their curricula to foster development of expertise as integral team members engaged in the delivery of high-quality direct patient care.

The University of North Carolina (UNC) Medical Center Department of Pharmacy is committed to providing the highest quality of care to the citizens of North Carolina. In 2010, pharmacists at UNC Medical Center were highly integrated within inpatient medical teams

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and in the ambulatory care setting. At a time when a reformed health care system was rapidly shifting focus to quality and outcomes and within the context of the PAI, the UNC Medical Center Department of Pharmacy was committed to expanding care for patients in both the inpatient and ambulatory care settings; and the UNC Eshelman School of Pharmacy had a critical need to train and clinically immerse student pharmacists in direct patient care. Consequently, the Partnership in Patient Care was established which is a synergistic, interdependent collaboration between the UNC Medical Center Department of Pharmacy and the UNC Eshelman School of Pharmacy. This collaboration recognizes that pharmacy residents and student pharmacists are critical to delivering high quality, interdisciplinary team-based patient care. This collaborative relationship values and prioritizes the engagement of learners in organizational patient care initiatives, which led to the development and implementation of the Layered Learning Practice Model (LLPM), an innovative approach to involving learners in patient care.[4] The LLPM reframes the traditional clinical specialist model by integrating a service-based "pharmacy team" within the larger interdisciplinary health care team. Specifically, the LLPM pharmacy team includes an attending pharmacist responsible for all aspects of patient-centered care; postgraduate pharmacy residents (PGY-1 and/or PGY-2); and fourth professional year student pharmacists (P4).[4] Some LLPMs also incorporate clinical pharmacist generalist(s) and pharmacy technician(s).[4] With layered learning, the attending pharmacist and residents collaborate to train PGY-1 residents and students and engage them in providing care appropriate for their level of experience.

A comprehensive literature review identified four publications related to LLPMs. Delgado and colleagues described involving P4 students as clinical extenders at a community-based hospital; however, layered learning was not included as pharmacy residents were not incorporated.[5] Soric and colleagues developed and implemented an LLPM with one internal medicine group at a community-based hospital.[6] Bates and colleagues described knowledge-based and perception outcome data from 16 residents and students engaged in an oncology-based LLPM with experiential syllabus redesign.[7] More recently, Pinelli and colleagues described the collective implementation experiences of attending pharmacists engaged in implementing LLPM in hospital or health system pharmacy practice, including the origin, goal and purpose, structure, patient services provided, and team members' roles and responsibilities of the LLPM.[4] In brief, the attending pharmacist was viewed as responsible for providing oversight, organizing the experience, and setting expectations. The goal was that each team member was responsible for precepting the learner in the level below them. Pinelli and colleagues also described key attributes of an effective LLPM and potential barriers to implementation, and found that attending pharmacists viewed flexibility to tailor the experience to the local practice environment and shared goals, concepts and ways of teaching as critical to feasible implementation.[4]

Our literature search failed to identify any publication that described the development of a consistent educational framework for engaging learners in the LLPM. Work must be done to identify core educational principles that can both guide the operationalization of flexible LLPMs and inform teaching strategies that effectively promote the development of key skills and competencies. One framework that holds great promise for LLPM is cognitive apprenticeship, a collection of pedagogical principles and methods aimed at enculturating learners into authentic practices by teaching them to understand the nature of expert practice and to think like an expert practitioner.[8] The cognitive apprenticeship framework has the potential to move beyond the traditional *see one, do one, teach one* maxim by incorporating cognitive processes that make expert thinking "visible" to the learner by providing learning experiences that make implicit processes explicit.[8] Cognitive apprenticeships provide an ideal environment in which learners can develop the thinking skills required for expertise. The cognitive apprenticeship framework uses four interconnected dimensions of all learning environments that are required to develop expertise (Table 1): *content* (knowledge and thinking strategies); *method* (teaching strategies); *sequence* (how learning tasks should be organized and presented to promote increasing complexity and diversity); and *sociology* (the influence of situated and cooperative learning supported by learners' intrinsic motivation and communication).

In the health professions, researchers have advanced cognitive apprenticeship as a useful approach to the design, implementation, and evaluation of educational practices. Research suggests that cognitive apprenticeship can improve learner knowledge, skills,[9] and attitudes,[10] enhance feedback to clinical teachers,[11] and provide insights into the clinical learning environment.[12] In addition, learning models derived from cognitive apprenticeship have been positively received by learners,[13,14] faculty,[15] and patients.[16]

The objective of this study was to use rigorous qualitative methods to identify the presence of cognitive apprenticeship themes in the LLPM according to the framework's dimensions and sub-dimensions, and

Table 1. Cognitive Apprenticeship Model

Content	Types of Knowledge Required for Expertise		Example Quote	LLPM Application
	Domain knowledge	Subject matter specific concepts, facts, and procedures	And [the students] need to be on rounds because they need to be learning in order to meet my expectations of knowledge. And they need to be reading about their patients, and they need to be doing all those things so that whenever they talk to me they know what's going on from a disease state [perspective].	Ask learners to document disease state and medication knowledge (eg, common indications, dosing, potential precautions).
	Heuristic strategies	Generally applicable techniques for accomplishing tasks	We're having to teach them how to interview patients, speak the right language to patients, learn the processes; I encourage our learners to listen, identify those medication-related problems that the patient has specified, and then follow up with that in the afternoon. . .go talk to patients.	Teach learners how to complete a task (eg, medication history interview).
	Control strategies	General approaches for directing one's solution process	I expect my learners to look at several different lists. . .I want the learner to evaluate all three of those lists to see how they match up or any sort of reconciliation that we need to do among those lists.	Help learners identify approaches to problem solve (eg, reconciling conflicting information in the medical record).
	Learning strategies	Knowledge about how to learn new concepts, facts, and procedures	I'm like, if you don't know a mechanism, what they're used for. . .you should be looking, not just collecting the history, but looking up and learning from those medication lists.	Teach learners processes to engage in self-directed learning (eg, conducting systematic, efficient, and thorough drug information searches).
Method	**Ways to Promote the Development of Expertise**			
	Modeling	Teacher performs a task so students can observe	Let them watch your behavior, how you interact with the team, how you round, you set your expectations; then I'll go and model for them and show them how do you ask appropriate questions and how do you rein the conversation in. . .	Perform a task (eg, interaction with the interprofessional care team) by having the learner observe.
	Coaching	Teacher observes and facilitates while students perform a task	In our patient reviews, I typically am the one responsible for asking follow-up questions and pointing the learner in the right direction.	Facilitate learner performing a task (eg, patient case presentation) by asking guiding questions and providing suggestions for next time.

(*Continued*)

Table 1. (*Continued*)

Content	Types of Knowledge Required for Expertise		Example Quote	LLPM Application
	Scaffolding	Teacher provides supports to help the student perform a task	I point out things that they're missing or things that should be looked at, or if they're making certain recommendations that I find need fine-tuning, we talk about that.	Help learner complete portions of the patient care plan that the learner isn't yet able or qualified to complete.
	Articulation	Teacher encourages students to verbalize their knowledge and thinking	We talk about, *Well, why is that question important?* And *how does that relate to drug therapy?* Like, they're telling you that these glucose readings are high, then *how's that affected by medicine?*	Encourage learner to verbalize their knowledge and thinking related to a task performed (eg, evaluation of medication therapy).
	Reflection	Teacher enables students to compare their performance with others	No quotes identified	Ask learner to reflect on their performance.
	Exploration	Teacher invites students to propose and solve their own problems	No quotes identified	Motivate the learners to generate solutions for improving a task they performed at the institution.
Sequencing	**Keys to Ordering Learning Activities**			
	Increasing complexity	Meaningful tasks gradually increasing in difficulty	Ideally they go in together, and that happens in the beginning, but then we want the student to have some autonomy, so we want them to learn how to interview without anybody in the room. . .	Provide learner with more autonomy in performing a task (eg, comprehensive medication review) once competency is demonstrated.
	Increasing diversity	Practice in a variety of situations to emphasize broad application	I tend to give them patients that have broader disease states that they're going to see on other rotations.	Ask learner to practice a task on varying but related situations (eg, patient cases).
	Global to local skills	Focus on conceptualizing the whole task before executing the parts	But what we educate learners on is that it's more than just that primary problem. We have to look at the whole patient.	Have learner focus on performing an entire task (eg, working up the whole patient case) before delving deeper in specific parts (eg, disease states).
Sociology	**Social Characteristics of Learning Environments**			
	Situated learning	Students learn in the context of working on realistic tasks	I'm able to get them involved in more active patient learning. I'm able to get them involved in doing things that pharmacists should be doing...	Ensure learner is exposed to real world tasks.

(*Continued*)

Table 1. (*Continued*)

Content	Types of Knowledge Required for Expertise		Example Quote	LLPM Application
	Communities of practice	Communication about different ways to accomplish meaningful tasks	. . .that there can be different ways to it for different services and different patient populations...	Engage learner in conversations regarding the selection of various medication therapy options.
	Intrinsic motivation	Students set personal goals to seek skills and solutions	I usually have them set goals so we make sure to accomplish what they want to accomplish for the month.	Have learner set goals for the experience at the beginning.
	Cooperation	Students work together to accomplish their goals	It's nice to have another learner with them because then they can spend more time and work through the problems together.	Have learners (eg, residents and pharmacy students) collaborate on various practice- related tasks.

categorize these emerging themes according to pairs of the LLPM individuals, including preceptor-resident, preceptor-student, and resident-student.

METHODS

To be eligible, the attending pharmacist must: be an acute or ambulatory care clinical pharmacy specialist, have responsibility and oversight of clinical patient care services, serve as a preceptor for resident and student learners, and have developed and implemented an LLPM service-based pharmacy team consisting of PGY-1 and/or PGY-2 resident(s) and P4 students. Participants were identified by examining the master LLPM learner rotation schedule for the 2011-2012 and 2012-2013 academic years and verified via self-report by the attending pharmacist. Eligible attending pharmacists were invited in person by the study principal investigator to participate in individual face-to-face, semi-structured, 90-minute interviews conducted in a private room located within a 5-minute walk of their clinical practice sites; participants were provided a $50 honorarium for their time. Before each interview, participants provided written informed consent and completed a demographic questionnaire. The study principal investigator used a semi-structured interview guide developed collaboratively by the interdisciplinary study team that explored three key topics related to the LLPM: team composition, roles and responsibilities set for team members, and methods for incorporation of the concept of layered learning. Interviews were digitally recorded and transcribed verbatim without personal identifiers. The study and consent procedures were reviewed and approved by UNC's Institutional Review Board.

Medians and interquartile ranges (for continuous variables) and percentages (for categorical variables) were used to characterize the participants. Content of the transcripts was analyzed qualitatively using the directed content analysis approach.[17] Three researchers independently analyzed transcripts using coding based on the categories and subcategories of the cognitive apprenticeship framework (Table 1).

As shown in Table 1, the *content* category of the framework involves types of knowledge required for expertise and is subcategorized as domain knowledge (eg, disease and drug specific knowledge), heuristic strategies (eg, "tricks of the trade" or ways in accomplishing various pharmacy tasks), control strategies (eg, processes used to develop solutions such as performing clinical decision making to select therapy), and learning strategies (eg, processes for learning new concepts, facts or procedures such as using drug information skills to engage in self-directed learning).

The *method* category includes various ways to promote the development of expertise, such as modeling (eg, performing a patient interview with learner observing), coaching (eg, asking probing or follow-up questions during patient case presentations), scaffolding (eg, completing development of an assessment and plan that the learner is not yet able to do), articulation (eg, asking the learner to verbalize rationale for recommended therapies), reflection (eg, asking the learner to compare his/her performance relative to an expert clinician in the practice environment), and exploration (eg, giving the learner room to frame and solve problems on their own).

The *sequencing* category describes keys to ordering learning activities, such as increasing complexity (eg, asking the learner to manage general medicine before

specialized patient populations) and increasing diversity (eg, over time asking the learner to communicate with additional stakeholders including the interprofessional team and patients/caregivers).

Sociology embodies the social characteristics of the learning environments, including situated learning (eg, learn in the context of patient care), communities of practice (eg, communicating about different ways to accomplish a task), intrinsic motivation (eg, engaging learners in personal goal setting), and cooperation (eg, learners work together to accomplish problem solving).

Coding was performed iteratively in two stages. In the first stage, general characteristics of cognitive apprenticeship in the LLPM according to the framework's dimensions and sub-dimensions were identified. In the second stage, the focus was on the patterns of specific themes based on pairs of relationships between individuals within LLPM (ie, preceptor-resident, preceptor-student, and resident-student). A series of meetings among the three raters were held to compare coding notes and to reach consensus on any discrepant coding. Selected quotes from the semi-structured interviews were chosen to reflect the four dimensions of the cognitive apprenticeship framework.

RESULTS

We identified 25 eligible attending pharmacists, 24 (96%) of whom agreed to participate. A description of the participants is presented in Table 2.

All four core dimensions of the cognitive apprenticeship framework emerged during the interviews (Table 1). The *content* category of the cognitive apprenticeship framework was addressed collectively between the preceptor, resident, and student and in pairs of LLPM members. Specifically, preceptors engaged students across a breath of domains and strategies while engaging residents with more depth in strategy areas. Preceptors appeared to focus on heuristic and learning strategies in their training of residents and intentionally apprenticed residents to be preceptors. For example, one preceptor said, "making sure they [residents] have all the tools they need to move forward to the next rotation and to life and to being a pharmacist." Preceptors indicated that residents provided some training and oversight of students related to domain knowledge and strategy development.

Methods of cognitive apprenticeship were prevalent in the data, with clear delineations between how this dimension is implemented among pairs of the LLPM. Preceptors focused on articulation as a primary method for developing expertise in all learners. Modeling and coaching emerged themes for the preceptor-student pairing. As one preceptor said, "Initially it's pretty much they're watching. I'm talking about the first week or so. I try to step back as best I can. . .but I am always kind of there in the background." In their engagement with residents, preceptors tended to use scaffolding and fading more often. Residents also played a key role in modeling, coaching, and articulation with students.

Sequencing was also a prevalent theme, with increasing complexity and global to local skills as common apprenticeship approaches. Preceptors tended to increase complexity for residents over time by growing the patient load with a focus on more sophisticated tasks associated with patient care. Preceptors also tended to increase complexity for students but emphasized the importance of conceptualizing the whole task (or patient) before focusing on more discrete aspects or parts of the patient care process. Residents played a role in helping students manage increasingly difficult tasks. For example, one preceptor said, "So at the beginning, it's more usually the pharmacy resident coaching and modeling for the student

Table 2. Demographic Characteristics of Attending Pharmacists Involved in the Layered Learning Practice Model[a]

Gender, female, n (%)	16 (66.7)
Postgraduate training completed, n (%)	
PGY-1 and PGY-2	7 (29.2)
PGY-1 only	6 (25.0)
PGY-1 and PGY-2 plus fellowship/ graduate degree	4 (16.7)
Specialty PGY-2 only	3 (12.5)
Graduate degree	2 (8.3)
No postgraduate training	2 (8.3)
Board certified, n (%)	18 (75.0)
Board certified with added qualification, n (%)	2 (8.3)
Years of experience, median, IQR	7 (4.8, 12.5)
Years of experience at current institution, median, IQR	5 (3.6, 13.3)
Practice setting, n (%)	
Acute care	19 (79.2)
Critical care	8 (42.1)
Non-critical care	11 (57.9)
Ambulatory care	5 (20.8)
Clinical specialty, n (%)	
Medicine	14 (58.3)
Surgery	4 (16.7)
Oncology	3 (12.5)
Pediatrics	3 (12.5)

[a]PGY-1=postgraduate year 1; PGY-2=postgraduate year 2; IQR=interquartile range

and then we'll transition to the student having more and more active role in the visit."

Since the LLPM is found in real world practice settings, the *sociology* dimension was an implicit aspect of the educational model (ie, situated learning). It also was explicitly described in some comments about the social characteristics of the learning environment. Cooperation and communities of practice were common social characteristics across all layers and pairings of the LLPM, with preceptors commonly acknowledging these elements as core to the development of expertise. However, unlike the other dimensions, the social characteristics described in the LLPM primarily extended across all levels and pairings of learner and preceptor, with less discrimination found by pairings.

DISCUSSION

Cognitive apprenticeship has been previously applied across various disciplines (eg, pharmacy, nursing, medicine, and veterinary medicine) and settings (eg, classrooms, clinical, and online).[15,18-21] Additionally, the framework has also been used as a theoretical framework for designing learning environments[9] and in analyzing teaching and learning practices.[22,23] This is the first study to demonstrate that all four cognitive apprenticeship principles are being used in the clinical environments operationalizing the LLPM.

Although these principles are widely used in LLPM, we found that preceptors vary in how they train pharmacy learners at different levels. This variability was especially apparent within the *content* and *method* domains. In terms of *content*, preceptors discussed engaging student pharmacists in developing expertise in learning therapeutic content and applying that content to the patient care process. In contrast, preceptors reported using heuristic and learning strategies to prepare pharmacy residents to serve as preceptors upon completion of postgraduate training. Within the *method* domain, preceptors commonly used modeling, coaching, and articulation with all levels of learners. Scaffolding and fading tended to be more prominent methods used in resident level learners. Reflection and exploration were not identified as methods currently used to promote development of expertise in either set of learners.

Our findings provide a framework for designing and implementing cognitive processes in the context of the LLPM. The theory of cognitive apprenticeship was introduced by Collins and colleagues to describe a set of teaching approaches that emphasize pedagogical strategies that experts use to teach complex tasks; and cognitive and meta-cognitive processes and skills required for expertise.[24] Cognitive apprenticeship encourages the use of authentic learning activities that empower learners to better understand and modify their own thinking processes. Cognitive apprenticeship can be used to develop a more consistent approach to experiential training while preserving flexibility across practice environments. Preceptors should identify the type of *content* knowledge and strategies required by the level of the learner to foster expertise in their clinical practice environments. Preceptors should identify the *methods* needed to promote development of expertise, starting the experience with modeling, coaching, and articulation and progressing through higher levels of scaffolding, reflection and exploration. Incorporation of principles such as *sequencing* by level of learner and time of the academic year as well as defining opportunities for learners to set goals, engage in cooperative situated learning, and reflect on different ways to accomplish meaningful tasks should also be considered.

More broadly, there is an opportunity to strengthen clinical education through use of sound/validated educational frameworks. Apprenticeship is an inherent aspect of clinical education and cognitive apprenticeship is one approach that can help to inform the use and operation of the core domains associated with training learners to become experts in authentic learning environments. For example, some cognitive apprenticeship elements did not emerge as themes in this data such as incorporation of reflection and exploration. This may present an opportunity to modify the delivery of the LLPM to foster the development of these skillsets among learners.

This study had a few limitations that limit generalizability. First, the sample included 24 attending pharmacists practicing in a single academic medical center with postgraduate training resources. Second, the sample included several early adopters of the LLPM who were committed to embracing an innovative practice model. Finally, this study did not capture perceptions of other key members of the LLPM, including PGY-1 and/or PGY-2 resident(s) and P4 students.

CONCLUSION

The LLPM was designed to foster development of the expertise and skills needed to provide high quality, team-based, patient care. This study suggests cognitive apprenticeship is an applicable and relevant educational framework when engaging multiple learners in clinical education environments, while preserving flexibility in design to allow preceptors to tailor experiences to the local practice environment. Future research and educational efforts should focus on training preceptors to tailor the theory and methods of cognitive apprenticeship to the practice environment, assessing implementation fidelity of these methods in practice, engaging in continuous quality improvement to enhance the model, and measuring

educational outcomes associated with engaging pharmacy learners in a consistent model of clinical education.

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