Cognitive Mapping Utilized With An Online Training Program: Developing A Conceptual Framework For Learning and Performance Outcomes in An Online Learning Program

Richard Fiene, Sarah Dore, Karl Kapp, Breanna Grable, Carlo Panlilio, Robert M. Hamm, Chengwu Yang, Erik B. Lehman, Claudia Mincemoyer, Nicole Verdiglione, Benjamin Levi

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Discussion of the Model

Much has been written about the benefits of spaced practice and spaced retrieval (need citations) and much has been written about the nascent field of gamification (need citations). However, there seems to be a dearth of literature on how to create a multi-year curriculum to be distributed via distance learning incorporating spaced practice, spaced retrieval and gamification (need citation about dearth of info).

This article outlines a model created to distribute materials to childcare workers across the state of Maine. This model has been successfully deployed and can serve as a model for non-profits and other organizations who are distributing content via a distance to personnel who are not direct employees of the organization. This challenge brings with it curriculum issues (What is the right content format and information to include in the curriculum), motivational issues (How do you motivate non-employees to participate?) and technological issues (How do you leverage technology that is accessible and available for all potential learners?) To address those issues we've created a model (cognitive map) to converge the three areas to provide the right distance learning approach for childcare workers in the State of Maine.

The next section of this paper discusses the three areas of the model individually.

Instructional Design

To understand the development of the large scale curriculum map for microlearning, it's important to understand how spaced retrieval, retrieval practice and learner mastery fit into the design of the process.

The design of the instruction is an important aspect of creating an effective model. There is a large body of research indicating the effectiveness of spaced practice and spaced retrieval for learning (kerfoot, shaw,etc). However, one element missing is a systematic approach to designing an overall curriculum map to determine the delivery of the right mixture of practice questions, triggering information, articles and other related materials provided at spaced intervals over time.

<u>Spaced Retrieval</u>

Web and mobile technologies have allowed small bits of content delivered via technology to be provided to learners using the concept of spaced retrieval. This concept involves providing students with course content spaced over time and has been shown to be an effective tool for aiding student retention (Carpenter & DeLosh, 2005). This is in contrast to mass practice where a learner attempts to learn a large amount of content all at one time. The methodology used in many professional development settings. The problem with mass practice is that the succeeding and preceding content can interfere with the learning of the new content and fatigue can set in. Spaced retrieval is effective when engaging learners with content over an extended period of time and when reinforcement of the content is important for learning and application. The use of spaced retrieval appears to be growing in popularity with the advent of such computer adaptive instructional models as ALEKS (Doignon & Falmagne, 1985) and LearnSmart (McGraw-Hill, 2013).

The greater the amount of spacing between retrieval events, the greater the potential benefit to retention. Spaced retrieval helps learners retain access to memorized information over long periods of time because the spacing promotes deeper processing of the learned material. Ideally, the time between the learning events is greater than 24 hours, but shorter times have also been found to be effective. As long as eight years after an original training, learners whose practices were spaced showed better retention than those who practiced in a more concentrated time period (Clark & Mayer, 2011).

Within an instructional setting or context, the learner could log onto a website or open a mobile application and be presented with content that they need to learn. The student may earn points for reviewing the content. The next day, the student would log back into the application or website and be presented with a review of the content and new related content. This would continue until all the required content was covered.

Retrieval Practice

Retrieval practice requires learners to recall information rather than simply reread or re-listen to it. Retrieval practice primarily uses tests or quiz questions as a means of requiring students to recall previously learned information. As an example, the learner is provided with a quiz question, asked to answer it, and given points, badges, or some other type of reward for correctly doing so. This is primarily used where students' learning is measured through performance on quiz questions and they are rewarded as the content is correctly recalled and eventually mastered. This process does involve repeating missed questions until the student gains mastery of all the content. Retrieval practice within the context of seems works best when content is required to be memorized and recalled.

A review of the pertinent scientific literature reveals that the benefits of retrieval practice have been known for at least 100 years and have been demonstrated with many diverse groups (Larsen et al., 2009). Modern computer systems with there ability to record student answers and keep track of performance, allows the learner to engage in the process and answer questions as they are presented in an engaging manner.

Retrieval practice improves student recall performance (Dobson, 2013). Using quizzing as a

technique for learning forces the learner to recall content learned previously, and the act of retrieving information from memory actually alters the retrieved memory by strengthening the existing memory trace and/or creating additional retrieval routes. One consequence of these changes is that the probability of successful retrieval in the future is increased, making testing a potent mechanism for enhancing long-term retention (Roediger & Butler, 2013). In essence, the quiz is the game element the student encounters, and answering the questions triggers additional game elements like points or badges.

As an example of this technique, is when a learner receives a quiz question on a daily basis and he or she answers the question. If the learner answers incorrectly, he or she is provided with immediate corrective feedback based on the answer. The question is then placed back into the pool of questions and will be given randomly to the leaner in the future.

Goal Orientation

For the iLookOut project, there were two types of goal orientation: performance orientation and mastery orientation (Blair, 2012). Each of these two types of goal orientation has an impact on how achievements awarded to learners should be constructed. Students who favor a performance orientation are concerned with other people's assessment of their competence. Students who have a mastery orientation are concerned more with improving their proficiency.

To balance student predisposition towards performance orientation, effective learning environments instill a mastery orientation in the goals and feedback they create. Creating a mastery orientation means that learners will more readily accept errors and seek challenging tasks, providing them with the opportunity to develop their competencies. When given mastery goals, learners will have higher self-efficacy and utilize more effective strategies. Students given mastery-oriented goals perform better on complex tasks (Winters & Latham, 1996). To foster mastery orientation, learners should be required to earn achievements that acknowledge effort put forth and support them during challenges. Errors and mistakes should be treated as opportunities to provide diagnostic feedback and encouragement.

Mastery Learning

Simultaneously the goal and the process of learning with a large-scale curriculum are progression through content. The learner masters an enabling objective on his or her way to eventual mastery of the terminal objective. Underlying this mastery learning approach is a philosophy asserting that under appropriate instructional conditions virtually all learners can master what is taught (Block & Burns, 1976; Bloom, 1971). The basic concept of mastery learning is that instruction is organized into discrete units where it's possible to master the discrete unit before moving to the next unit. The method of moving through the instruction is based on ungraded assignments with formative evaluation as a tool for identifying what is learned and what is yet to be learned and then providing additional support for concepts that have not been mastered (Bloom, 1971; Melton, 2008).

Mastery learning provides an approach that recognizes that aptitude for learning may be more closely linked to time and perseverance than to ability (Bloom, 1971; Melton, 2008). This is

similar to the idea underlying the concept of criterion-referenced tests, which is to assess the performance of each test-taker without regard to the performance of others (Shrock & Coscarelli, 2007). There is no limit to the number of learners who can succeed on a criterion-referenced test, as opposed to a norm-referenced test, which strives for a bell-shaped distribution curve, meaning some students pass and others fail regardless of mastery on the test. The curriclum design process we used for iLookOut uses criteria and levels of mastery to advance the learner from one element of the instruction to the next.

Motivational Approach

The motivational elements of the model are built on Self-Determination Theory utilizing gamification and badging.

Self-Determination Theory

The motivation foundation for the model is based on the Self-Determination Theory. Self-Determination Theory (SDT) is a macro-theory, which explains human motivation to perform a task or an activity as being internally driven as opposed to the externally driven theory of operant conditioning.18 The theory has been used to describe motivation in a broad range of human activities including sports, healthcare, religion, work, and education.

Self-Determination Theory addresses factors that either facilitate or undermine motivation. The theory has several sub-theories including cognitive valuation theory, which proposes that events and conditions that enhance a person's sense of autonomy and competence support intrinsic motivation. And that factors that diminish perceived autonomy or competence undermine intrinsic motivation.

One of the first elements of SDT is autonomy which is the feeling a person has that they are in control and can determine the outcome of their actions. It is the feeling of having control over one's actions and is an integral part of SDT.

Another key aspect of the theory is competence. The concept of competence is defined as a need for challenge and a feeling of mastery. Cognitive evaluation theory proposes that factors enhancing the experience of competence, such as the opportunity to acquire a new skill or the chance to be appropriately challenged enhance perceived competence and, in turn, are intrinsically motivating.

The third major element in SDT is the concept of relatedness. Relatedness is experienced when a person feels connected to others. This can happen most often in an online multiplayer game, but it can also happen when two or more friends are playing a video game together. Researchers have found evidence that "the psychological 'pull' of games is largely due to their capacity to engender feelings of autonomy, competence and relatedness, and that to the extent they do so they not only motivate further
play, but also can be experienced as enhancing physiological wellness."19

In terms of our model, there is evidence to indicate that "badges, leaderboards, and performance graphs positively affect competence need satisfaction, as well as perceived task

meaningfulness, while avatars, meaningful stories, and teammates affect experiences of social relatedness."(Sailer et. al, 2017).

Badging

This has informed our decision to use badging to show progress to the CCPs. This is due to the fact that the curriculum unfolds over a long period of time. Therefore, it's important to demonstrate to the leaner, that they are, indeed, making progress toward mastery of the content and skills to be learned. The act of receiving a badge for making progress through the content provides a visual indication of progress. The design of the curriculum orients the learner to where they are in the instructional process, where they are going, and how much further they have to go until the end. The concept is that the learner is able to "see" progress and receives tangible recognition of their progress in the form of a badge and a level indication (Kapp et al., 2013).

Gamification

Gamification has been defined as the "use of game design elements within non-game contexts" (Deterding, Dixon, Khaled & Nacke, 2011, p. 1). Gamification has also been described as game based elements that are utilized in a non-game settings (Dominguez et al., 2012) for example, using achievements, badges, or experience points in corporate educational efforts. Al-Azawai et al. (2016) make the distinction between games and gamification techniques by explaining that gamification actually makes learning a game whereas game based learning is using a game during learning. For an instructional context, the most relevant definition is one that combines elements from the above definitions and defines gamification as "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp, 2012, p. 10).

The central idea is to take the 'elements of games, and to implement these in real-world situations, often with the goal of motivating specific behavior within the gamified situation. Many authors see gamification as an innovative and promising concept that can be applied within a variety of contexts (Werbach & Hunter, 2012; Zichermann & Cunningham, 2011; Zichermann & Linder, 2013.), however, there is a dearth of research on the impact of gamification on CCPs.

We've used the technique of gamification to deliver the contents to the CCP's in a variety of approaches centered around using game elements for motivation. This includes providing points, badges for progress and even leaderboards among the CCPs.

The iLookOut Model Utilizing Cognitive Mapping

Cognitive Mapping has been used in many different venues and as a tool in several areas, such as, planning health research (Stadler, et al, 2013), and engineering (Dixon & Lammi, 2014) are two examples in which very complex relationships can be reduced to key elements that can be easily manipulated to make certain that all relationships can be seen and measured. The purpose of this article is to demonstrate its use in an online training program "***iLookOut for Child Abuse Prevention Program***" for early care and education providers (aka, early childhood educators, childcare workers, early childhood

professionals) by demonstrating how the cognitive map will a blueprint for what a trainee needs to learn, and what the curriculum needs to cover via child abuse prevention learning modules.

Cognitive Mapping was first introduced in 1948 by Edward Tolman, an educational psychologist, (Tolman, 1948). Originally, it was used to explain how rats learned the locations of rewards in a maze and as such generated a practical model for mapping the environment.

The advantage of Tolman's work is a move away from a simple S-R relationship and the demonstrated "latent learning" with rats in maze learning where non-reinforced rats still learned about the maze by exploring the maze. By including a cognitive component, we begin to see the move toward a social cognitive framework by including cognition as an important aspect of learning. By bringing in cognition, we are able to further explore learner characteristics that help improve learning (e.g., self-regulated learning components of goal-directedness, motivation, goal feedback, etc.). An important component of learning is outcome expectations (Schunk & Zimmerman, 2006), which is rooted in Tolman's concept of field expectancies. According to this notion of expectancies, a learner is able to anticipate contiguous relations between stimulus and response. For example, lightning is followed by thunder. Field expectancies helped people form cognitive maps, which are internal representations of these expectancies along with the selection of actions needed to help learners attain their goals.

The notion of latent learning is important because learners may not demonstrate adequate learning and performance outcomes during the process of learning. Yet the learning activity is important for acquisition of knowledge that learners may use at a later time. This could be at the summative assessment period or, more relevant for our participants, at the time that they are in classrooms and working with infants and toddlers. According to a Social Cognitive framework, learners will act in a manner that is believed to be successful and will orient toward viable observational or learning models that will provide the important skills or tools to ensure success. Thus, cognitive maps help with this process. This is where the cognitive maps developed for iLookOut can help so that by understanding how we guide our learners through a more efficient development of this map, rather than relying on individual differences in map formation, we can ensure that learners can develop the necessary and more efficient means to respond to abuse and neglect scenarios in the classroom (i.e., displaying latent learning).

By definition "cognitive maps" are literally just mental or conceptual models, "thinking maps" that like other forms of cartography maps territory. But here it is cognitive "territory" rather than geographic terrain that is being characterized. Sometimes, cognitive maps provide a linear progression of a concept, or the relationships between various factors. But they also can serve a developmental purpose, helping people (be they researchers, policy makers, teachers, or learners) develop a deeper understanding of how different elements are (or should be) related to one another.

There are many applications of cognitive maps, here are some examples that have been used in the past: 1) Perceptual, such as - a. Inquiring, investigating, gathering data or information; b. Noticing, attending to, becoming aware of; c. Differentiating, distinguishing, discriminating. 2) Cognitive, such as - a. Organizing data, sorting, chunking, finding patterns and relationships; b. Interpreting data, understanding it, making sense of it, what it means; c. Analyzing data, reasoning about it; d. Troubleshooting, diagnosing; e. Drawing conclusions; f. Framing, reframing; g. Illuminating, insights, clarity; h. Estimating probability, confidence levels, degrees of certainty. 3) Evaluative, such as - a. Evaluating, assessing, judging anything; b. Evaluating performance, effectiveness, success (relative to a Purpose); c. Predicting likelihood and degree of future success; d. Assigning importance, urgency, priority; e. Providing feedback, including monitoring and measuring progress. 4) Volitional, such as - a. Identifying desires; b. Defining or clarifying purposes; c. Planning. 5) Behavioral, such as - a. Acting, behaving, performing (relative to a

Purpose); b. Implementing a plan (performance relative to a Purpose); c. Communicating; d. Learning knowledge; e. Building or improving skills; f. Developing.

Of these various applications of cognitive mapping, this article will focus on the development of a cognitive map for the iLookOut program for the following purposes: coordinating learning knowledge, implementing a plan, predicting likelihood and degree of future success, providing feedback, monitoring and measuring progress, evaluating and assessing achievement, organizing data, and finding patterns. As such, this article will provide the details of how the process was developed and applied to an online training program to help prevent child abuse: ***iLookOut for Child Abuse Prevention Training Program***.

So more specifically, the cognitive map helps to organize the development of the iLookOut curriculum and will focus on the following elements as delineated in the above topical list:

-Discriminate ––i.e., to distinguish different concepts learning points

-Finding patterns and relationships ––i.e., to demonstrate associations between various components

-Measuring progress ––i.e., to map learners' actual progress through different stages of learning (particularly with regard to the pinging, which is sequential)

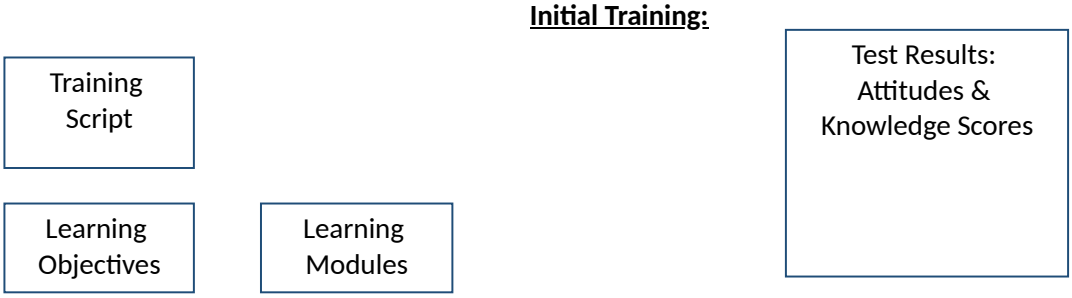
-Clarifying purposes ––i.e., to clarify the purposes of various components of the learning program, pinging activities, etc.

-Building or improving skills ––i.e., to create a framework for how learners will progress through various activities so as to develop their skills

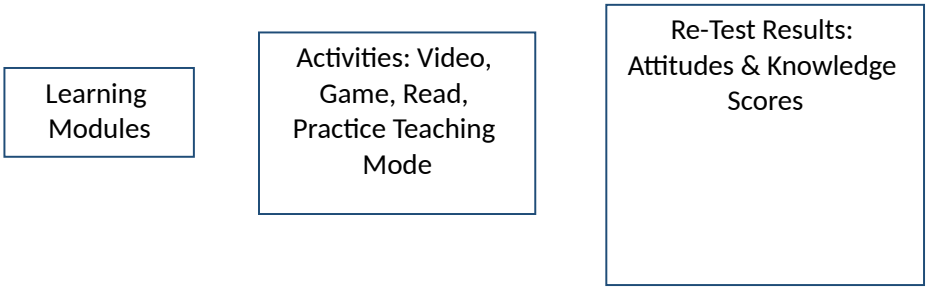
METHODOLOGY

This section will provide an overview of and detail about the methodology used in creating the cognitive map and the schematic formatting in moving from learning modules to actual activities utilized online. Figure 1 provides an overview cognitive map in summary format to demonstrate how all the key elements to the ***iLookOut Training*** program fits together into a unified whole.

Figure 1 - Cognitive Map in Summary format.



Follow-Up (Pinging):



Badging and Behavior Change:

And hopefully behavior changes

The above cognitive map depicts moving from the initial learning objectives and all the subsequent steps for developing the learning modules, training script, and activities. It also shows how these various components are assessed via attitude and knowledge assessments. The following figures will provide the details of the sequencing presented in the above cognitive map giving the reader a blueprint to follow in developing the actual activities used in the learning program and follow-up reinforcement.

Figures 2 and 3 provide the details of the mapping that occurred from learning modules and objectives to the actual activity plans for pinging.

Figure 2 - Template/Chart of Learning Modules, Objectives

Figure 2 clearly shows the relationship between the various learning modules, objectives and the assessment process used in the training program. This figure helps the curriculum planner to make certain that all the learning objectives of the program are within the script and learning modules and will be accessed via knowledge or attitudinal tests.

Learning Objectives (LO) of iLookOut	Script Intervention & Learning Modules (LM)	Learning Module Type	Knowledge Test (KT) Conceptual Areas	Attitudinal Items
Orientation to iLookOut	(LM-0) “Learning Module Orientation”	Optional Slide		
	(LM-2) “Key Questions”	Slide with VO		
	(LM-3) “State Specific Requirements”	Slide with VO		
	(LM-4) “iLookOut Course Worksheet”	Slide with Insturctions and Resource File Handout #1: iLookOut Course Worksheet		

Based upon the learning that occurs in the above figure, follow-up learning via a Pinging delivery model in which very short and targeted activities are used to reinforce any learning that may be lacking based upon the scores from the knowledge and attitudinal assessments. These are presented in figure 3 below.

Figure 3 - Activity Plans Chart for Pinging

Figure 3 demonstrates how the learning modules can be sequenced into online learning activities that help to support these modules and objectives. This figure lists the topic for each week along with the module taken from Figure 2 along with the activity name and actual location within the learning platform and the primary teaching mode.

TOPIC	WEEK	MISSION/MODULE NAME (CODE)	MISSION/MODULE NAME (FRONT END)	ACTIVITY NAME	mLevel LOCATION	PRIMARY TEACHING MODE
				If You Don’t	PathFinder	
If You Don’t	Learnin		"If You Don't	Who Will		

Don't Who Will	g Program	LP1	If You Don't, Who Will"	Certificate of Completion	External Link	Video
(1)Types of Child Abuse	**1**	Y1M1a	Director Message: Types of Abue	What to Expect: Month 1	PathFinder	Game
		Y1M1	Module1	iLookOut Pinging Program	Pathfinder	Game
				Welcome Video	Go Animate Video	
				Types of Abuse	Pathfinder	
	2	Y1M2	Module 2	Video: Types of Abuse	Go Animate Video	Video
				Video Check - in: Types of Abuse	Block Party	
	3	Y1M3	Module 3	Child Abuse Reading	External Link	Reading
				Check In: Types of Child Abuse	Checkpoint	
	4	Y1M4	Module 4	In Practice: Types of Abuse	custom Task	In-Practice
				Check In: In Practice	External Link (RedCap)	
				Congratulations!	Custom Task	

CONCLUSION/IMPLICATIONS

This article briefly describes the utilization of cognitive mapping as an organizational and conceptual model to clearly delineate the relationships between Learning Objectives, Learning Modules, and Pinging Activities in an online delivery system of training on child abuse prevention called ***iLookOut for Child Abuse***. A cognitive map is more broadly based and flexible than utilizing more linear modeling, such as developing an outline.

Sharing this process is to demonstrate to other researchers who may be interested in doing assessments or evaluations of professional development, training or technical assistance interventions a process that can be used empirically to determine how the various components within an online program are related. Based on the process, it will provide potential paths to

assessing the best combination of activities in an individualized learning paradigm for each learner.

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Members of the iLookOut Research Team, College of Medicine, Penn State Hershey:

Carlomagno Panlilio, PhD 1; Chengwu Yang, MD PhD 2; Nicole Verdiglione 1; Claudia Mincemoyer 1; Sarah Dore 1; Breanna Grable 1; Richard Fiene, PhD 1; Erik Lehman 1; Robert M. Hamm, PhD 3; Benjamin Levi, MD PhD 1; Karl Kapp 4.

(1 Penn State; 2 New York University; 3 University of Oklahoma; 4 Bloomsburg University).