APPLYING LEARNING THEORY PRINCIPLES IN THE DESIGN OF EFFECTIVE LEARNING OBJECTS

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by

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ABSTRACT

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This Design-based research study aimed to develop a design framework that would help learning designers to apply learning theory principles when designing learning objects. The study examined the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop the iterative learning development (ILD) model. Several iterations of testing and refinement were conducted throughout the development and implementation of the ILD model.

A group of professional learning designers (n=5) tested the ILD model by creating a 3-module exemplary learning object (LO) in collaboration with subject matter experts at Gollis University. Learning designers tested version one of the ILD model by developing module one of the 3-module exemplary learning object. Peer reviewers provided quantitative and qualitative feedback to measure the effectiveness of version one of the ILD model. Module one was then implemented in a real classroom at Gollis University. Students (n = 32) were surveyed, and the instructor was interviewed during the implementation. Feedback from students, the instructor, and peer reviewers was used to develop version two of the ILD model.

Version two of the ILD model was tested by creating module two. Several iterations of refinement were conducted during the development and implementation of version two. Student surveys, instructor interviews, and peer reviewer feedback were used to create version three of the ILD model. Finally, version three of the ILD model was tested by developing module three of the exemplary learning object. Similarly, several cycles of iterative revisions were conducted throughout the development and implementation of version three. Peer reviewers' feedback and responses from student surveys and instructor interviews were used to refine the effectiveness of the final version of the ILD model (i.e., version three).

Findings revealed successive improvements in the effectiveness of the ILD model. Version one did not provide expected guidance to learning designers to apply learning theory principles effectively when designing objects. Module one content contained a higher proportion of extraneous information, misalignment between learning objectives and associated content, and irrelevant multi-media. Version two helped designers improve module two's overall flow and organization. However, there was a lot of extraneous information in the reading content. This means that learning designers did not apply IPT-1/CLT-2 effectively to remove all extraneous information from the content. Finally, version three of the ILD model showed higher performance than previous versions. Using version three, learning designers showed significant progress in removing extraneous information, mapping content with learning objectives, and packaging content into manageable chunks that learning designers can process without feeling cognitive overload. The development and implementation of the experiment continued for 28 weeks.

KEYWORDS: Design-based research, Passive learning, Active learning, Concrete experience, Reflective observation, Abstract conceptualization, Experimentation, Learning objects, Learning objectives, Learning designers, Instructional designers, Information processing, Cognitive load, Extraneous load, Germane load, Experiential learning.

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Dr. Song has been my mentor and instructor since I joined Sam Houston State University (SHSU) as a graduate student. I am indebted for his unwavering support and guidance throughout my educational journey at SHSU.

PREFACE

My interest in this research topic originated from my passion for designing learning objects and my interest in understanding human performance improvement. My experience in instructional design also influenced my decision to select this topic. As a learning designer, I conduct performance analysis, identify gaps, and design learning interventions that respond to the needs of learners. My professional goal is to become a scholar-practitioner in the educational technology field. To achieve this, I intend to pursue my career in designing and developing state-of-the-art learning programs that can positively impact individuals' and organizations' learning performance and productivity.

The research topic supports my professional goal, and the outcome is expected to benefit individuals involved in the instructional design profession. Researching and writing about this topic was not easy. I could not have delivered it without the unwavering support from my dissertation committee. Therefore, I thank Dr. Song, Dr. Angrove, and Dr. Kim for their invaluable feedback and guidance throughout this journey.

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CHAPTER I

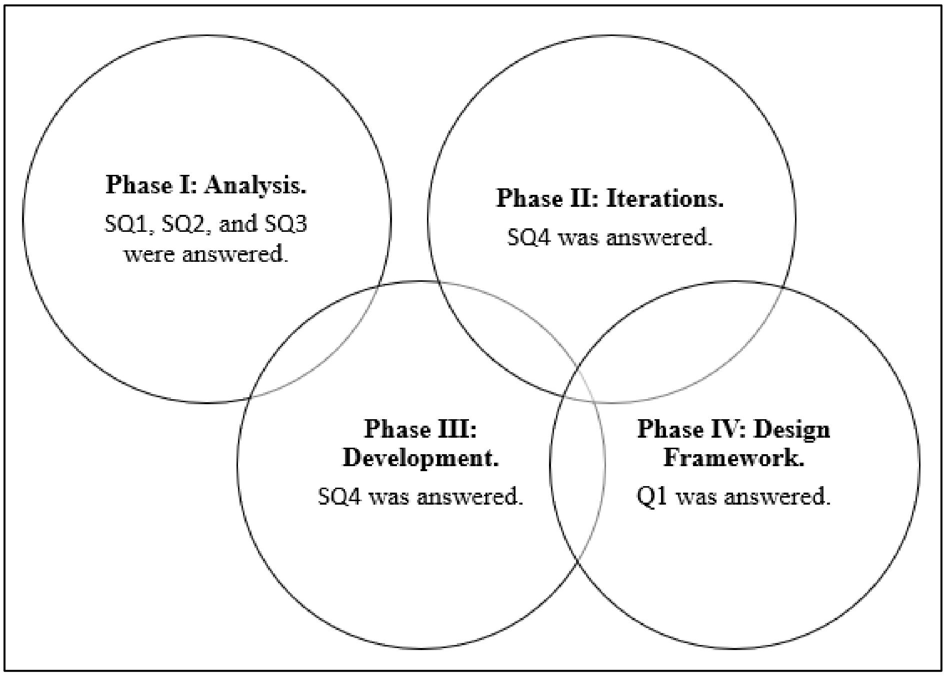
Introduction

This study was administered in four phases (see figure 1). Reeves et al. (2005) proposed these four phases for design-based research approaches in educational technology research. Herrington et al. (2007) expanded these phases to provide guidelines for students who want to use design-based research to conduct their dissertation research. In addition, they offered suggestions in each phase for doctoral students to consider when preparing their dissertation proposals using design-based research. For example, in phase I, they proposed to analyze a practical problem in collaboration with practitioners in the field. In addition, they offered to conduct a preliminary literature review to refine the problem statement and form a solid argument.

In phase II, Herrington et al. (2007) suggested developing solutions based on existing literature and design principles. Researchers must describe the "lens through which the problem will be investigated" Herrington et al. (2007). In addition, they suggested drafting a brief description of the proposed design intervention through conducting a relevant literature review, consulting, and collaborating with practitioners. In phase III, researchers proposed to complete iterative cycles of testing and refinement of the proposed solution. Research participants, data collection and analysis procedures, and implementation plans of the proposed intervention should be described in this phase. Finally, in phase IV, researchers suggested reflecting on the process with the intent to produce design principles and enhance solution implementation. In this phase, researchers should describe the entire development process and outline the research outcome. Figure 1 maps the four phases and research questions to be answered in each stage.

Figure 1

Phases of Research Cycle



Note. Four phases of conducting design-based research.

Phase I describes the problem statement, consultations with practitioners, purpose statement, research questions, the definition of the learning object, and literature review.

Problem Statement

Designing an effective learning object (LO) requires applying instructional systems design (ISD) models, learning technology, and learning theory principles. Learning designers use ISD models to systematically examine instructional problems and technology tools to bring the learning experience to light by creating interactive learning content. In addition, learning designers need to apply learning theory principles to design useful learning objects (Baruque & Melo, 2004) by chunking the content into bite-size pieces of information that learners can process and transform into knowledge and application.

The experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) provide these principles. However, many learning designers do not apply learning theory principles in the design of learning objects. A survey of 113 learning designers revealed that only half use learning theory principles to make instructional strategy decisions (Christensen & Osguthorpe, 2008). But the study did not mention what specific learning theory principles they use and whether they use them to design learning objects. Over the past century, many learning theories have been proposed. However, not all learning theories provide principles pertinent to designing learning objects. Therefore, it is the responsibility of learning designers to identify and apply relevant learning theory principles to create effective learning objects. Research indicates that many learning designers encounter difficulties identifying and applying relevant learning theory principles (Yanchar et al., 2010). As a result, learning objects created by professional learning designers are not grounded in learning theory principles.

In some cases, designers overuse technology by adding unnecessary animations or complex graphics. In other cases, they include convoluted paragraphs or fail to simplify the content by chunking it into bite-size pieces of information that learners can digest. Adding unnecessary information or failure to organize the content creates cognitive overload and hinders learners' ability to process the new concept.

In recent decades, many researchers discussed the importance of applying learning theory principles when designing learning objects (Christensen & Osguthorpe, 2008; Duffy, T.M., & Jonassen, D.H. (Eds.). 1992; Hannafin, Hannafin, Land, & Oliver, 1997; & Reigeluth, 1999). However, there is a literature gap on how to apply learning theory principles to design effective learning objects.

Consultation with Practitioners

I consulted with the dissertation committee members and practitioners in the instructional design field to define the problem statement. In addition, a preliminary literature review was conducted to support the development of the problem statement. Several iterations of revision were undertaken to refine the problem statement and ensure that it is manageable to investigate within the time given for this dissertation. Subject matter experts and representatives from Gollis University were engaged throughout the development process. Purists encourage to define the problem statement in collaboration with practitioners (Herrington et al., 2007). After refinements, committee members approved the problem statement, and practitioners agreed to participate in the study.

Purpose Statement

This study aimed to develop a design framework that provides design guidelines for learning designers to apply learning theory principles when designing learning objects. The study examined the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop the proposed design framework. An exemplary learning object was created and implemented in a real classroom at the information and communications technology (ICT) faculty at Gollis University. The development and implementation of the experiment continued for 28 weeks. During development, several iterations of testing were conducted.

Research Objectives

The following research objectives were developed to address the problem described in the above statement:

1. Develop a design framework that provides design guidelines for learning designers when developing learning objects grounded in learning theory principles.
2. State why many learning designers overlook using learning theory principles in the design of learning objects.
3. Describe learning theories that are relevant to the design of learning objects.
4. Describe the importance of applying learning theory principles in designing learning objects.
5. Create an exemplary learning object grounded in learning theory principles.

Research Questions

Q1 – How do you develop a design framework that provides design guidelines for learning designers when designing learning objects grounded in learning theory principles?

SQ1 – Why do many learning designers overlook the application of learning theory principles in the design of learning objects?

SQ2 – What learning theories must designers consider when designing learning objects?

SQ3 – Why is it important to use learning theory principles to design learning objects?

SQ4 – How do you use learning theory principles to design learning objects grounded in learning theory principles?

Research questions SQ1, SQ2, and SQ3 were answered by conducting a literature review. The focus of the literature review was to identify why many learning designers overlook the application of learning theory principles, identify learning theories that are relevant in the design of learning objects, and describe the importance of using learning theory principles when designing objects. An exemplary learning object was developed in collaboration with subject matter experts (SMEs) to answer research question SQ4 and demonstrate how to apply learning theory principles in the design of learning objects.

Finally, the main research question Q1 was answered by creating a design framework that provides design guidelines for learning designers when designing learning objects grounded in learning theory principles.

Definition of Learning Object

In the context of this dissertation, a learning object (LO) is defined as a combination of content, practice, and assessment items packaged into a single learning objective. Content items include instructional videos, reading materials, graphics, animations, etc. Practice items include exercises and quizzes. Assessment items include exams, capstone projects, etc. Learning designers developed an exemplary learning object using the proposed design framework.

CHAPTER II

Literature Review

A literature review was conducted to dissect existing literature about this topic. Several online databases were employed to amass peer-reviewed articles, conference papers, and ebooks. These databases included the SHSU academic library, ERIC, EBSCO, and Google Scholar.

Keywords such as design-based research, passive learning, active learning, concrete experience, reflective observation, abstract conceptualization, experimentation, learning objects, learning designers, instructional designers, information processing, cognitive load, experiential learning, etc., were used to search articles in these databases.

The following four major themes emerged from the literature review: a) learning theories that are pertinent in the design of learning objects, b) importance of using relevant learning theory principles in designing learning objects, c) importance of developing clear learning objectives, and d) reasons many designers do not apply learning theory.

Learning Theories That are Germane in the Design of Learning Objects

Cognitive and educational psychology researchers wrote extensively on how learners process information and construct knowledge. However, behaviorists, cognitivists, and constructivists interpret learners' learning differently.

Behaviorists

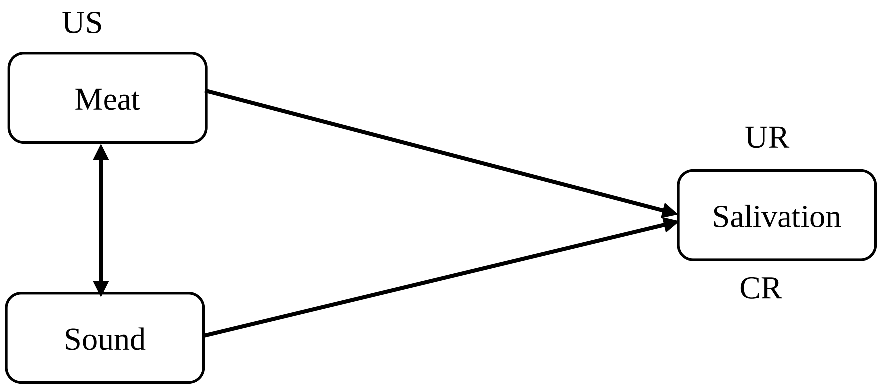
Behaviorists believe that learning occurs through reflexes conditioned by reward and punishment. They focus on observable behaviors and how environmental factors influence and shape the behaviors of individuals and animals. Prominent contributors to behavioral psychology include Ivan Pavlov, John B. Watson, and B.F. Skinner.

Ivan Pavlov (1849 – 1936) was a Nobel Prize winner Russian Physiologist. After completing his doctorate, Pavlov pursued his career as a professor of Physiology. His laboratory research on gastric glands, pancreas, gastrointestinal tract, and other discoveries on physiological functions led him to receive the Nobel Prize in 1904 (Dewsbury, 1997). Although Pavlov considered himself a physiologist, his contributions to educational psychology made him one of the most influential behavioral psychologists. His well-known Classical Conditioning (CC), also known as Pavlovian conditioning theory, includes one of the most cited theories in behavioral psychology.

Pavlov developed the classical conditioning theory after conducting an experiment with his dog. Pavlov's original intention was to study his dog's digestion and salivary glands. He wanted to measure the saliva the dog produces when given a piece of meat. He used test tubes to gauge how much the dog salivates when eating the meat. He called the meat: an unconditioned stimulus (US) because it stimulated the dog's salivary glands and made them produce the expected response (i.e., the saliva). It is natural and intuitive that meat causes the dog to salivate. So, Pavlov called salivation: an unconditioned response (UR) because it is the response to an unconditional stimulus. Pavlov then expanded the experiment by ringing a bell before giving the meat to the dog. For instance, he rings the bell and immediately presents the meat to the dog. After repeated tests, the dog associated the bell sound with the meat and started to drool with the bell sound before the meat was presented. Pavlov called the bell sound: conditioned stimuli (CS) and the salivation conditioned response (CR). This experiment was the birth of the classical conditioning theory. Figure 2 depicts classical conditioning theory.

Figure 2

Classical Conditioning Theory



Note. Classical Conditioning Theory by Pavlov (1927).

In figure 2, meat is an unconditioned stimulus (US) and creates an unconditioned response (UR) – salivation. On the other hand, the sound is a conditioned stimulus (CS) and generates a conditioned response (CR) – salivation. UR and CR are the same response (salivation), but the trigger is different stimuli.

John B. Watson (1878 – 1958) is considered the father of behaviorism. He played a significant role in developing behaviorism. The core of Watson's work is best known for his emotional conditioning experiment with little Albert in 1920 at John Hopkins University.

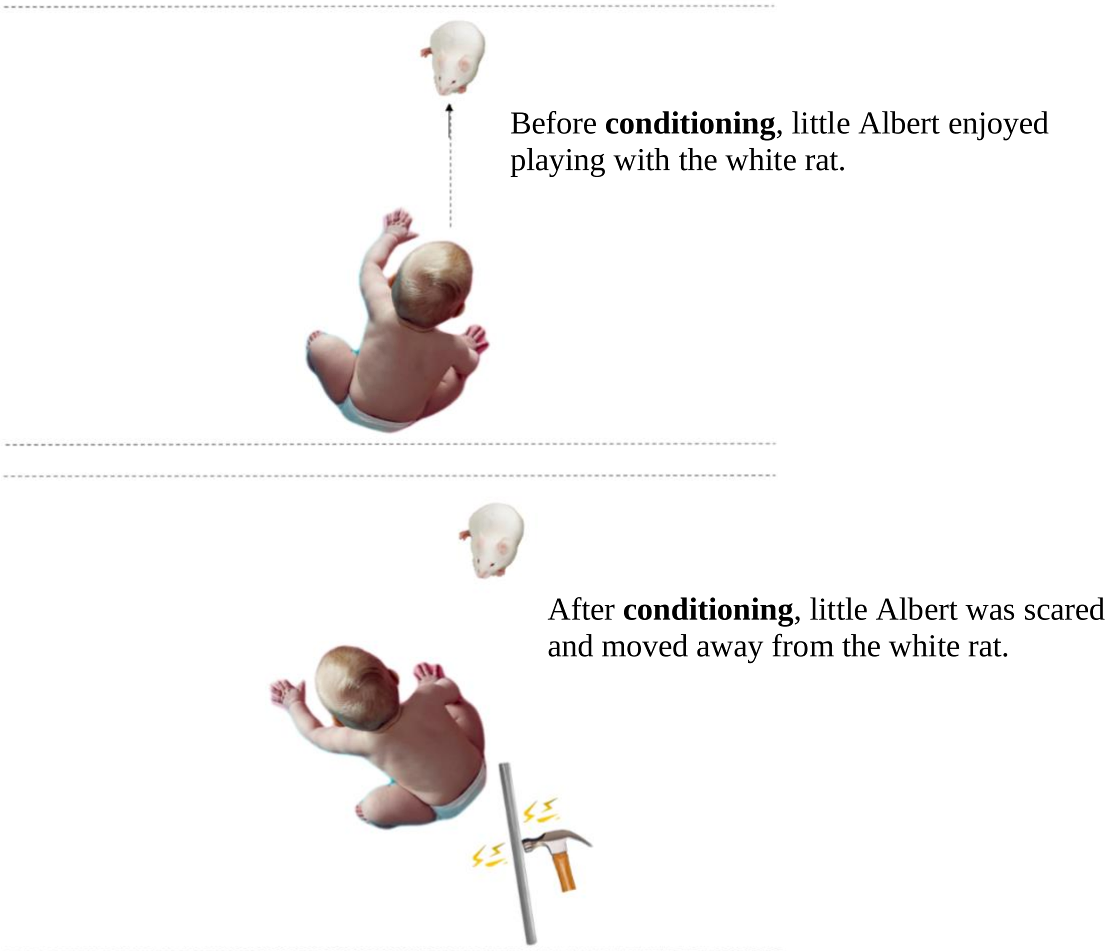
Watson was famous for saying, "give me a dozen healthy infants, well-formed, and my specified world to bring them up in, and I'll guarantee to take anyone at random and train him to become any type of specialist I might select — doctor, lawyer, artist, merchant chief, and yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors. I am going beyond my facts, and I admit it, but so have the advocates of the contrary, and they have been doing it for many thousands of years.” (Watson, 1924, p. 82, 1930, p. 104).

Watson introduced little Albert, a white rat, to play during his experiment. Little Albert loved it and enjoyed playing with the white rat. Later, whenever little Albert starts to play with the white rat, Watson used to bang an object behind little Albert’s head to make a loud scary noise. Little Albert would then cry and move away from the white rat. After repeated conditioning trials, little Albert started to associate the loud scary noise with the white rat and started to cry whenever the white rat was presented to him before the loud noise was introduced (see figure 3). “The little Albert experiment demonstrated that classical conditioning could be used to create a phobia” (McLeod, 2020). In addition, the experiment indicates that feelings developed through conditioning associations can be generalized (Samelson, 1980). For example, if a child dislikes mathematics due to an experience with a specific teacher, the child may continue to detest learning mathematics, even if the teacher changes.

Another example could be police interaction with black teens in America. Many black teens developed a negative association with law enforcement because of recorded events related to interactions between police and black teens in the United States. Although countless decent men and women in law enforcement are relentlessly serving and keeping their communities safe, a few bad apples created a negative experience between police and black teens in the United States. Figure 3 depicts the little Albert experiment conducted by Watson and Rayner (1920).

Figure 3

Little Albert Experiment



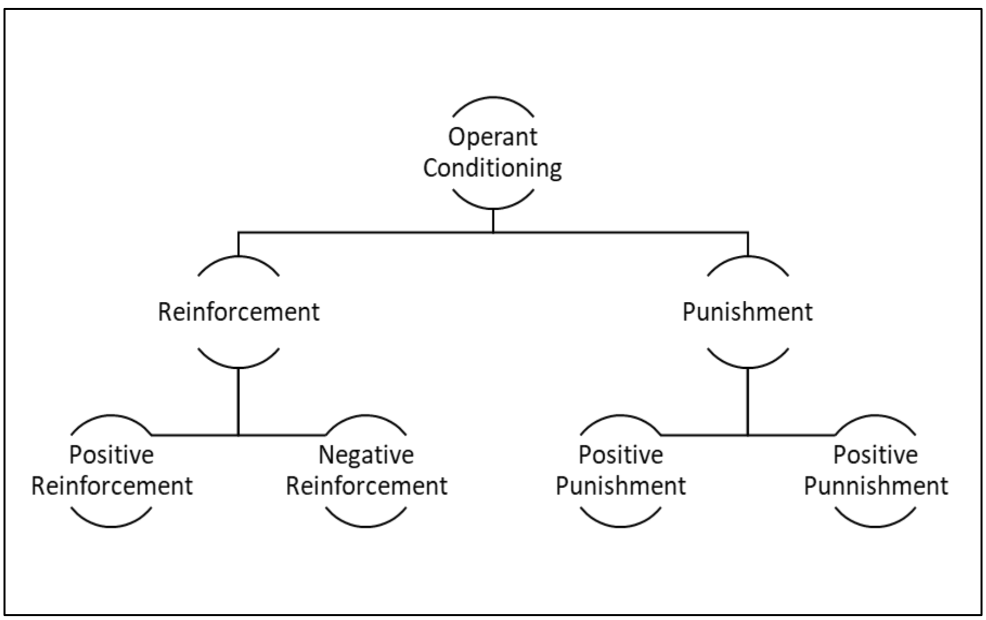
Note. Figure 3 shows the Little Albert Study by Watson and Rayner (1920).

B.F. Skinner (1904 - 1990) was an American Psychologist, behaviorist, and author. Skinner's publications and ideas influenced different fields, including psychiatry and pedagogy. For example, in his famous Operant Conditioning Theory, Skinner argued that studying observable behaviors of organisms is far more productive than figuring out how their internal mental processes work and then predicting their future behaviors (McLeod, 2018). In 1905 Psychologist Edward Thorndike coined the law of effect theory, which states that every behavior with favorable consequences is likely to happen again, and behavior with unpleasant consequences is expected to stop. Thorndike's law of effect influenced Skinner to develop the operant conditioning theory (Catania, 1999).

Skinner argued that every behavior is a factor of its consequences. Operant Conditioning is based upon the idea that learning occurs when an individual behaves differently because of the outcomes (results) of the behavior. For example, in his experiment, the rat learned that food is dispersed whenever the lever is pressed (Touretzky & Saksida, 1997). Figure 4 shows the four components of the operant conditioning theory.

Figure 4

Operant Conditioning



Note. Based on operant conditioning theory.

Reinforcement is a learning method that employs pleasant consequences (rewards) to increase desirable behavior. Positive reinforcement is used to flourish certain behaviors. For example, if a positive compensation is provided immediately after an individual performs a desirable behavior, the individual will likely repeat that behavior in the future. In Skinner's rat experiment, food was dispensed every time the rat pressed the lever. Recognizing an employee's contribution among her colleagues goes a long way in work settings. Skinner argued that positive reinforcement intends to increase desirable behavior.

Negative reinforcement also increases the desirable behaviors of individuals. This technique removes unpleasant consequences from individuals to improve positive behavior. For instance, in a parent-child relationship, a mother stopped nagging her son after he started cleaning his room regularly. Skinner called this negative reinforcement because of its intent to increase good behavior by removing unpleasant consequences. In his experiment, Skinner electrified the rat in the box; however, whenever the rat touched, pushed, pressed, or sat on the lever, the electricity stopped.

Punishment employs unpleasant consequences to decrease undesirable behavior. Positive punishment adds unpleasant consequences to reduce unwanted behavior. In Skinner's experiment, the rat was electrified whenever it touched the lever. Skinner intended to teach the rat not to touch the lever to avoid electric shock. After a while, the rat learned the desirable behavior and stopped touching the lever. In work settings, employees are expected to be punctual. If John repeatedly comes late, a verbal warning may help him stop the undesirable behavior. Skinner called this positive punishment because of its intent to decrease unwanted behavior by adding an unpleasant consequence.

Negative punishment removes pleasant consequences to reduce undesirable behavior. For instance, in a parent-child relationship, a mother confiscated her son's smartphone after he did not clean his room. Skinner called the removal of pleasant consequences (i.e., smartphone) with the intent to decrease undesirable behavior (i.e., not cleaning his room) a negative punishment. Operant Conditioning Theory can be summarized as follows:

- Positive reinforcement increases desirable behaviors by providing pleasant consequences.
- Negative reinforcement increases desirable behavior by removing unpleasant consequences.
- Positive punishment decreases undesirable behaviors by adding unpleasant consequences.
- Negative punishment decreases undesirable behaviors by removing pleasant consequences.

Cognitivists

Cognitivists de-emphasize observable behaviors and focus on “complex cognitive processes such as thinking, problem-solving, language construction, concept formation, and information processing” (Snelbecker, 1974). They focus on learners’ internal mental structures and how they process information. They argue that learning occurs when learners assimilate and accommodate new information into existing cognitive systems. They emphasize learning through discovery as “major areas of interest in cognitive psychology include language, attention, memory, decision-making, and problem-solving” (Cherry, 2020). Ulric (Dick) Neisser is considered the “father of cognitive psychology” (Hyman, 2012). Neisser argued that behaviorists' assumptions are wrong because they rejected the idea of studying mental processing. Behaviorists claim that observing and objectively measuring internal mental processes is hard. Thus, they focused on observable behaviors and discounted the source of these behaviors, which is the brain. This assumption limits what psychologists can accomplish in understanding how the human brain works. Without explicitly attacking behaviorism, Neisser presented a compelling argument in “research concerning perception, pattern recognition, attention, problem-solving, and remembering” (Hyman, 2012). His argument resonated with many researchers working on problems in the field because they saw Neisser’s work as a unified theory that helps them connect the dots (Hyman, 2012).

McLeod (2020) outlined several studies that led to the evolution of cognitive psychology:

- Kohler (1925) published a book called, The Mentality of Apes. He reported observations suggesting that animals could show insightful behavior and rejected behaviorism in favor of an approach known as Gestalt psychology.
- Norbert Wiener (1948) published Cybernetics: or Control and Communication in the Animal and the Machine, introducing terms such as input and output.
- Tolman (1948) worked on cognitive maps – training rats in mazes, showing that animals had an internal representation of behavior.
- Cognitive psychology's birth often dates back to George Miller’s (1956) “The Magical Number 7 Plus or Minus 2.”
- The development of the General Problem Solver (GPS) by Newell and Simon (1972).

- In 1960, Miller founded the Center for Cognitive Studies at Harvard with the famous developmental cognitivist Jerome Bruner.
- Ulric Neisser (1967) publishes "Cognitive Psychology," which marks the official beginning of the cognitive approach.
- Process models of memory Atkinson and Shiffrin’s (1968) Multi-Store Model.

Atkinson and Shiffrin’s (1968) information processing model triggered the evolution of cognitive psychology. Many researchers contributed to the development of cognitive psychology. Bechtel and Zawidzki (n.d.) documented brief biographies of significant contributors to cognitive psychology. One of the early contributors to cognitive psychology was Jean Piaget.

Jean Piaget (1896 – 1980) was a Swiss clinical psychologist best known for his eminent child development theory. His interest in science and its history led him to study neuroscience and psychology, focusing on a child's development. Piaget focused on a child’s cognitive development, from information processing to language learning and other aspects of brain development. Piaget initiated the cognitive development theory with the tenet that infants have specific basic skills such as grabbing and thrusting items into their mouths. These skills are based on their sensory-motor, which infants use to explore their environment. Piaget called these skills schemas. A schema is an organized pattern of knowledge.

According to Piaget, if you give an infant his favorite rattle, he will grub and thrust it into his mouth. This action indicates that the child is employing schema skills. Suppose you change the rattle with a different object. For instance, with mommy’s gold wrist cuff, the infant will use the same schema skill to grab and thrust it into her mouth. Piaget called this process assimilation. Assimilation is how individuals attempt to adapt new information using their old schema. Piaget also discussed accommodation, which involves modifying old schema to understand and accommodate the data. For example, if you give the infant a larger object – like a tennis ball, he will try to employ his old schema of grabbing and thrusting it into his mouth. Again, he may squeeze the ball to fit into his mouth. But this time, the old schema is not working.

Piaget developed four stages of cognitive development. Table 1 depicts the description of each stage.

Table 1

Cognitive Development

Age in years	Cognitive Development Stage	Description	Concept learned
0 – 2	Sensorimotor	Infants learn the relationship between their body and environment using their senses and motor abilities.	a. *Object permanence* - meaning that infants learn that objects exist even if they can't see them. For example, if you hide the infant's doll, she will look for it because she understands that the toy exists. Infants develop object permanence at 12 months or older. b. *Mental representation* - meaning infants can hold an image in their minds. For example, they may grab the phone and pretend to call daddy because they have seen mommy doing so. They develop mental representation at 18 months or older.
2 – 7	Preoperational	Kids can engage and manipulate in symbolic plays.	Kids can use symbols to learn new information. For example, they use drawings or images to learn animal names, plants, fruits, food, etc. Language development is another example of using symbols. At this stage, kids are egocentric.

(continued)

Age in years	Cognitive Development Stage	Description	Concept learned
7 – 11	Concrete operations	Kids start to think logically about concrete events but may have difficulty understanding hypotheses or abstract ideas.	Kids learn the ability to conserve numbers, length, and volume. Conservation means that quantity remains the same even if the appearance is changed.
Over 11 years	Formal operational	Children develop the ability to understand abstract ideas.	Children learn hypothetical thinking, deductive reasoning, and more abstract concepts.

Note. Table 1 shows Jean Piaget's Stages of Cognitive Development.

Recent researchers who contributed to cognitive psychology include John Sweller and David Kolb. Sweller (1988) is best known for formulating the cognitive load theory (CLT), suggesting that a learner's working memory can only hold a small amount of information at any one time and that instructional methods should avoid overloading it. CLT is one of the most cited theories in the instructional design field. Learning designers use it to organize learning content into manageable chunks. Kolb (1984) extensively investigated experiential learning, individual and social change, career development, and executive and professional education. However, he is best known for the experiential learning cycle (ELC). ELC suggests that effective learning occurs when a learner progresses through a cycle of four stages: experience, reflection, thinking, and acting.

Constructivists

Constructivists argue that learners construct knowledge rather than passively absorbing information (Arends, 1998). They emphasize immersing learners into a community of learning. They encourage collaborative assimilation and accommodation of new information. Constructivists argue learners' prior knowledge influences how they construct meaning from new learning experiences (Phillips, 1995). Constructivism is an approach that encourages learners to participate in the construction of their language actively. Some early contributors to constructivism include Jean Piaget, John Dewet, and Lev Vygotsky, just to name a few.

John Dewey (1859-1952) was an American philosopher and educator. He was one of the prominent educators in the first half of the twentieth century. His ideas have been influential in education and social reform. He proposed compelling arguments against teacher-centered approaches and worked to change pedagogical methods and curricula. He was an advocate for progressive education. He believed that learning by doing is the best learning approach. Democracy and education and Logic are two of Dewey's most well-known works, published in 1916 and 1938.

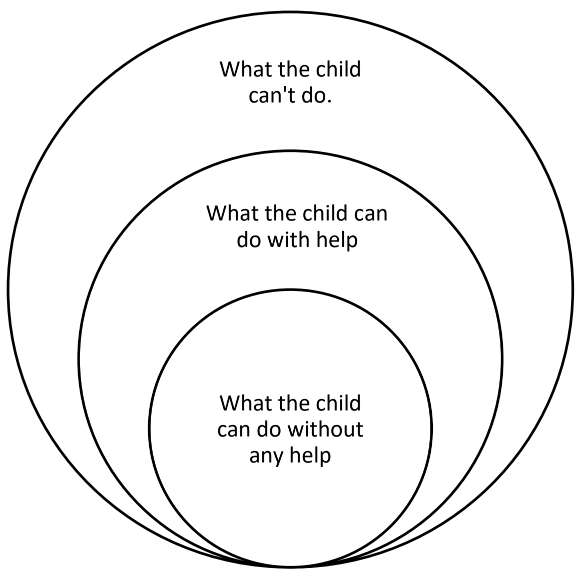
Lev Vygotsky (1896 - 1934) was a Soviet constructivist psychologist best known for his sociocultural theory. Vygotsky was a lawyer by training, but his passion for psychology steered his career as a psychologist. He published several articles and books on the subject. His theories include sociocultural theory, which states that social interaction plays a significant role in a child's cognitive development. Vygotsky believed that a child's mental development and world views are shaped by interactions with people and the environment (Gallagher, 1999). According to Vygotsky, cultural tools are passed from adults to children (Gallagher, 1999) through imitative, instructive, and collaborative learning. According to Gallagher (1999), Vygotsky's theory is based on the following four basic tenets:

1. Children construct their knowledge
2. Development is shaped by social context
3. Learning leads to the development
4. Language plays a significant role in mental development.

One central element in Vygotsky's sociocultural theory is the Zone Proximal of Development (ZPD). In this element, Vygotsky categorized learning experiences into three. Figure 5 depicts the zone proximal to development.

Figure 5

Zone Proximal of Development



Note. Figure 5 shows the Zone of Proximal Development developed by Vygotsky.

The first is a concept or task the learner can do without help. For example, a driver can change a flat tire without any assistance. The second is a concept or task that the learner can do with the aid of an expert. For instance, a driver can change a rear taillight with the help of an expert. The third is a concept or task that the learner can't do even with the help of an expert. For example, building a car engine from scratch. This task is beyond the learner's comprehension capabilities at this stage.

The purpose of this study is in alignment with the cognitive psychology philosophy. The study aimed to develop a design framework that may help learning designers to apply learning theory principles by organizing the content into manageable chunks.

Cognitive psychology involves the scientific study of mental functions and human behavior. Therefore, after an intense review of the different schools of thought (i.e., behaviorism, cognitivism, and constructivism), it was determined that cognitivism is relevant to this study's purpose.

Over the past century, cognitive psychology researchers proposed many learning theories. However, they are not equally pertinent in the design of learning objects. Many learning designers can't sift through the ocean of learning theories and apply theories relevant to the development of learning objects (Yanchar et al., 2010).

In some cases, professionals involved in instructional design activities do not have formal training in learning theories and the science of instruction (Khalil & Elkhider, 2016). Research shows that many textbooks in the educational technology field and college programs are organized around the process models (Branch, 2009; & Tracey & Boling, 2014). This indicates that even learning designers with formal training in educational technology lack the skills to apply learning theories relevant to designing learning objects. In addition, learning designers do not get enough practical assignments on how to create effective learning objects grounded in learning science principles throughout their degree programs.

After an intense review of the existing learning theories, this study identified experiential learning theory (Kolb, 1984), information processing theory (Atkinson &

Shiffrin, 1968), and cognitive load theory (Sweller, 1988) as relevant learning theories in the design of learning objects. These theories provide learning principles that are critical for designing practical learning objects.

Experiential Learning Theory

The experiential learning theory (ELT) was developed by Kolb (1984). The works of prominent thinkers in educational psychology in the 21st century, such as John Dewey, Kurt Lewin, Jean Piaget, etc., inspired David Kolb to develop the ELT. After an extensive review of these giant thinkers' works, Kolb synthesized them and created the experiential learning theory. The experiential learning cycle (ELC) is the core of the ELT.

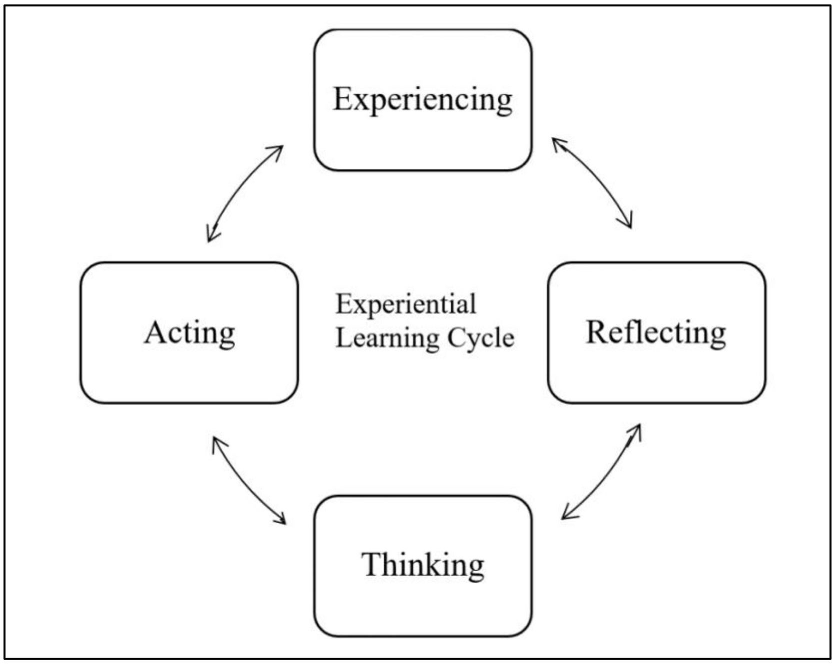
ELC dissects how learners learn using four different but interrelated stages. The four stages are experiencing, reflecting, thinking, and acting (see figure 2).

Through concrete experience and abstract conceptualization, learners receive information and transform it through reflective observation and active experimentation. Learners are both receivers and creators of knowledge. Learners’ actions in the experimentation step trigger the next concrete experience, and the cycle restarts. The cycle does not merely repeat; it evolves to help learners gain an in-depth understanding of the new concept.

The ELC describes how learners process and transform information into knowledge and application. It is a framework that enables learning designers to present the data using a systematic approach that allows learners to experience the content, reflect upon it, engage their critical thinking, and experiment with the content to deepen their understanding of the concept. Figure 6 shows the four phases of the experiential learning cycle.

Figure 6

Experiential Learning Cycle



Note. Figure 6 shows Kolb's (1984) experiential learning cycle.

This study employed the experiential learning cycle and the information processing and cognitive load theories to develop a design framework that provides design guidelines for learning designers to use when designing learning objects grounded in learning theory principles. Participating learning designers created an exemplary learning object using the experiential learning cycle as a framework. They developed various learning activities to provide concrete experience to participating learners, such as whiteboard animations, succinct reading texts, animated graphics, etc. In addition, designers created exercises that forced participating learners to reflect upon the new concept, conceptualize it, and act upon it. These exercises include delivering presentations, conducting role-plays, or performing hands-on activities.

Information Processing Theory

Many prominent researchers contributed to developing the information processing theory (IPT). For example, Atkinson and Shiffrin (1968) proposed a version of the now popular information processing model in a study titled "human memory: a proposed system and its control processes" (Atkinson & Shiffrin, 1968).

The model (see figure 3) illustrated humans' sensory, short-term, and long-term memories. In addition, the model depicted how information is transferred from sensory through short-term to long-term memories.

Further, the model showed how the data is retrieved from long-term to short-term memories (i.e., working memory).

Baddeley and Hitch (1974) created a model to explain the main functions of the human working memory. The model consists of three subsystems: central executive, phonological loop, and visuospatial sketch pad. Baddeley (2000) added the fourth subsystem, the episodic buffer. Baddeley's working memory model argues for the existence of multiple short-term memory stores. The phonological loop deals with verbal or acoustic information. The visuospatial sketch pad is concerned with visual information. The phonological loop and visuospatial sketch pad depend on the central executive's attention-based control system (Baddeley, 2003). The central executive does not have a storage capacity but merely serves as a control system (Baddeley, 2003). The episodic buffer is a storage system responsible for integrating information from several sources to create a unified memory (Henry, 2010).

Other contributors to the IPT include George A. Miller. He played a significant role in developing the IPT by researching the capacity of the working memory. In his famous paper “The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information” (Miller, 1956), he discussed the limitations of the working memory for humans and argued that it could handle seven plus or minus two items at a given time. Recent studies indicated that young adults' working memory capacity is limited to 3—5 meaningful items or verbal chunks (Gilchrist AL et al., 2008).

The IPT evolved from the cognitive development domain and is based on the idea that humans process the information received rather than responding to stimuli. The IPT compares how the human brain processes information to computer processors. The human brain receives input from the external world through the sensory register and transfers it to working memory. The working memory then encodes the information and sends it to the long-term memory for permanent storage. The data is then retrieved from the long-term memory and reprocessed in the working memory.

The IPT provides significant insight into designing an effective learning object that could potentially increase learning outcomes. Therefore, learning designers must use IPT principles to create engaging learning objects, which may increase learning outcomes. This study demonstrated how to apply IPT principles by developing an exemplary learning object. Participating learning designers applied IPT principles to create 3-module exemplary learning objects. Designers packaged the content into small chunks to help learners process the new concept and transform it into knowledge and application. Designers considered the limitations of the working memory and chunked the content accordingly. Designers created whiteboard animations, handouts, lecture notes, online quizzes, engaging group exercises, and module tests in each module. Each learning object went through several cycles of revisions. Peer reviewers provided extensive feedback to learning designers during the development stage of the learning objects.

The peer reviewers' feedback was used to ensure that the content was not overwhelming. Designers applied IPT principles by chunking the content into bite-size pieces of information that learners can receive, process, and transform into knowledge and application. Learners were tested after completing each module to measure their learning gains.

Cognitive Load Theory

The cognitive load theory (CLT) was developed by Sweller (1988) to expand existing knowledge regarding the amount of information that human working memory can process at one time. The CLT builds upon the popular human information processing model that Atkinson and Shiffrin (1968) developed. In addition, the theory uses evolutionary psychology and human cognitive architecture to provide a framework (Sweller et al., 2011) that learning designers can use when designing learning objects.

Learning designers must recognize learners' cognitive overload when creating learning objects. Integrating extraneous information into the learning object causes cognitive overload and reduces learning outcomes.

The CLT includes one of the most highly cited educational psychology theories in the instructional design field. It argues that instructional information imposes three types of loads on the learner's working memory (Sweller et al., 2011). The first load is called "intrinsic cognitive load" and is imposed by the basic structure of the information exposed to the learner (Sweller et al., 2011). For example, the grammar structure of a new language causes an intrinsic cognitive load on learners. The second load, called “extraneous cognitive load, " is caused by how the content is presented to the learner (Sweller et al., 2011). Poor instructional design strategies typically cause this load.

The third load is called” germane cognitive load.” Unlike intrinsic and extraneous cognitive loads, germane cognitive load is not imposed by the nature of the learning materials or how it is presented (Sweller et al., 2011). Germane load serves as working memory resources devoted to dealing with cognitive loads caused by the nature of information and how it was presented (Sweller et al., 2011). In other words, germane load deals with cognitive loads caused by intrinsic and extraneous loads. Germane load helps learners to link the new information with their prior knowledge. When designing content, learning designers must manage the intrinsic load by packaging the content into bite-size chunks. And eliminate extraneous load by removing all unnecessary information. In addition, they must foster germane load by creating interactive content that stimulates learners’ mental processes.

The intrinsic and extraneous cognitive loads impede working memory’s ability to process instructional information effectively. This impediment causes learners to struggle to transfer data into their long-term memories for permanent storage and future retrieval.

Learning designers must be mindful of these cognitive loads when designing learning objects. To manage learners’ intrinsic cognitive load, designers must examine the complexity of the subject and conduct a thorough learner analysis to understand learners’ prior knowledge relevant to the new concept. For example, solving simultaneous equations requires that learners are familiar with solving simple algebraic expressions. Understanding the complexity of the subject and learners' prior relevant knowledge helps designers manage the intrinsic load by chunking the content into smaller and manageable pieces of information. The extraneous load is unnecessary and distracting information that must be eliminated to avoid overloading learners' working memory. Mayer (2010) proposed five research-based tips to reduce the extraneous load:

- **Coherence**: remove all unnecessary information to keep the learning object simple and clear.
- **Signaling**: highlight essential information to draw learners' attention.
- **Redundancy**: delete redundant information. For example, do not add onscreen captions to narrated graphics.
- **Spatial contiguity**: indicate things that are related. For example, write words or descriptions near the corresponding part of the graphics.
- **Temporal contiguity**: present related information simultaneously. For example, present spoken words and associated graphics at the same time.

Germane load "refers to the mental resources devoted to acquiring and automating schemata in long-term memory" (Debue & van de Leemput, 2014). This load can be fostered by creating interactive content that engages and stimulates learners' mental processes. In other words, increasing learning performance can be attributed to a germane load enhancement (Debue & Van De Leemput, 2014).

Importance of Using Relevant Learning Theory Principles

Designing an effective learning object (LO) that engages learners and increases learning outcomes requires an in-depth understanding of learning theories relevant to designing learning objects. Relevant learning theories inform learning designers on how learners receive, process, and transform information into knowledge and application. After an intense review of existing learning theories, this study determined that experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) are relevant in the design of effective learning objects.

These theories provide principles that help designers understand how learners learn. Knowing how people receive and process information is a critical skill that every learning designer must acquire. To realize this skill, learning designers must develop an in-depth understanding of learning theory principles applicable to designing learning objects. Learning designers with in-depth knowledge of learning theories, instructional design models, and learning technology tools can lead the collaborative course creation process to produce an effective learning object. Therefore, learning designers must apply principles derived from these learning theories to create learning objects (Baruque & Melo, 2004).

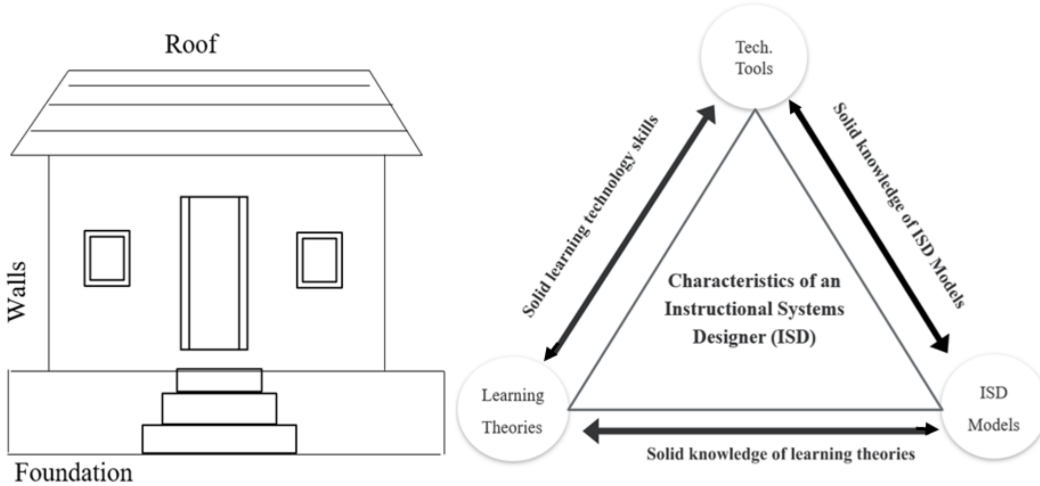
Developing an effective learning object (LO) is like building a house. The structure of a home can be divided into three major components: foundation, walls, and roof. An effective LO can be constructed using appropriate instructional design models, learning technology tools, and applying relevant learning theories. A civil engineer conducts needs analysis to identify materials, tools, and workforce required to construct a building. A learning designer performs a needs analysis to determine training needs. A civil engineer designs a construction based on building requirements. A learning designer creates a learning object based on training needs. An engineer uses appropriate technology tools to build a house. Similarly, a designer develops a learning object (LO) using the right technology.

Learning theory principles set a solid foundation for developing an effective learning object. A house with a weak foundation will probably collapse. Simultaneously, a learning object without a weak basis in learning theory principles will not deliver the desired learning outcome. Unfortunately, however, the sad reality is that most learning designers overlook the learning theory principles when designing a learning object. Instead, they focus on applying process models (i.e., ADDIE, Sam, etc.) and learning technology (i.e., authoring tools), which are essential in their ways.

However, they lose sight of the most critical component of instructional systems design: applying learning theory principles to create learning objects. Applying learning theory principles is essential for developing a learning object grounded in educational sciences, which may increase learning outcomes. This study demonstrated how to use principles derived from experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) by developing an exemplary learning object. Participating learning designers created a 3-module learning object using the experiential learning cycle as a framework and applying principles provided by information processing and cognitive learning theories. Figure 7 portrays the similarities between building a house and creating a learning object.

Figure 7

Building a House vs. Creating a Learning Object



Note. Similarities between building a house and creating a learning object.

Why use Experiential Learning Theory in the Design of Learning Objects?

The Experiential Learning Theory (ELT) breaks down how learners learn into four different but interrelated steps. Kolb (1984) called these steps the experiential learning cycle (ELC). The four stages are experiencing, reflecting, thinking, and acting. In ELC, learners receive information through concrete experience and abstract conceptualization and transform it through reflective observation and active experimentation (Kolb, 1984). Learners are both receivers and creators of knowledge.

In the concrete experience stage, learners receive information through their sensory cortex from the outside world in the form of vision, hearing, touch, position, smells, and taste (Zull, 2002). The information could be a novel experience, such as learning a new language or continuing an existing subject. In this stage, learners use their senses to receive information without engaging in critical thinking to deepen their understanding of the concept (Widiastuti & Budiyanto, 2018). Experiences in this stage include reading a text, looking at a static picture, listening to a lecture, watching a video, or doing an activity (e.g., setting up a virtual local area network [VLAN] for the first time). Learners can regurgitate the information but have not organized it to form ideas, plans, and actions (Abdulwahed & Nagy, 2009; & Zull, 2002). In this stage, learners gain a conceptual understanding and a "reference point with textures, feelings, meanings, and emotional impulses" (Baasanjav, 2013) of the new concept. However, they have not transformed information received into knowledge yet.

In reflective observation, learners engage their back integrative cortex to rearrange information, form memory, create connections between existing knowledge and new concepts, develop spatial relationships of objects and faces and create images and meaning (Young, 2002; & Zull, 2002). For example, learners may reflect on setting up a VLAN by rerunning the experience in their heads, listing the required equipment, and writing down the steps to take when setting up a VLAN from their memory. Learners examine their experiences from all perspectives, deepen their understanding of the new concept, and draw conclusions (Akella, 2010). The reflection stage helps learners to process and transform information into knowledge.

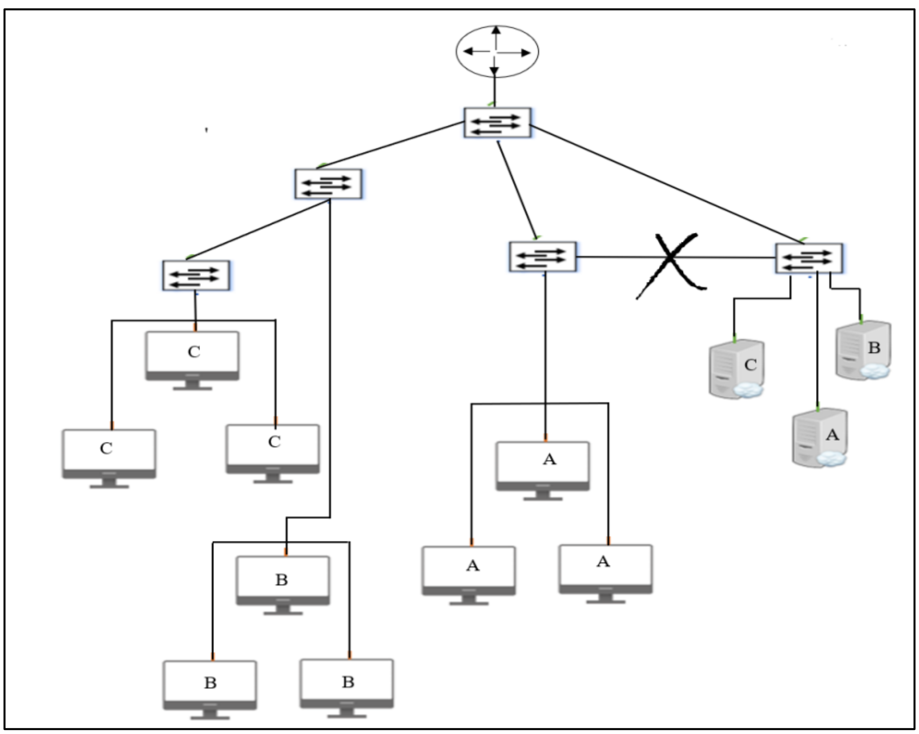
In the abstract conceptualization stage, learners engage their frontal integrative cortex to deepen their understanding of the new concept, create solutions, make decisions, assemble action plans, and prepare the entire body to act (McMullan & Cahoon, 1979; & Zull, 2002). For example, learners may organize steps to set up a VLAN in sequence order, describe the function of each piece of equipment, explain how to logically group stations with common sets of requirements, describe the advantages and disadvantages of VLAN, explain how to prevent VLAN attacks, and develop a plan to set up a VLAN. In this stage, learners critically examine the situation to generate a new understanding of the subject. They use “logic and ideas instead of feelings to understand situations and problems” (Kasirloo et al., 2015; & Akella, 2010). In this stage, learners emphasize critical thinking to generate ideas and solutions, compare options, and create plans for future actions.

In the active experimentation stage, learners perform activities and carry out plans and ideas that originated from the prior stage (i.e., abstract conceptualization stage), including the actual production of language through speech (i.e., doing presentations) and writing (Golden, 2001; & Zull, 2002). For instance, learners may set up a simple switch domain with a router, three VLANs, and one blocking port (see figure 6). To set up a simple switch domain, learners may actively test abstractions that require converting knowledge into physical action (Kasirloo et al., 2015; & Zull, 2002). In addition to the physical activities, learners may perform intellectual activities such as writing the steps in sequence, examining relationships, researching further instructions, presenting findings, and talking in debate or conversation (Kolb & Kolb, 2018; Svinicki & Dixon, 1987; & Zull, 2002). The active experimentation stage deepens learners’ understanding of the concept and triggers the cycle's next phase (i.e., the concrete experience). The cycle does not just repeat; it evolves to ensure learners achieve an in-deep understanding of the concept.

Therefore, this study used the experiential learning cycle as the framework for developing the exemplary learning object. ELC provides a framework that learning designers can use to organize the content in a systematic approach. For example, designers may create activities that challenge learners to reflect on the learning experience and foster learners' critical thinking. In addition, designers may develop scenarios in which learners actively experiment with the new concept. Using ELC, participating learning designers created a 3-module learning object. The exemplary learning object allowed learners to receive a concrete experience, reflect on the experience, engage in critical thinking to deepen their understanding of the experience and conduct active experimentation of the experience to convert knowledge into application. Figure 8 shows a simple domain switch.

Figure 8

Switch Domain



Note. Simple domain switch.

Why use Experiential Learning Theory in the Design of Learning Objects?

One of the fundamental principles derived from the information processing theory is how to chunk the learning content into bite-size pieces of information that learners can receive, process, and transform into knowledge and application. The IPT dissects how people receive and process information using their sensory, short-term, and long-term memories. It considers several assumptions. First, information is presented to the receiver by the environment. For instance, learners may receive data in classroom settings by attending instructor lectures, watching videos, reading a text, participating in debates, having discussions with peers, etc. Learners use their sensory memory to process the information.

Sensory memory (i.e., sensory register) is a precursor to short-term memory. It has multiple routes that provide information. These paths include sight, hearing, smell, touch, and taste. Sensory memory is the first store of the multi-store model that we possess as human beings. Its primary function is to sift through the information received through the five senses. It weeds out the information you ignore by deflecting it as if you have never experienced it. Sensory memory has a high capacity but limited duration to store information (Tripathy & Öğmen, 2018). Most information received through the sensory memory is forgotten due to its limited storage capacity. Instead, the information items paid attention to are recognized and transferred to the working memory for processing.

The first principle that can be extracted from the sensory memory work indicates not to overwhelm the sensory memory with extraneous information, which does not contribute to or facilitate understanding the new concept. In many cases, learning designers overload the content with information irrelevant to the learning objective. Instead, learning designers must dissect the content and map it with learning objectives by applying the abovementioned principle. Any content that is not relevant to learning objectives must be removed.

The second principle extracted from the sensory memory is to chunk the relevant content into bite-size pieces of information that learners can recognize and transfer to the working memory. Applying this principle requires learning designers to consider several factors when deciding to chunk the content. The first factor is to define the learner by thoroughly analyzing the learner's prior relevant knowledge, attitudes towards learning, relevant experience, technology literacy, language ability, etc. The second factor is to examine the complexity of the subject. Subjects have different levels of complexity. For instance, historical events that led to World War II do not have the same complexity as teaching derivatives. Therefore, learning designers must consider the above-stipulated factors when determining how complex a learning concept could be for target learners.

The working memory is a multi-component region in the brain with limited retention and storage capabilities. Its primary function is to process information received by performing mental operations such as reasoning, learning, and comprehension. The data processed in the working memory is then transferred to long-term memory for permanent storage and future retrieval. Atkinson and Shiffrin’s (1968) multi-store model depicted the working memory as one component. The model triggered numerous subsequent studies on the subject. Findings indicated a problem with Atkinson and Shiffrin’s (1968) characteristics of working memory. One of the most influential studies that expanded our understanding of working memory is Baddeley and Hitch (1974). They argued that Atkinson and Shiffrin's (1968) Multi-Store Model is too simple to characterize the working memory.

Baddeley and Hitch (1974) created a model that portrayed working memory as a multi-component system. Baddeley and Hitch (1974) argued that working memory consists of the central executive, phonological loop, and visuospatial sketch pad. In 2000, Baddeley added the fourth subsystem, the episodic buffer. The phonological loop deals with verbal and auditory information. It consists of two components: the phonological store, which holds data in a limited amount of time, and the rehearsal process, which involves verbal and acoustical practices. The rehearsal process protects information from decay from the phonological store. For instance, if you want to remember a telephone number until you find a pen and paper to write it down, you may repeatedly say the digits to prevent it from decaying from the phonological store. The principle extracted from the phonological loop is to embed activities that would help learners rehearse the learning content into the design of the learning objects. Designers must be creative in integrating these activities into the learning object. These activities must revolve around specific essential information you would like learners to recall.

The visuospatial sketch pad is responsible for storing and processing data in a visual and spatial form. It holds images and enables us to describe or draw these images later. It also creates mental images from descriptions and spatial structures. A typical example of visual form could be converting a story into a graphic representation or a movie. An example of spatial could be when one tries to visualize how a piece of furniture may look in a room while still shopping. A visuospatial sketch pad temporarily holds and manipulates images and their location in space (Baddeley & Hitch, 1974). The principle extracted from the visuospatial sketch is integrating images, graphics, maps, animations, etc., into learning contents to help visual learners recall critical information. These learning elements engage the visuospatial sketch pad of the working memory. This engagement may increase learners’ retention of the learning content and improve learning outcomes.

The episodic buffer is a storage system responsible for integrating information from several sources to create a unified memory (Henry, 2010). It links information from the phonological loop, visuospatial sketch pad, and relevant activated long-term semantic and linguistic knowledge into a coherent whole (Henry, 2010). The principle that learning designers can take from the episodic buffer is to feed the phonological loop and visuospatial sketch pad systems with relevant information to help the episodic buffer extract this information and integrate it into a whole to create a unified memory.

The central executive does not have a storage capacity but merely serves as a control system (Baddeley, 2003). It coordinates and assigns work to the phonological loop, visuospatial sketch pad, and episodic buffer.

The central executive acts as the company's boss by controlling attention and prioritizing activities. For example, you may drive and converse with a friend. In this situation, the central executive divides tasks between the phonological loop and visuospatial sketch pad while controlling attention. However, if the traffic ahead slams its brakes, you may pay undivided attention to the road and pause the conversation with the friend. This means the central executive prioritized tasks by giving full attention to the road ahead.

The working memory encodes information by creating a unified memory and transfers it into the long-term memory for permanent storage and future retrieval. Long-term memory is a multi-storage system with unlimited capacity to record enormous amounts of information. This does not mean that every piece of information stored in the long-term memory can be retrieved effectively. The challenge of recalling information is more of an accessibility issue than availability (Schwarz, 1998). The data exists in the long-term memory, but it is hard to remember partly because the information was not packaged to enable your brain to recall it later. According to Oregon State University: Academic Success Center, performing activities such as repetition, elaboration, schemas, multiple modes, sleep, and breaks help to successfully store information in the long-term memory in a retrievable format.

- Repetition refers to rehearsing information with the intent to recall it later. For instance, quiz yourself repeatedly until you master the concept.
- Elaboration refers to connecting new information with prior knowledge and mapping relationships. For example, simplifying mixed fractions requires recalling addition, multiplication, and division.
- Organizing schemas refer to creating patterns between ideas in your brain. Schemas help the brain to remember information using patterns, associations, or connections between ideas.
- Multiple Modes refer to engaging visual, auditory, and kinesthetic senses, when possible, to create stronger memories that can be retrieved later.

- Sleeping enough hours is vital for processing and storing information and recalling it when needed. Healthy sleep helps the brain acquire, consolidate, and remember information effectively.
- Breaks refer to spacing out studying time to avoid overwhelming the brain with an unbearable amount of information for an extended period. Short breaks help the brain to reflect information, deepen understanding, and refresh concentration.

Long-term memory storage is divided into explicit and implicit. Explicit memory involves descriptive knowledge. Long-term memory requires a specific mental effort and consciousness to retrieve correct information from storage. For example, Washington DC is the capital of the United States, birthdays of family members, etc. However, implicit memory refers to unconscious or automatic memories that do not require mental effort to recall. For example, walking, eating breakfast, drinking water, navigating familiar neighborhoods, etc. Episodic memory is a type of explicit long-term memory responsible for storing information about events—for example, life experiences and memories of the wedding day (Tulving, 1993). Finally, semantic memory is an explicit long-term memory responsible for storing information about the world Saumier and Chertkow (2002). For example, Washington DC is the capital of the United States. Retrieving this type of information involves a certain level of consciousness.

Procedural memory is an implicit long-term memory responsible for knowing how to do things. For example, how to ride a horse. Emotional memories involve events that trigger emotional responses (American Psychological Association). Emotional memories can be classified as either explicit or implicit long-term memories. An example of explicit emotional memory could be expressing feelings when describing the loss of a family member. An example of implicit emotional memory could be conditioned fear due to prior personal experience. The principle extracted from the long-term memory is to embed activities that engage multiple learning modes (i.e., visual, auditory, and kinesthetic senses) into learning objects. In addition, these activities must be designed to compel learners to perform repetition and elaboration to help them restructure their schemas.

Why use Cognitive Load Theory in the Design of Learning Objects?

The cognitive load theory is an extension of the information processing theory. It examines the functions of human working memory. The working memory is a cognitive system with a limited capacity to hold and process information. It plays a significant role in cognitive tasks that require temporary recollection, such as reading, solving math problems, comparing and contrasting various attributes of different objects, etc., intending to accomplish these tasks. Learning designers must understand how learners' working memory works and how much information it can hold and process at a given time. The cognitive load theory explains how working memory functions. Sweller (1988) suggested that working memory can only keep a small amount of information at any one time and that instructional methods should avoid overloading it. The principle that learning designers can take from the cognitive load theory is to manage intrinsic, extraneous, and germane loads when designing learning objects. The inherent complexity of materials imposes an intrinsic load. Inherent complexity refers to the number of interactive elements that learners must process simultaneously in their working memories for schema construction (Debue & van de Leemput, 2014; Orru & Longo, 2018). This study defines an element as “anything that needs to be or has been learned, such as concept or procedure” (Sweller, 2010, p. 124). When elements increase, the complexity of the learning material increases and imposes a more significant intrinsic load, which impedes the desired learning outcome. The interactivity of the elements is another factor that increases the complexity of learning materials. Element interactivity refers to the concept that learned elements are interdependent – meaning they cannot be learned separately. In other words, elements must be processed simultaneously in the working memory to learn the concept. An example, algebraic linear equations (e.g., $2X + 3 = 13$) have a high element interactivity. The principle extracted from the intrinsic load is to organize content into smaller chunks by reducing the number of elements learned at a given time. In certain topics, it is difficult to reduce element interactivity as it is inherent in the nature of the subject. However, chunking the content into smaller pieces lessens the complexity of the learning materials and eventually reduces the intrinsic load.

Extraneous load refers to unnecessary information integrated into learning materials, which does not contribute to schema acquisition and attainment of desired learning outcomes. Poorly designed instructional materials typically contain extraneous information irrelevant to learning objectives. Learners may spend mental efforts processing this information, which has nothing to do with the learning objective. This type of information is classified as “extraneous load.” It exhausts learners mentally, drains their energy to learn elements that matter, and impedes their ability to acquire schema. One way to think about extraneous load is like a roadblock that thwarts learners from achieving desired learning outcomes. The principle that learning designers must take from the extraneous load is to reduce or eliminate (if possible) any irrelevant information to free up learners' mental resources for schema acquisition and learn essential elements relevant to learning objectives.

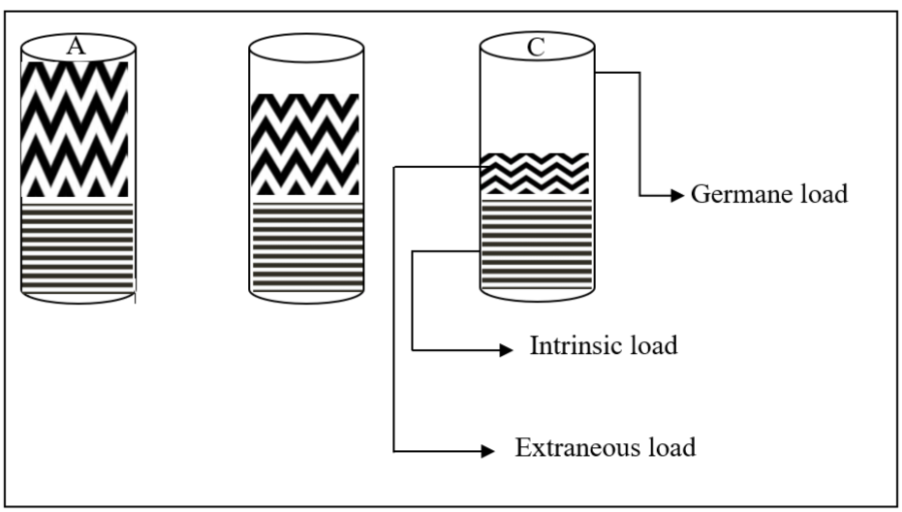
Germane load refers to the mental effort spent constructing and automating schemata in the long-term memory (Debue & van de Leemput, 2014). Learning occurs when extra effort is exerted to process information and build schemata in the long-term memory. Reducing extraneous load and improving germane load must be the core task of the instructional design. Instructional materials that enhance germane load led to good learning outcomes. The principle extracted from the germane load is to package the instructional content in a format that provides the appropriate level of difficulty to ignite mental resources devoted to constructing schemata in the long-term memory.

One lesson that all learning designers must take away from the cognitive load theory is not overloading learners' working memory. Therefore, learning designers must reduce the extraneous load by eliminating extraneous information, manage the intrinsic load by packaging the content into smaller chunks to reduce the number of elements being learned at one time, and enhance the germane load by providing relevant instructional tasks that trigger mental resources required to constructing schemata in the long-term memory. Figure 9 depicts the importance of balancing the three cognitive loads. First, the intrinsic load can be managed by presenting the interactive elements in a format that does not overload the working memory. The extraneous load can be managed by removing all unnecessary instructional from the content to avoid overloading learners' working memory. Finally, the germane load can be managed by employing instructional tasks that trigger mental resources required to construct schemata in long-term memory.

In Figure 9, the cylinder represents the working memory, straight stripes represent intrinsic load, zig-zag stripes represent extraneous load, and the empty area of the cylinder represents germane load. Condition A indicates poorly designed instructional materials with enormous irrelevant information, leaving no room for the germane load to flourish in the working memory. In this situation, it is difficult for learning to occur. Condition B indicates good instructional material with some level of extraneous information. However, it spares space in the working memory for the germane load to construct schemata in the long-term memory. In this situation, learning is expected to occur. Finally, condition C indicates better instructional materials with minimal extraneous information and plenty of space in the working memory for the germane load to acquire, construct, and automate schemata in the long-term memory. In this situation, the maximum learning outcome is expected to occur. Figure 9 depicts the importance of balancing the three cognitive loads.

Figure 9

Working Memory and Cognitive Loads



Note. Figure 9 is based on Sweller's (1988) cognitive load theory.

Importance of Developing Clear Learning Objectives

The first step to developing an effective learning object is to write clear learning objectives. Bloom (1956) proposed the widely used taxonomy (i.e., Bloom’s taxonomy), classifying the different learning objectives and skills that learning designers must set before developing effective learning objects. Without clear learning objectives, designers will lose sight of the level of expertise that learners are expected to achieve upon completing the learning object. Therefore, designers must develop terminal and enabling learning objectives based on the findings of the needs analysis report and in collaboration with subject matter experts (SMEs). Terminal learning objectives measure the anticipated level of performance that learners should achieve after completing the learning object. Enabling learning objectives are smaller, more manageable steps that learners must complete to achieve the terminal learning objectives.

Bloom (1956) developed the widely used multi-tier framework in collaboration with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl. The framework is widely used by educators and learning designers around the globe to create measurable objectives. Bloom and his collaborators identified six categories, “all lying along a continuum from simple to complex and concrete to abstract” (Armstrong, 2010). These categories are knowledge, comprehension, application, analysis, synthesis, and evaluation.

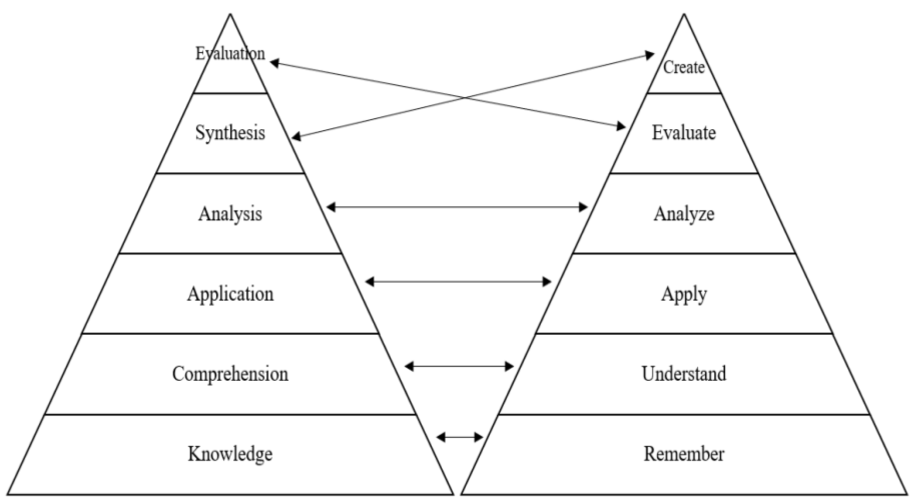
Here are the authors’ brief explanations of these main categories from the appendix of Taxonomy of Educational Objectives (Handbook One, pp. 201-207):

- **Knowledge** “involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting.” For example, recalling that the value of pi (π) is 3.14.
- **Comprehension** “refers to a type of understanding or apprehension such that the individual knows what is being communicated and can use the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications.” For example, being able to describe what the summer solstice represents.
- **Application** refers to the “use of abstractions in particular and concrete situations.” For example, setting up a simple switch domain with a router, three VLANs, and two blocking ports.
- **Analyses** represent the “breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between ideas expressed are made explicit.” For example, providing a full-scale analysis of why seasons are reversed in the southern hemisphere.
- **Synthesis** involves “putting together elements and parts to form a whole.” For example, proposing ideas to minimize food waste from school cafeterias across the United States.
- **Evaluation** refers to creating “judgments about the value of material and methods for given purposes.” For example, creating a criterion to evaluate seasons on a newly discovered planet?

Bloom (1956) and his collaborators proposed a list of verbs that can be used for each category. These verbs measure the level of expertise required for learners to acquire in each category. Learning designers must use these verbs intentionally when developing learning objectives. Anderson et al. (2001) revised the taxonomy “to incorporate new knowledge and thought into the framework.” Authors used verbs to label the categories and gerunds for the associated useful verbs instead of the nouns of the original taxonomy (Armstrong, 2010). For example, they relabeled “knowledge” as “remember”; and “synthesis” as “create.” They also reordered the last two categories. For example, the term “create” is now at the peak of the pyramid instead of “evaluation.” Figure 10 compares the original Bloom’s taxonomy and the revised version.

Figure 10

Bloom’s Taxonomy



Note. The left side of figure 10 is Bloom (1956), and the right side is Anderson et al. (2001).

A well-written objective contains an action verb and a noun (i.e., object). The action verb indicates the desired cognitive process that learners will engage in, and the noun refers to the knowledge that learners will acquire or construct upon completion of the learning object (Anderson et al., 2001, pp. 4-5). Knowledge, comprehension, and application are lower-order thinking skills because they engage the lower-level cognitive processes such as concrete thinking, memorization, and understanding Bloom (1956). In contrast, analysis, synthesis, and evaluation are higher-order thinking skills because they engage higher-level cognitive processes such as abstract, critical, metacognitive, and creative thinking.

Learning designers must apply Bloom's taxonomy to write clear learning objectives when designing a learning object. Learning objectives must be written using verbs proposed by Bloom and his collaborators (1956) and revised by Anderson et al. (2001). Most universities have revised versions of Bloom's list on their websites. An example could be the Center for Excellence in Learning and Teaching at Iowa State University. Learning designers must refer to university websites and review Bloom's updated list to refresh their memories. This study used Bloom's taxonomy to demonstrate how to create clear learning objectives for the exemplary learning object. Participating learning designers created clear learning objects for each lesson. The content of the 3-module learning object was developed based on learning objectives developed by participating learning designers. Table 2 depicts Bloom's taxonomy revised by Anderson et al. (2001).

Table 2

Revised Bloom's Taxonomy

Category	Useful Verbs	Alternative Names	Potential Activities and Products
Remember: retrieve relevant knowledge from long-term memory.	1. recognizing 2. recalling	1.identifying 2.retrieving	1. "Locating knowledge in long-term memory consistent with presented material (e.g., Recognize the dates of important events in U.S. history)." 2. "Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in U.S. history)."
Understand: construct meaning from instructional messages, including oral, written, and graphics.	1. interpreting 2. exemplifying 3. classifying 4. summarizing 5. inferring 6. comparing 7. explaining	1. clarifying, paraphrasing, representing, translating 2. illustrating, instantiating 3. categorizing, subsuming 4. abstracting, generalizing 5. concluding, extrapolating, interpolating, predicting 6. contrasting, mapping, matching 7. constructing models	1. "Changing from one form of representation {e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)." 2. "Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)." 3. "Determining that something belongs to a category {e.g., Classify observed or described cases of mental disorders)." 4. "Abstracting a general theme or major point(s) {e.g., Write a summary of the event portrayed on a videotape)." 5. "Drawing a logical conclusion from presented information (e.g., learning a foreign language, inferring grammatical principles from examples)." 6. "Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)." 7. "Constructing a cause-and-effect model of a system (e.g., explain the causes of

(continued)

Category	Useful Verbs	Alternative Names	Potential Activities and Products
			important 18th Century events in France)."
Apply: "carry out or use a procedure in a given situation."	1. executing 2. implementing	1. carrying out 2. using	1. "Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)." 2. "Applying a procedure to an unfamiliar task (e.g., Use Newton's Second Law in situations in which it is appropriate)."
Analyze: "break material into its constituent parts and determine how the parts relate to one another to an overall structure or purpose."	1. differentiating 2. organizing 3. attributing	1. discriminating, distinguishing, focusing, selecting. 2. finding, coherence, integrating, outlining, parsing, structuring 3. deconstructing	1. "Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant numbers in a mathematical ward problem)." 2. "Determining how elements fit or function within a structure (e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)." 3. "Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)."
Evaluate: "Make judgments based on criteria and standards."	1. checking 2. critiquing	1. coordinating, detecting, monitoring, testing 2. judging	1. "Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data)." 2. "Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency;

(continued)

Category	Useful Verbs	Alternative Names	Potential Activities and Products
			detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem)."
Create: "Put elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure."	1. generating 2. planning 3. producing	1. hypothesizing 2. designing 3. Constructing	1. "Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon)." 2. "Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic)." 3. "Inventing a product (e.g., Build habitats for a specific purpose)."

Note. Table 2 shows Bloom's revised taxonomy.

Why many Designers do not apply Learning Theories

Studies have shown that many professionals involved in instructional design activities do not have formal training in learning theories and the science of instruction (Khalil & Elkhider, 2016). Partly, many learning designers lack a deep understanding of learning theories. Some of them are engineers, computer science majors, linguists, etc., who happened to be professional learning designers through experience. These learning designers are usually experts in applying instructional design models and learning technology tools (i.e., authoring tools) to develop courses. However, they do not apply learning theory principles because they lack the expertise on how to extract from relevant learning theories and use them to design effective learning objects grounded in educational science.

Learning theories inform how people receive, process, and transform information into knowledge and application. Thus, learning designers must have a solid foundation in learning theories (Baruque & Melo, 2004) and apply them in the course creation process. If learning designers do not apply learning theories in the design and development processes, the learning object produced may fail to deliver desired learning outcomes. This study created a design framework to help novice learning designers apply learning theory principles to create learning objects that engage learners and potentially increase learning outcomes.

Smith (2011) indicated that learning designers with formal training in educational technology could help schools and organizations achieve the desired transformational change if they apply learning theory principles when designing and developing learning objects. Halupa (2019) listed the core competencies of learning designers. Among the list is applying learning theory principles to the discipline of instructional design (Halupa, 2019). However, many college programs in the educational technology field do not teach students how to use learning theory principles in the course creation process.

Research shows that many textbooks in the educational technology field and college programs are organized around the process models (Branch, 2009; & Tracey & Boling, 2014). This indicates that students do not get good practice in applying learning theory principles throughout their degree programs. Therefore, students must get adequate hours of practical assignments in applying learning theory principles in the course creation process during their studies. Students will struggle to apply learning theory principles without practice when starting their instructional design careers. Therefore, this study proposed a design framework to help novice instructional designers apply learning theory principles in the course creation process. After an intense literature review of existing educational theories, this study determined that experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) are relevant in the design of effective learning objects.

Furthermore, these theories provide principles that learning designers can use to develop learning objects grounded in educational science. This study extracted nine principles from the information processing and cognitive load theories and used the experiential learning cycle as the framework. The proposed framework will help novice learning designers to apply learning theory principles in the course creation process.

Learning theories enable designers to methodically chunk the content into bite-size pieces of information, remove extraneous load, and manage learners' working memory. The Linking Theory (Tennyson & Rasch, 1988) proposed a model that links the cognitive learning theories and instructional prescriptions to increase learning outcomes. Tennyson (2002) indicated that learning outcomes could be improved if designers establish a link between learners' mental processes and the means of instruction, delivery, and assessment of learning objects. This linkage can be achieved if learning designers apply learning theory principles to develop learning objects.

However, the problem is that many novice learning designers do not apply learning theory principles when designing learning objects. Instead, they focus on applying learning technology tools (i.e., authoring tools) and instructional design models (i.e., ADDIE, Sam, Pebble-in-the-pond, R2D2, etc.). In some cases, learning technology tools dictate the design of learning objects. Therefore, learning designers must apply principles derived from the experiential learning cycle (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) in the design and development of learning objects.

CHAPTER III

Methodology

This study used the design-based research (DBR) method to develop the proposed design framework in collaboration with real-world practitioners. In addition, a literature review was conducted to examine relevant learning theories in the design of learning objects and identify principles that learning designers must extract and apply when designing learning objects. Further, using the proposed design framework, a 3-module exemplary learning object was created with subject matter experts (SMEs) at Gollis University. The exemplary learning object was delivered in a real-world classroom. Participants were tested after they had completed each module.

Description of Research-Based Method

Design-based research (DBR) is a systematic approach to improving learning by conducting iterative analysis, design, development, and implementation in collaboration with practitioners in real-world settings (Wang & Hannafin, 2005, p. 6). DBR may also produce new theories, artifacts, and practices that potentially improve learning and teaching in naturalistic settings (Barab & Squire, 2004). Unlike predictive research designs, DBR compels researchers to collaborate with practitioners to identify a practical problem, develop a solution, implement the intervention, administer several iterative testing cycles to refine the solution, and generate design principles.

Reeves et al. (2005) compared the difference between predictive and design-based research approaches in educational technology. A hypothesis is developed using observations or existing theory and tested using designed experiments in predictive investigation Reeves et al. (2005). This approach is conducted in isolated contexts using control and treatment experiments, and practitioners are not involved in designing and implementing predicted research studies Reeves et al. (2005). In contrast, DBR engages practitioners throughout the investigation, and their input reflects on the results. In addition, DBR experiments are conducted in real-world contexts, and original data are collected and analyzed Reeves et al. (2005).

Definition of Research-Based Method

The DBR method is an emerging paradigm for educational research, and its definition is still evolving. It can be defined as "design experiments that entail particular forms of learning" (Cobb et al., 2003). Wang and Hannafin (2005) proposed a research-based definition that captures the most critical characteristics of DBR:

A systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually sensitive design principles and theories (p. 6).

Characteristics of Research-Based Method

According to Wang and Hannafin (2005), DBR is pragmatic, theory-driven, Interactive, iterative, flexible, integrative, and contextualized.

Pragmatic

DBR aims to solve real-world problems by designing and enacting interventions, expanding learning theories, and refining design principles (Design-Based Research Collective, 2003; Van den Akker et al., 2006). It enables researchers to explore possibilities to create novel learning and teaching environments, develop theories, advance design knowledge, and foster educational innovation (Design-Based Research

Collective, 2003). DBR is considered primarily design agnostic because it utilizes different research tools and techniques (Anderson & Shattuck, 2012) to connect research findings with real-world problems. Theories are typically developed and tested using control and treatment experiments, and practitioners are not involved in developing theories. In recent years, however, many educational researchers have considered DBR an emerging design paradigm that can be used as a strategy for developing or refining theories (Edelson, 2002). The goal is to link learning theories and real-world practice so that theories may “do real work” (Cobb et al., 2003). Learning theories focus on creating successive patterns in students' reasoning, which is essential for educational improvement to be a long-term, generative process (Cobb et al., 2003). This study created a design framework grounded in principles derived from relevant learning theories in collaboration with real-world practitioners. The framework's purpose is to pave the way for a substantial change in the design and development of effective learning objects. The researcher worked closely with practitioners to develop the proposed design framework. Participating learning designers then applied the proposed design framework to create a 3-module exemplary learning object in collaboration with SMEs from Gollis University. The exemplary learning object was designed to respond to a real-world problem at Gollis University. The intervention was implemented in a real classroom at Gollis University to measure learning progress and validate the effectiveness of the proposed design framework.

Theory-Driven

DBR is a theory-driven methodology because researchers focus on advancing existing theories or generating new ones to connect with the real-world context. Edelson (2002) proposed three theories that can be generated using DBR. First is domain theory, which describes learning situations involving students, teachers, learning environments, and interactions. The second is the design framework, which provides guidelines for a particular design challenge (p. 114). The third is a design methodology, in which researchers conduct an iterative design process to refine the intervention and make it more applicable to practice. This study aims to generate a design framework that provides guidelines for learning designers to use when designing learning objects. The process of conducting and applying design-based research differs from predictive experiments (Collins et al., 2004; Van den Akker et al., 2006; Wang & Hannafin, 2005). In part, theories developed in laboratory experiments are generally pushed aside by practitioners because it is difficult for them to draw connections between theories and real-world situations. However, theories developed using DBR may lead to much more practical application due to being conducted in a real-world context in collaboration with practitioners.

Interactive, Iterative, and Flexible

DBR is an interactive, iterative, and flexible approach. Researchers and practitioners work together to thoroughly analyze a specific problem and design and develop an intervention. Then, the intervention is implemented, which triggers a redesign and redevelopment of the intervention until the desired solution is achieved. The collaboration ensures that the intervention responds to the problem in a real-world context (Reeves et al., 2005; Wang & Hannafin, 2005). Also, researchers use mixed methods by collecting both qualitative and quantitative data. In short, DBR is flexible due to its iterative nature. It allows researchers to stretch their imagination and use different research tools and techniques to refine the design process.

Integrative

DBR is an integrative approach. Integrative means researchers integrate various research methods (i.e., qualitative and quantitative) to achieve the desired research goal. Researchers collect data from multiple sources with the intent to confirm and enhance the "credibility" of findings (Van der Merwe, 2019; Wang & Hannafin, 2005, p. 8). Then, they analyze the data to arrive at conclusions that support the problem's solution. In contrast, the analysis may show that the data do not support the proposed solution for the issue at hand. Researchers utilize integrative mixed methods to build a body of evidence supporting their research goal.

Contextualized

DBR is a contextualized research approach because the outcome is "connected with both the design process through which results are generated and the setting where the research is conducted" (Design-Based Research Collective, 2003). Conducting a DBR study in an authentic, real-world context allows researchers to keep detailed records of the process and collect original data from participants in a real-world context.

Ethical Consideration

Full consent was obtained from participants before implementing the research. See appendices C and D to view the sample consent form. In addition, full permission was obtained from Gollis University to administer this study at the Information and

Communications Technology (ICT) faculty. See appendix G to view the permission letter provided by Gollis University. Participants' privacy was protected to show respect for their dignity. Honest and transparent communication was maintained throughout the study.

Participants encountered no risks or discomforts throughout the study. In contrast, participants' engagement and learning outcomes dramatically increased. Any information obtained concerning this study that could be used to identify participants was kept confidential. The information will be disclosed only with the participant's permission or as required by law. Confidentiality was maintained using anonymity. Participants' reactions/responses and exam scores were not associated with their names. Instead, an identification number was assigned to each participant. Abdiwahab Guled, the Principal Investigator, kept data collected during the study in safe cloud-based storage.

CHAPTER IV

Iterative Learning Development Model

This chapter describes the development processes of the proposed iterative learning development (ILD) model. ILD model is a recursive rather than linear process designed to develop learning objects grounded in learning theory principles. The DBR method was used to create the proposed ILD model in collaboration with real-world practitioners. In addition, a literature review was conducted to identify learning theory principles relevant to the design of effective learning objects. Three iterations of testing and refinement were undertaken to create the final proposed ILD model (i.e., version three). In phase, I, version one of the ILD model was developed and tested in collaboration with practitioners. In phase II, version two of the ILD model was created. Challenges encountered during the development of version one were addressed, and feedback from practitioners was used to update version two of the ILD model. In phase III, the final version (i.e., version three) of the ILD model was created. Challenges faced during the development of version two were addressed, and feedback from practitioners was used to update version three of the ILD model.

Description of the ILD Model

The DBR method was used in the context of educational technology to develop the iterative learning development (ILD) model. The goal was to generate a design framework that could help novice instructional designers to create effective learning objects that would potentially enhance learning gains in a "naturalistic setting" (Barab & Squire, 2004). The ILD model is a recursive rather than linear process designed to develop learning objects grounded in learning theory principles. The model aims to provide design guidelines for learning designers to apply learning theory principles when creating learning objects. ILD suggests using the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop learning objects grounded in educational science. Three iterations of testing and refinement were conducted to establish the ILD model. In each iteration, the ILD was tested by creating a module of the 3-module exemplary learning object. Finally, the module was implemented in a real classroom in the information and communications technology (ICT) faculty at Gollis University Gollis University to test the effectiveness of the ILD model. Feedback from practitioners during the development and delivery of the module was used to improve the ILD model. The development and implementation of the experiment continued for 28 weeks.

Theoretical Framework

A literature review was conducted to identify relevant learning theories that can be integrated into the proposed ILD model. Experiential learning, information processing, and cognitive load theories were identified as applicable and used for the theoretical framework of this study. The experiential learning theory was the main theoretical framework for developing the ILD model. The information processing and cognitive load theories were used as supplemental theoretical frameworks. The intention was not to compare these theories and determine which theory is more appropriate for designing learning objects. All three theories provide essential principles and guidelines that learning designers must apply when creating learning objects. However, experiential learning theory was used as the main theoretical framework in this study. Seven learning theory principles were derived from the information processing and cognitive load theories and integrated into the design framework to improve its effectiveness. These principles help learning designers organize the content into manageable chunks if used appropriately. In addition, they help learning designers manage learners' cognitive loads when designing learning objects.

Below is a brief description of the experiential learning, information processing, and cognitive load theories.

Experiential Learning Theory

The experiential learning cycle (ELC) is the most widely recognized element in experiential learning theory (ELT). The cycle contains four stages, experiencing, reflecting, thinking, and acting. ELC is a simple and adaptable framework that learning designers can use to design learning objects that actively engage learners. The cycle depicts a continuous exchange process between learners' mental processes and their external environment. The information received from the external environment is processed and transformed into knowledge by learners. Learners then apply the knowledge to expand their understanding of the learning concept and gain new perspectives. Finally, the cycle restarts again until deep learning is achieved.

In the context of this paper, deep learning is the ability to define, analyze, and recreate a learning concept without assistance. For example, suppose the terminal learning objective is to set up a switch domain. In this example, deep learning can be achieved if the learner can describe the function of each piece of equipment in the switch domain, explain what could happen if an equipment malfunctions, and install the switch domain correctly.

According to ELC, learners receive information through concrete experience and abstract conceptualization and transform it through reflective observation and active experimentation. The learner is both a receiver and a creator of knowledge. Through the acting stage, the learner's actions affect the following experience stage, and the cycle restarts. The cycle does not merely repeat; it evolves to help learners understand the experience in-depth. Therefore, this study used the ELC to develop a design framework that provides design guidelines for learning designers to use when designing learning objects. A group of professional learning designers used the proposed design framework to demonstrate how to develop an effective learning object.

Information Processing Theory

The Information Processing Theory (IPT) examines how individuals receive, process, store, and retrieve information. Based on the IPT, the information is processed and retrieved in three stages: 1) encoding, which means translating information into meaningful messages that humans can understand; 2) storing, which means transferring information into the long-term memory for future retrieval; 3) retrieving, which means recalling information stored in the long-term memory. This study used the IPT to demonstrate how to chunk the content into bite-size pieces of information that learners can receive, process, and transfer into long-term memory. The theory provides significant insight into designing an effective learning object that could potentially increase learning outcomes.

Cognitive Load Theory

The Cognitive Load Theory (CLT) dissects the amount of information that learners' working memory can process at a given time. The CLT expands the human information processing model developed by Atkinson and Shiffrin (1968). It suggests eliminating extraneous load by removing all unnecessary information that has nothing to contribute to improving the learning outcome. Extraneous load creates a distraction in the learning process.

In addition, CLT suggests managing the intrinsic load caused by the complexity of the topic. Every learning object imposes a specific intrinsic load on learners' working memory. Learning designers must handle this load by chunking the content into bite-size pieces of information that learners can efficiently process. Further, CLT discusses germane load, a mental process that supports creating a schema and connecting existing knowledge and the new concept. Learning designers must design content that fosters the germane load, eliminate the extraneous load, and manage the intrinsic load. This study used CLT to demonstrate eliminating extraneous loads, managing intrinsic loads, and fostering germane load when designing learning objects.

Applying Learning Theories to Develop the ILD Model

The experiential learning, information processing, and cognitive load theories were used to develop the ILD model. Below is a brief description of how each learning theory was used in this study to create the proposed design framework.

How was ELT used to Develop the Design Framework?

The experiential learning cycle (ELC) was the main theoretical framework for developing the proposed ILD model. The four phases of the ELC were used as the foundation of the ILD model. In the concrete experience stage, the framework offers to create various learning activities that provide a concrete experience to learners about the new concept. These activities may include instructional videos, reading notes, instructor lectures, etc. In addition, the framework suggests that learning designers select appropriate learning strategies when developing the learning activities mentioned above. For instance, learning designers may use the flipped classroom learning strategy to expand access to content and foster self-learning.

In the reflective observation stage, the framework suggests developing reflective exercises about the new concept that was taught in the concrete experience stage. These exercises must compel learners to review the content to rearrange information and create schemata by identifying connections between existing knowledge and the new concept. In addition, the framework proposes that learning designers select an appropriate learning strategy to present reflective exercises. For instance, learning designers may use a brainwriting strategy to deliver the exercise. Brainstorming is an approach that allows learners to individually document their responses to reflective questions and pass them to their peers for review and refinement (Mind Tools, n.d.).

The framework suggests that learning designers create exercises that trigger learners' critical thinking in the abstract conceptualization stage. These could be scenario-based exercises, where learners work in groups to complete the activity. In addition, the framework proposes selecting an appropriate learning strategy to deliver the exercises. For example, learning designers may use the scale-up learning strategy to design brainstorming exercises. Scale-up is a learner-centered approach that allows learners to work in groups to discuss specific questions regarding the content. These exercises help learners deepen their knowledge of the content by engaging their critical thinking skills. Through these thinking exercises, learners may generate ideas and create action plans.

In the active experimentation stage, the framework suggests that learning designers create performed-based exercises to help learners solidify their understanding of the new concept. These activities may include implementing action plans developed during the thinking exercises. For example, presenting findings or setting up a wireless local area network (WLAN) using Linksys E900. These performance-based exercises deepen learners' understanding of the new concept.

How was IPT used to Develop the Design Framework?

The following four principles were extracted from the information processing theory. These principles were integrated into the proposed ILD model along with all four stages (i.e., experience, reflection, thinking, and acting) of the experiential learning cycle. These principles were labeled IPT-1, IPT-2, IPT-3, and IPT-4.

Principle One of the Information Processing Theory. Principle one of the information processing theory (IPT-1) is the first principle extracted from the information processing theory. IPT-1 advises learning designers to examine the content, map it with learning objectives, and remove extraneous information to avoid overwhelming learners' working memory. Any information that does not contribute to or expand understanding of the new concept is considered extraneous. In many cases, learning designers overload the content with information irrelevant to the learning objective.

Principle Two of the Information Processing Theory. Principle two of the information processing theory (IPT-2) was developed after dissecting how the human sensory memory works in accordance with IPT. This principle suggests chunking the relevant content into bite-size pieces of information that learners can recognize and transfer to the working memory. IPT-2 requires learning designers to consider several factors when chunking the content. The first factor is to define the learner by conducting a thorough analysis of the learner's prior relevant knowledge, attitudes towards learning, relevant experience, technology literacy, language ability, etc. The second factor is to examine the inherent complexity of the subject. Understanding these two factors determine how much content is a bite-size chunk for the target audience.

Principle Three of the Information Processing Theory. Principle three of the information processing theory (IPT-3) was developed after dissecting how the phonological loop works in accordance with IPT. This principle suggests embedding activities that would help learners rehearse critical information. Designers must be creative in integrating engaging exercises into learning objects. First, as a learning designer, you must identify essential information you want learners to remember. Then, design reflective/brainstorming activities to challenge learners to recall this critical information. For instance, mastering how the BODMAS rule works will help learners solve mathematical expressions with multiple operators. 4.

Principle Four of the Information Processing Theory. Principle four of the information processing theory (IPT-4) was developed after examining how the visuospatial sketch works in accordance with IPT. This principle suggests integrating images, graphics, maps, animations, etc., into learning content to help learners visualize and recall critical information. These learning elements engage the visuospatial sketch pad of the working memory to increase learners' retention of the learning content and improve learning outcomes.

How was CLT used to Develop the Design Framework?

The following three principles were extracted from the cognitive load theory. These principles were integrated into the proposed ILD model along with the experiential learning cycle (i.e., experience, reflection, thinking, and acting) and IPT principles. These principles were labeled CLT-1, CLT-1, and CLT-3.

Principle One of the Cognitive Load Theory. Principle one of the cognitive load theory (CLT-1) is the first principle extracted from the cognitive load theory. CLT-1 describes how to manage the intrinsic load. It proposes constructing the learning object into smaller chunks to reduce the number of elements learners interact with simultaneously. Some subjects like mathematics contain many interactive features, which increase the intrinsic cognitive load. It is difficult to reduce the interactivity features of these subjects as it is part of the inherent complexity of the topic. However, chunking the content into smaller pieces lessens the complexity of learning materials and eventually reduces intrinsic cognitive load. For example, teaching a single digit and carryover addition simultaneously may overwhelm learners' working memory and impede their ability to understand the subject. Therefore, learning designers must apply the CLT-1 to chunk the content to avoid overloading learning memory.

Principle Two of the Cognitive Load Theory. Principle two of the cognitive load theory (CLT-2) describes managing the extraneous load. This principle reinforces IPT-1. It suggests removing all information irrelevant to the learning objective to free up learners' mental resources for schema acquisition.

Principle Three of the Cognitive Load Theory. Principle three of the cognitive load theory (CLT-3) is related to managing the germane load. This principle suggests packaging the content in a format that provides an appropriate level of difficulty based on learners' prior knowledge to ignite mental resources devoted to constructing schemata in the long-term memory.

Learning Strategies

To effectively apply the experiential learning cycle and the proposed ILD model, learning designers must use different learning strategies appropriate for the learning content, context, and learner characteristics. Table14 depicts learning strategies that learning designers may consider when applying the proposed ILD model. Some of these learning strategies apply to more than one stage of the experiential learning cycle. The list was reviewed and refined throughout the study. In this study, learning designers selected strategies they deemed appropriate for developing the exemplary learning object considering the content, learning context, and learner characteristics. For instance, in the concrete experience stage, they selected instructional videos, reading content, online quizzes, and instructor lecture slides. The table proposes several learning strategies for each ELC stage.

Selecting appropriate learning strategies to design learning objects helps organize and use particular skills to present the learning content or have learners accomplish tasks more effectively and efficiently (Schumaker & Deshler, 1992). Table 3 shows 18 learning strategies proposed by this study.

Table 3

Proposed Learning Strategies

Experiential Learning Cycle (ELC) Stages	Proposed Learning Strategies
Concrete experience	Instructional videos Reading content quizzes Instructor lecture
Reflective observation	Brainwriting Concept mapping Think-pair-share Peer-review
Abstract conceptualization	Brainstorming Socratic questioning Jigsaw Fishbowl Reciprocal questioning Scale-up
Active experimentation	Role plays Presentations Hands-on activities Case study

During orientation workshops, learning designers were encouraged to select appropriate learning strategies from the proposed list to design module two learning content. In this study, the proposed learning strategies in table 3 are defined as follows:

- **Instructional video**. A video that contained subtitles, graphics, animations, voiceover, text, etc., to simplify the learning concept. The video was presented to learners before they attended in-person sessions. Research shows that instructional videos increase engagement and retention of important information (Yadav et al., 2011). Instructional videos add life to the content by making it practical and engaging. They facilitate the learning experience by reducing cognitive overload and maximizing retention.

- **Reading content**. A written text containing pictures, diagrams, graphs, etc., to help learners understand the learning concept. The reading content was shared with learners through Google Classroom. Learners were given access to content and encouraged to read before attending in-person sessions. Reading stimulates brain cells and improves concentration. It is a much more complex task than watching a video. But it is one of the critical pillars to enhancing learning outcomes.
- **Online quizzes**. A set of knowledge-check questions that learners must complete after they have read the content and watched the instructional video. Learners completed online quizzes before attending in-person sessions. The instructor reviewed student responses before live sessions to gauge learners' knowledge gap and understanding of the concept. The instructor tailored his presentation to explain critical information, clarify misconceptions, and answer any questions learners found difficult when completing online quizzes.
- **Instructor lecture**. Lecture notes that instructors used to recap the learning material and answer learners' questions. In addition, learning designers prepared lecture notes as part of the exemplary learning object package.

- **Brainwriting**. A learning approach for quick idea generation. Unlike brainstorming, there is no group discussion in brainwriting. Instead, learners individually document their responses to reflective questions and pass them to their peers for review and refinement (Mind Tools, n.d.). Learning designers used this approach to create reflection exercises, which learners completed during in-class sessions. For example, in this activity, learners were asked to generate quick ideas on troubleshooting a wireless local area network (WLAN) based on a specific scenario.
- **Brainstorming**. A group activity encourages learners to dissect a particular problem by providing spontaneous ideas to arrive at a solution (Bernstein (2017). Learning designers created brainstorming exercises and had students work in groups in the abstract conceptualization stage. This activity helped learners deepen their understanding of the concept, create solutions, make decisions, assemble action plans, and prepare themselves to act (Zull, 2002).
- **Peer-review**. A quality check approach that allows learners to receive feedback from their peers. Learning designers used a peer-review approach during reflective exercises. Learners shared their answers with their peers to receive constructive feedback. This activity helped learners to collaborate and learn from each other. In addition, learning designers used this activity during content development to provide critical input to design learning objects.
- **Jigsaw**. A group activity where learners worked on separate assignments about the same learning concept (Hance, 2021). Teams are then remixed, with one member from each original group joining a new group. Each learner then shares

their findings with the members of the new group. This activity promotes collaboration, discussion, and knowledge sharing among students. Learning designers applied the jigsaw method to design some of the exercises.

- **Concept mapping**. An instructional approach allows learners to visually demonstrate relationships among different concepts (Kane & Trochim, 2007). Learners categorize concepts, ideas, topics, etc., using circles, boxes, connecting lines, labeled arrows, etc., to show a graphical representation of information and knowledge. Learning designers used the concept mapping approach to visualize relationships of different learning elements.
- **Think Pair Share**. An instructional strategy compels learners to find an answer for a particular question individually and then discuss it with a peer before settling on a final response (Hyman, 2012; & Sugiarto & Sumarsono, 2014). The instructor used this approach during live sessions to increase learner participation.
- **Fishbowl**. An engaging learning activity for large groups. Learners are seated in two circles (inner and outer). Learners in the inner circle ask questions and share their opinions on a particular topic, while learners in the outer ring listen carefully and take notes. Learners take turns to ensure they all contribute to the discussion.
- **Role plays**. A learning approach that allows learners to apply learning materials. Learners take positions as they engage their peers to complete the tasks assigned to them in their specific roles. In addition, learners are more “engaged as they try to respond to the materials from their character's perspective” (Science Education Resource Center at Carleton College, 2020).

- **Learner presentation**. An active learning approach that compels learners to think, create, and present their opinions or facts about specific topics assigned to them. Learners may work in groups to prepare presentations and select a leader to deliver to the class on their behalf while answering audience questions as a group.
- **Hands-on activities**. A learning approach where learners perform tasks that require physical movement. An example could be setting up a wireless local area network. In addition to the physical activities, learners may perform intellectual activities such as writing, deriving relationships, researching, presenting findings, and participating in debates or conversations (Svinicki & Dixon, 1987; Zull, 2002).
- **Reciprocal questioning**. An instructional activity where instructors and learners engage in discussions (Palincsar & Brown, 1984). Learners take on the instructor role and ask a list of questions about a reading selection. The instructor answers questions during the session. The instructor used reciprocal questioning in this study to help learners understand the new concept. Learners prepared a list of questions after watching the instructional video and reading lecture notes, and the instructor answered their questions during the in-person session.
- **Socratic questioning**. An interactive learning approach is designed to engage critical thinking (Carey & Mullan, 2004). Instructors pose thought-provoking questions about the learning concept to have learners think through and work out answers. In this study, the instructor used Socratic questioning during live sessions.

- **Scale-up**. A learner-centered approach for small and large groups (Beichner et al., 2000). Learners work in groups on engaging problems, and instructors facilitate the discussion. In this study, the scale-up strategy was used to design brainstorming exercises. The activity helped learners deepen their understanding of the content by reviewing and answering specific questions.
- **Case study**. An intensive and systematic investigation of a particular problem. It involves an in-depth examination of a specific case. Learners may work in groups or individually to investigate assigned tasks and present findings.

Development Process of the Version One ILD Model

Version one of the iterative learning development (ILD) model (see figure 18) was developed in collaboration with practitioners. It consists of six interconnected phases: analyze, design, develop, formative evaluation, and summative evaluation. ILD uses a recursive approach to creating learning objects grounded in learning theory principles. In each phase, learning designers must conduct iterative cycles of revision and refinement. In the analysis phase, learning designers must answer three fundamental questions to clearly define the problem, determine its root cause, and propose intervention.

1. What seems to be the problem?
2. What seems to be the root cause of the problem?
3. What is the appropriate solution?

Training is not the solution to every problem. Defining the problem and understanding its root cause helps designers determine the appropriate intervention to address the issue. If training is the solution, further analyses must be conducted to describe the organizational strategy, target audience, task, and learning context. The training needs must be aligned with the organization's resources and business strategies. In addition, learners' prior knowledge, learning characteristics, previous experience, and attitudes towards the topic must be clearly defined. Understanding the target audience shapes design decisions and influences the instructional methods and strategies that must be used to implement the intervention.

Further, task analysis must be performed to break complex tasks into sequential smaller steps or a flowchart that outlines the journey from problem to solution. Context analysis must also be conducted to identify the physical environment within which learning may occur. Understanding the learning context helps to determine appropriate learning strategies. Finally, the first draft of the analysis report must be reviewed by SMEs and all stakeholders for quality assurance. Feedback must be implemented accordingly to produce a comprehensive analysis report.

In the design phase, learning designers must use the products of the analyses phase to develop a blueprint that answers specific design questions. Below is an example of design questions that learning designers must answer:

- What are the titles of units/modules/lessons/topics of the course?
- What are the terminal and enabling learning objectives?
- In what sequence do you plan to chunk and present the content and related activities?
- What is the expected learning outcome of each terminal learning objective?
- What learning strategies will you use to achieve each learning objective?

- What media/resources will you use to facilitate learning?
- How will you assess students' understanding/performance of each learning objective?

The product of the design phase is a blueprint that systematically defines how to chunk the content and determines course format, learning strategies, and assessment plan. Learning designers are the ringleaders of designing the content, but stakeholders such as subject matter experts, peer reviewers, training managers, etc., must participate as reviewers for quality assurance. Stakeholders' feedback must be used to refine the design document.

In the development phase, learning designers must create a prototype using the product of the design phase, solicit feedback from stakeholders, refine the prototype using input provided by stakeholders, develop actual course materials, and perform a test run for quality assurance purposes. In this phase, learning designers must chunk each topic into four stages: experience, reflection, thinking, and acting.

In each step, they must apply specific learning strategies and learning theory principles appropriate for delivering the content. For example, in the experience stage, learning designers may use learning strategies such as creating instructional videos, reading content, quizzes, instructor lecture notes, etc. These activities provide learners with a concrete experience. In the experience stage, learners receive this information through their sensory cortex from the outside world through vision, hearing, touch, position, smells, and taste (Zull, 2002). They use their senses to receive information without engaging in critical thinking to deepen their understanding of the concept.

Experiences such as reading a text, looking at a static picture, listening to a lecture, watching a video, or doing an activity for the first time create a concrete experience (Widiastuti & Budiyanto, 2018). However, learners have not transformed information received into knowledge yet. In this stage, expected learning outcomes include that learners can regurgitate the information without organizing it to form ideas, plans, and actions (Zull, 2002).

In the reflection stage, learning designers may use learning strategies such as brainwriting, concept mapping, think-pair-share, peer-review, etc., to create exercises and activities that help learners reflect upon the content learned in the experience stage. Reflective exercises help learners engage in their back integrative cortex to rearrange information, form memory, create connections between existing knowledge and new concepts, and create images and meaning (Young, 2002; & Zull, 2002). With carefully designed reflective activities, learners examine their experiences from all perspectives, deepen their understanding of the new concept, and draw conclusions (Akella, 2010). The reflection stage helps learners process and transform information into knowledge.

In the abstract conceptualization stage (i.e., thinking stage), learning designers may use learning strategies such as brainstorming, jigsaw, fishbowl, reciprocal questioning, scale-up, etc., to create activities that engage learners' frontal integrative cortex to deepen their understanding of the new concept. With carefully designed abstract conceptualization activities, learners may develop solutions, make decisions, assemble action plans, and prepare themselves to act (McMullan & Cahoon, 1979; & Zull, 2002). For example, suppose learning designers want to create an exercise on how to set up a wireless local area network (WLAN). Learners may brainstorm and develop a plan to set up the WLAN. The plan may include steps to take in sequence order, the function of each piece of equipment, how to group them, etc.

In the acting stage, learning designers may apply learning strategies such as role-plays, presentations, hands-on activities, case studies, etc., to develop performance-based activities. With these activities, learners may carry out plans and ideas from the prior stage (i.e., abstract conceptualization), including hands-on activities, presentations, and writing (Golden, 2001; & Zull, 2002). For example, in setting up a WLAN, learning designers may create hands-on exercises for learners to install the WLAN using the action plan they made in the abstract conceptualization stage. When completing this exercise, learners tested abstractions that require converting knowledge into physical action (Kasirloo et al., 2015; & Zull, 2002) and deepened their understanding of the concept.

In the formative evaluation phase, iterative cycles of revision and improvement must be made during content development. This evaluation must be conducted throughout the development process to improve the quality of the learning objects. For example, during the development phase, learning designers must create a prototype using the product of the design phase. Then, they must share the prototype with reviewers and solicit feedback to refine and enrich the content. Formative evaluation enables learning designers to identify and correct the weaknesses of the learning object.

The summative evaluation must be performed as an end-to-end measurement for the whole package. The package must be piloted in a real-world setting to measure the effectiveness of the learning materials. Typically, an instructor delivers the course, and the learning designer evaluates whether the different components of the learning object (e.g., content, exercises, assessment) are performing as per design. Some of the key questions that can be answered during summative evaluation include:

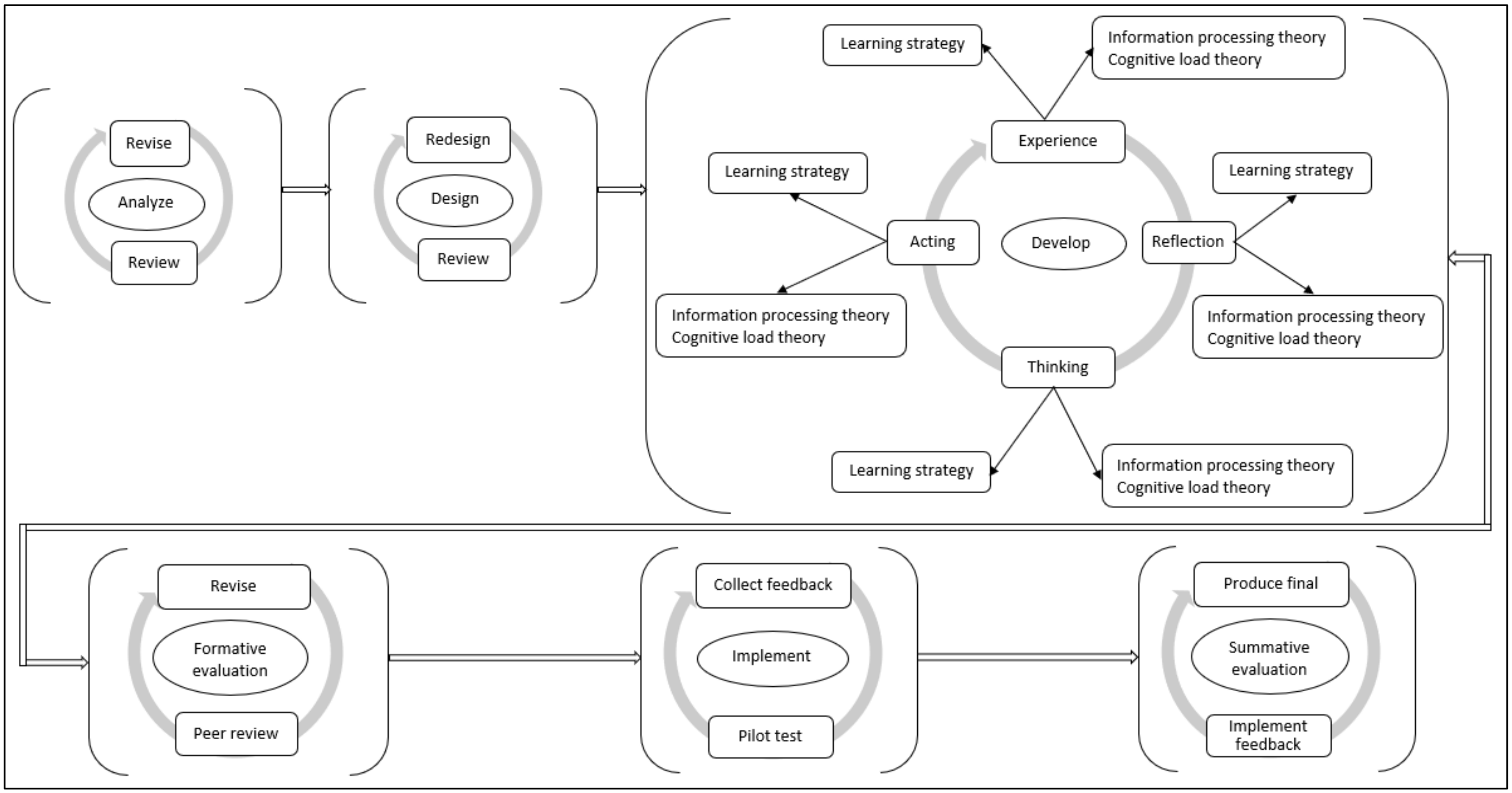
- Were the learning objectives clear and achievable within the allotted time?
- Were learners able to achieve the expected learning outcomes as planned?
- Were the learning activities/exercises delivered the desired outcomes? What would have them more effective?
- Were there convoluted parts of the content that learners encountered difficulty comprehending? Were there any parts that could have been done differently?
- Were images, graphics, animations, and other learning aids relevant to the learning objectives? Were there any parts that could have been done differently?

Version One of the ILD Model

Figure 11 shows version one of the iterative learning development (ILD).

Figure 11

Version One of the ILD Model



Note. Version one of the ILD model.

Testing Version One of the ILD Model by Developing Module One

The design-based research (DBR) method proposes conducting iterative cycles of testing and refinement of the intervention. Two types of iterations were performed to refine version one of the ILD model. The first iteration was administered by creating module one of the 3-module exemplary learning object using version one of the ILD model. The second iteration was conducted by implementing module one in a real classroom at Gollis University. Feedback provided by practitioners during the content development and module delivery was used to improve the subsequent versions of the ILD model.

Developing Module One using Version One of the ILD Model

Module one was developed to test the effectiveness of version one of the ILD model. Participating learning designers (n = 5) used version one of the ILD model and created module one content. Learning designers were oriented on how to use the ILD model. The importance of applying learning theory principles was emphasized.

Participating Learning Designers. A total of five learning designers (n=5) participated in the design and development of the exemplary learning object. Tiffany Smith spearheaded the creation of the exemplary learning object. Ms. Smith is a professional learning designer with over 5-year experience designing and developing state-of-the-art learning programs for large and medium-sized corporate training organizations. Throughout her career, Ms. Smith worked with thought leaders, subject matter experts, and senior management to identify measurable business outcomes and design and develop learning solutions grounded on educational science. She has an in-depth understanding of how to use learning theory principles in designing learning objects. Ms. Smith collaborated with stakeholders on various projects to share knowledge of best practices, promote the benefits of workplace learning, and the importance of being a learning organization.

Ms. Smith holds MSc. in educational technology from Boise State University, BSc. in international business from Illinois State University, and BSc. in telecommunications management from DeVry University. In addition, Ms. Smith holds several licenses and certifications from ATD. These include designated ATP Master of Instructional Designer, Credentialed ATD Consultant, and Designated ATD Master E-learning Instructional Designers. As a senior designer, Ms. Smith oversaw the design and development of the exemplary learning object. She allocated tasks to learning designers, reviewed prototypes, and provided feedback to improve the effectiveness of learning objects. In addition, she facilitated workshops and review meetings.

Ahmed Abdelqadir participated in designing and developing the exemplary learning object. Dr. Abdelgadir holds a Ph.D. in Mechanical Engineering from King Abdullah University of Science and Technology (KAUST) University, Saudi Arabia, an MSc. in Mechanical Engineering from the University of Colorado, USA, and a BSc. in Chemical Engineering from the University of Khartoum, Sudan. Dr. Abdelgadir has over 4-year experience in instructional design and curriculum development. He developed numerous line-specific training programs for the industrial workforce. In addition, he worked as a data science analyst to perform data analytics and provide data-driven reports to senior management. His work helped senior management to make data-driven decisions, optimize training programs, and quantify training impact. In the context of this research, Dr. Abdelgadir provided peer review feedback for learning objects developed by other learning designers. His feedback was used to improve the effectiveness of the learning objects and the proposed design framework.

Dauda Jamada participated in the design and development of the exemplary learning object. Mr. Jamada holds a BA in educational leadership and administration from Makerere University, Uganda, with over 9-year experience designing curriculum materials and teaching higher education. In addition, Mr. Jamada contributed to several research studies at Gollis University. He currently serves as the vice president and director of the research center at Gollis University. In the context of this research, Mr. Jamada closely worked with SMEs from Gollis University to design and develop specific components of the exemplary learning object.

Further, he worked closely with other instructional designers to coordinate design and development efforts. Iterative cycles of revision were conducted to refine the exemplary learning object. Mr. Jamada implemented the revisions in collaboration with SMEs and other instructional designers.

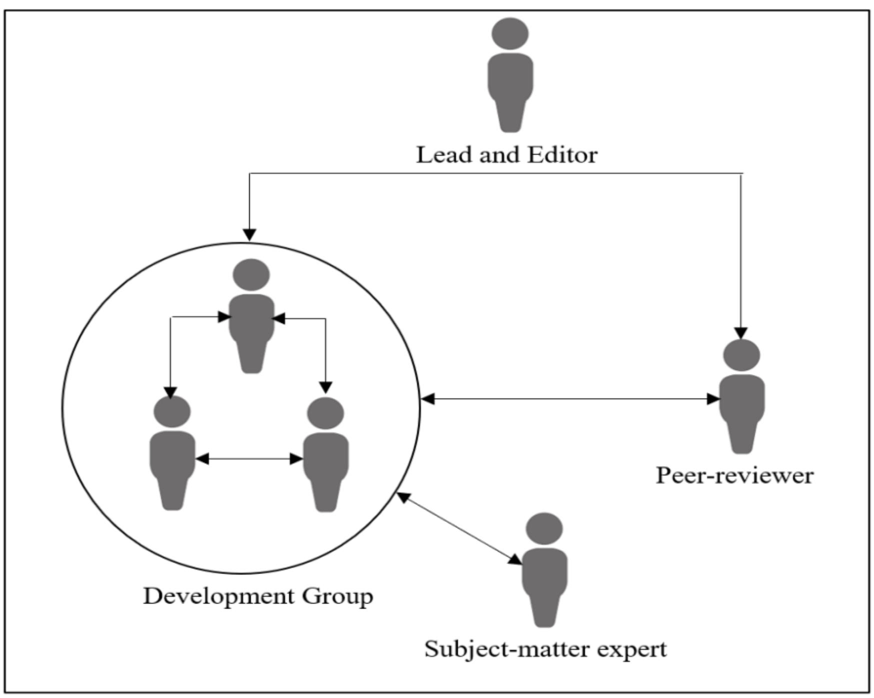
Salim Ali was integral in designing and developing the exemplary learning object. Mr. Ali holds a BS in information technology from Makerere University, Uganda, with over 6-year experience designing and developing course materials and teaching higher education. In the context of this study, Mr. Ali worked with other learning designers to design and develop specific components of the exemplary learning object.

Manohar Shinde is a professional instructional designer with over 15-year experience creating technical training programs in the oil and gas industry. With a chemical engineering degree, Mr. Shinde designed and developed line-specific training programs for various corporations. In addition, he spearheaded course development processes and oversaw the work of other learning designers. He currently leads seven instructional designers and oversees the development process of 32 major projects in his organization. In the context of this research, Mr. Shinde worked with other learning designers to design and develop exemplary learning objects. In addition, he conducted peer reviews and provided feedback to other learning designers.

Three learning designers developed the learning objects in collaboration with SMEs at Gollis University. In addition, one learning designer oversaw the development process, performed peer-review, conducted workshops, and facilitated review meetings. And one learning designer conducted peer-review and provided feedback to developers. Figure 12 depicts the development cycle and learning designers' roles.

Figure 12

Learning Designers



Note. Participating learning designers.

Workshop One for Learning Designers. A workshop was conducted to orient learning designers with version one of the proposed ILD model (see figure 11). The model consists of six interconnected phases: analyze, design, develop, formative evaluation, and summative evaluation. The development phase was emphasized during the workshop. This phase suggests applying three learning theories – experiential learning, information processing, and cognitive overload. In addition, the development phase encourages using appropriate learning strategies for the learning content. Table 3 provides a list of proposed learning strategies. The importance of selecting appropriate learning strategies for the learning content was also addressed during the workshop. Finally, the importance of applying learning theory principles was also underscored.

Module One Development Processes. Module one was developed by learning designers collaborating with subject matter experts (SMEs) from Gollis University. SMEs provided the content, and learning designers developed the module using version one of the proposed ILD model. Peer reviewers provided feedback to learning designers on each learning object created throughout the development of module one for quality assurance purposes. For example, peer reviewers provided feedback on instructional videos using a scoring rubric (see table 13). Learning designers accordingly implemented peer reviewers' feedback before producing a final instruction video. To effectively apply version one of the ILD model, learning designers kicked off module one development with an analysis to describe the target audience, task, and learning context.

Target Audience. Learner analysis was conducted to understand participants' entry behaviors, attitudes towards learning, academic motivation, and general group characteristics. Findings informed to construct relevant learning objectives and design the content. In addition, the learner analysis report provided learning designers with a clearer picture of learners' prior knowledge, backgrounds, and learning preferences.

- **Entry behaviors**. Learners came to this experiment having no previous networking experience. Their highest educational level was a high school education. Based on a survey completed by the instructor of this course, most learners have challenges comprehending wireless networking due to the language barrier. The medium of instruction for this course was English, and the learners' native language is Somali. The instructor does not speak Somali. In many countries, such as the United States, students who do not have college English language proficiency attend preparatory courses to enhance their language proficiency before being admitted to college. However, this was not the case for the target audience of this research. Before being admitted to college, they did not take preparatory courses to enhance their English language proficiency. As a result, they had to deal with two intrinsic cognitive loads—one imposed by the basic structure of the subject matter (i.e., the wireless networking) and one caused by the language barrier. Gollis University administered English and Math placement tests for all applicants. However, it seems the objective of the placement test was not to measure whether learners have college-level English proficiency.

- **Attitudes towards training and academic motivation**. Attitude refers to learners' mental readiness or mindset to acquire new skills and knowledge. Based on informal interviews with representatives from Gollis University, learners were highly motivated to learn new skills. Despite challenges such as language barrier, lack of electronic devices (i.e., personal laptops) for some learners, etc., learners showed positive attitudes towards learning. In particular, learners showed excitement in learning this wireless networking course.
- **Group characteristics**. Profiling learners' age intervals, experience, technology literacy, etc., is vital in designing and developing learning objects. Therefore, a survey was conducted to capture information regarding learners' age, experience, and technology literacy.
- **Age**. Understanding the median age of the target learners is crucial for designing and developing an age-appropriate learning object. Age is a factor in understanding a learner's perceptions and attitudes toward learning (Liam et al., 2007). It is often associated with cognitive abilities to learn new skills. Research indicates that age involves learners' performance in academic settings (Navarro et al., 2015). The age interval of the target audience ranged from 18 to 23 years. This information was critical for learning designers to remember when designing the exemplary learning object for the target audience.
- **Experience**. The target audience had a certificate in computer application before attending this course. However, they did not have any experience in

wireless networking. Therefore, learning designers organized the content in small chunks to help learners process and transform the information into knowledge and application, considering learners' lack of previous experience in networking.

- **Technology literacy**. Participants were deemed to be digital natives. However, based on survey responses from Gollis representatives, less than 50% of the learners had personal laptops. The school has a functioning computer lab designed for learners to use when practicing their lessons. Learners who did not have personal laptops used the school computer lab to complete online assignments during the experiment.

Participating learning designers created module one in collaboration with subject matter experts (SMEs) at Gollis University, considering learners' English language ability. They attempted to chunk the content into bite-size pieces of information that learners' working memory can process and transfer into long-term memory. The intent was to manage intrinsic load, reduce extraneous load, and foster germane load to allow learners' working memory to process critical information and connect the new concept and existing knowledge in the long-term memory.

Context Analyses of Module One Delivery. The module was delivered in a real classroom at Gollis University. A total of 32 learners participated in the implementation. The classroom was equipped with chairs, tables, flat-screen TV, whiteboard, markers, computers, overhead projector, books, etc. Most learners did not have personal laptops to follow lessons and complete online assignments. However, learners were given access to the school computer lab to practice their work and complete learning activities. In addition, learners were given theory and practical sessions to assist them in applying knowledge learned during the experiment.

Task Analyses of Module One Development. Wireless networking has become one of the fastest-growing segments in the computer industry. This course introduced learners to wireless and mobile network standards fundamentals. The exemplary learning object covered the fundamentals and practical aspects of wireless networking. Topics included wireless standards, mobile development platforms, emerging technologies, and network security. The course described concepts, technology, and wireless networking applications as used in current and next-generation wireless networks. In addition, the learning object addressed the fundamentals of wireless communications and provided an overview of the existing and emerging wireless communication networks.

This course aimed to impart state-of-the-art wireless networking technologies and motivate learners to advance their knowledge in network technology. After completing this course, learners could describe wireless networking technology, wireless communications, short- and long-range wireless technology, network planning, and wireless network standards and security. At the end of the program, learners completed a case study on setting up and configuring wireless local area (WLAN) using Linksys E900 wireless router to apply knowledge learned throughout the experiment.

Designing Module One Content using Version One of the ILD Model. Using the findings of the analysis phase, learning designers developed a blueprint (see table 5) for module one development. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies. Learning designers used this blueprint to develop module one content.

Module One Description. Module one provided an overview of the history of the wireless networking field. It described layers of the OSI (Open Systems Interconnect) model, network layer technologies, IP addressing, routing, data link layer technologies, physical layer technologies, etc. In addition, it defined the wireless network topology and devices for LAN, PAN, and MAN. Module one contained three lessons. Table 4 provides a brief description of each lesson in the module.

Table 4

Module One Schedule

Module	Lesson	Description	Reference Material
Module 1	M.1: Lesson 1: Introduction to Wireless Networking Technology	Lesson 1 provides an overview of the development of wireless networking and the diversity of wireless networking.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 1—7). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.
	M.1: Lesson 2: Wireless Network Logical Architecture	Lesson 2 describes layers of the OSI (Open Systems Interconnect) model, network layer technologies, IP addressing, routing, data link layer technologies, physical layer technologies, etc.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 9—36). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.

(continued)

Module	Lesson	Description	Reference Material
	M.1: Lesson 3: Wireless Network Physical Architecture	Lesson 3 describes wireless network topology and devices for wireless LAN, PAN, and MAN.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 37—70). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.

Module One Detailed Design Blueprint. Table 5 shows a detailed design description of module one. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies. Learning designers used this blueprint to develop module one content.

Table 5

Detailed Design Blueprint

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
Module 1	Lesson 1: Introduction to Wireless Networking Technology	Describe the development of wireless networking and the diversity of wireless networking	Development of Wireless Networking. Diversity of Wireless Networking	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 1—7). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	270 mins
	Lesson 2: Wireless Network Logical Architecture	Describe the OSI model layers, network layer technologies, IP addressing, routing, data link layer technologies, and physical layer	The OSI Network Model. Network Layer Technologies. Data Link Layer Technologies. Physical Layer Technologies. Operating System Considerations.	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 9—36). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400,	450 mins

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
		technologies.				Burlington MA 01803.	
	Lesson 3: Wireless Network Physical Architecture	Describe the wireless network topology and wireless devices for LAN, PAN, and MAN	Wireless Network Topologies. Wireless LAN Devices. Wireless PAN Devices. Wireless MAN Devices.	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 37—70). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	400 mins

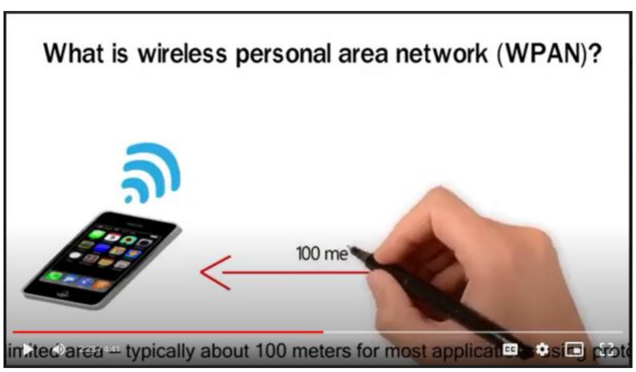
Note. Table 5 shows a detailed design blueprint of module one.

Creating Module One Content using Version One of the ILD Model. This module consisted of three lessons. First, learning designers created reading materials, exercises, and exam questions in collaboration with SMEs at Gollis University. Second, learning designers created storyboards and used Doodly software to develop whiteboard animation videos. The videos contained pictures, graphics, animations, text, voiceover, and subtitles to help understand the new concept. Finally, feedback from peer reviewers was used to refine the proposed ILD model.

Instructional Videos. Learning learners developed a storyboard for each video. The storyboards were revised several times before producing final versions. Doodly software was used to create whiteboard animation videos. Doodly is a whiteboard animation software that allows professionals with technical or design skills to develop real whiteboard videos in minutes. Each video contained pictures, graphics, animations, text, voiceover, and subtitles. Figure 13 shows a screenshot of an instructional video.

Figure 13

Instructional Video

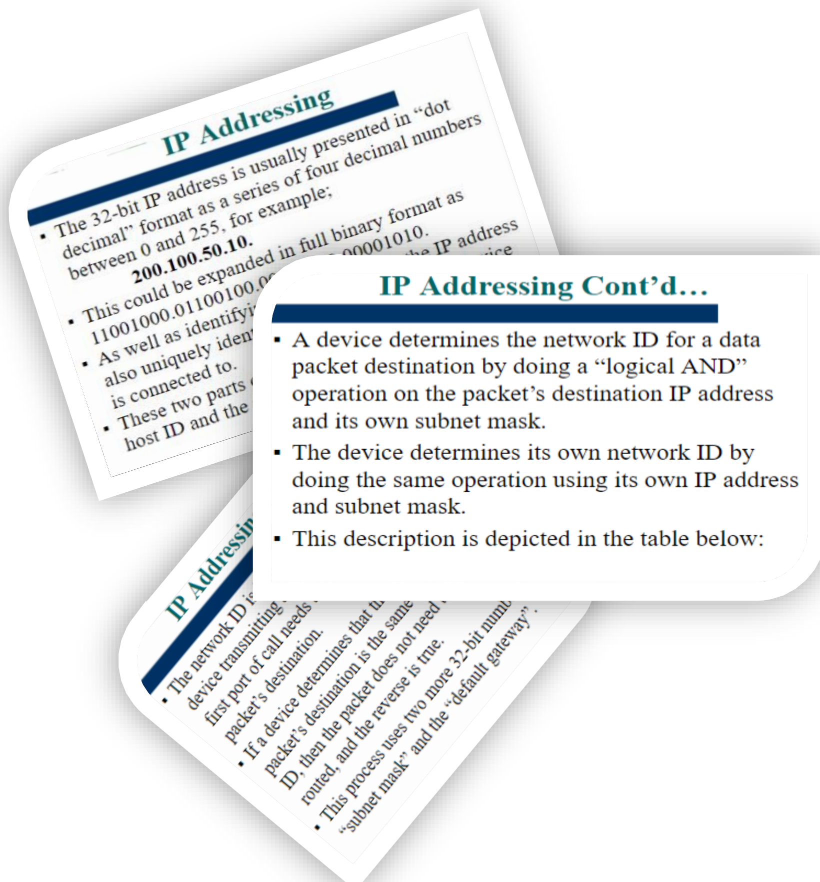


Note. A screenshot of module one.

Reading Materials. Learning learners created reading materials in addition to the instructional videos. The reading materials were revised several times to incorporate peer reviewer feedback. Figure 14 depicts a sample of the reading materials created by learning designers.

Figure 14

Sample Reading Material with Extraneous Information

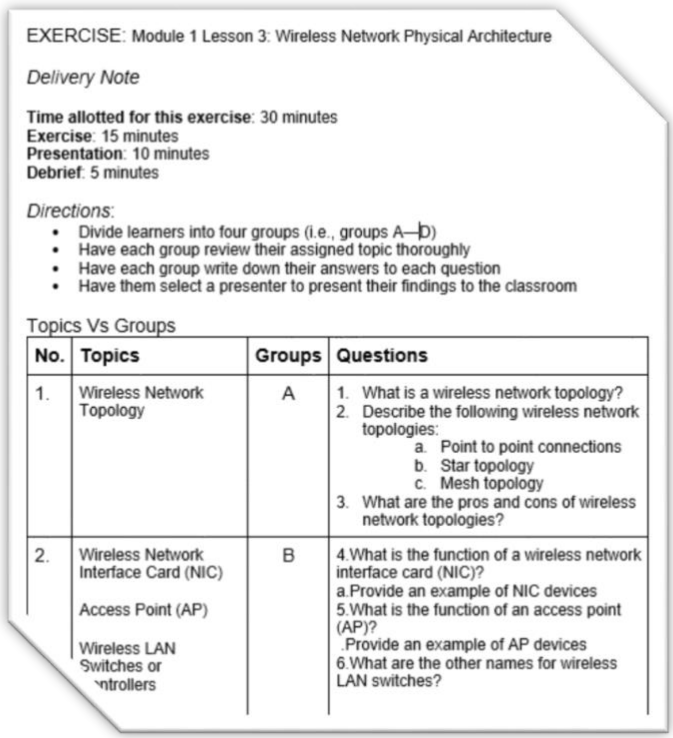


Note. Sample reading materials created by learning designers.

Exercises. Learning learners also created activities to help learners understand the content. Figure 15 shows a sample exercise that learning designers developed.

Figure 15

Sample Exercise



EXERCISE: Module 1 Lesson 3: Wireless Network Physical Architecture

Delivery Note

Time allotted for this exercise: 30 minutes
Exercise: 15 minutes
Presentation: 10 minutes
Debrief: 5 minutes

Directions:

- Divide learners into four groups (i.e., groups A—D)
- Have each group review their assigned topic thoroughly
- Have each group write down their answers to each question
- Have them select a presenter to present their findings to the classroom

Topics Vs Groups

No.	Topics	Groups	Questions
1.	Wireless Network Topology	A	1. What is a wireless network topology? 2. Describe the following wireless network topologies: a. Point to point connections b. Star topology c. Mesh topology 3. What are the pros and cons of wireless network topologies?
2.	Wireless Network Interface Card (NIC) Access Point (AP) Wireless LAN Switches or ntrollers	B	4.What is the function of a wireless network interface card (NIC)? a.Provide an example of NIC devices 5.What is the function of an access point (AP)? .Provide an example of AP devices 6.What are the other names for wireless LAN switches?

Exam Questions. Learning learners also created exam questions to help students reflect upon coursework. In addition, the exam questions were designed to assess the strengths and weaknesses of the course so that learning designers and instructors measure students' learning gains.

Testing Version One of the ILD Model by Implementing Module One

Module one was implemented in an ICT classroom at Gollis University to test the effectiveness of the version one ILD model. Students were surveyed during the experiment to measure their satisfaction regarding the flow, organization, and content chunking of module one. In addition, the instructor was interviewed to capture his feedback regarding the flow, organization, and content chunking. Feedback from the instructor and students was used to refine version one of the ILD model and improve the quality of subsequent modules.

Participating Students

A total of 32 learners, males (n=24) and females (n=8) from various socioeconomic backgrounds, participated in the experiment. The age interval of the target audience ranged from 18 to 23 years. Learners came to this experiment having no previous networking experience. Their highest educational level was a high school education. Based on a survey completed by the instructor of this course, most learners have challenges comprehending wireless networking due to the language barrier. The medium of instruction for this course was English, and the learners' native language is Somali. The instructor does not speak Somali. Despite challenges such as language barrier, lack of electronic devices (i.e., personal laptops) for some learners, etc., the analysis revealed that learners have positive attitudes towards learning.

Delivery Procedures

The flipped classroom strategy was used to deliver module one. Students watched the instructional videos, completed online quizzes, and read learning materials before attending in-person sessions. The instructor presented the content during in-person sessions, answered questions, and facilitated exercises. In each lesson, students completed two types of exercises: reflective and abstract. Reflective exercises were designed to help learners reflect on the content and rehearse the critical information. Abstract exercises were designed to trigger learners' critical thinking. Some of these exercises were scenario-based activities where learners worked together in groups to brainstorm and find solutions. Figure 16 depicts the delivery strategy for all modules.

Figure 16

Delivery Strategy

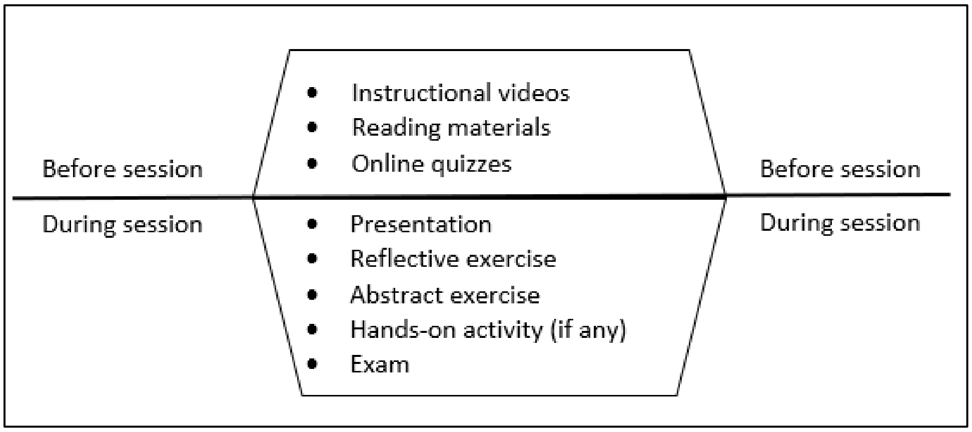


Figure 17 shows students completing the final exam. Students used their devices (e.g., laptops, tablets, smartphones, etc.) to complete the exam online.

Figure 17

Students Taking Exam

Note. Participating students taking the final exam.

Challenges of using Version One ILD Model

Version one of the ILD model was used to design and develop the content of module one. Findings revealed that version one of the ILD model did not provide expected guidance to learning designers to apply the seven learning theory principles extracted from the IPT and CLT in the design of module one content. Version one of the ILD model does not specify the seven principles. Therefore, learning designers attempted to identify and apply these principles. This design error caused a significant challenge for learning designers.

Challenges Faced during Content Development

A formative evaluation was conducted throughout the development of module one content to measure the effectiveness of the version one ILD model. Every learning object (e.g., instructional video) created by the learning designers was reviewed by peer reviewers on time. Each learning object went through several iterations of revisions and refinement. Peer reviewers checked the flow, organization, and content chunking of each learning object in the module. The intent was to ensure that learning designers apply learning theory principles in the design and development of module one. Findings revealed that version one of the ILD model did not provide expected guidance to learning designers when designing modules. Therefore, learning designers did not apply learning theory principles effectively to chunk into bite-size pieces of information that learners can efficiently process and transfer into knowledge and application.

Challenges Faced during Implementation

A summative evaluation was conducted after implementing each module one in a real classroom at Gollis University to measure the effectiveness of version one of the ILD model. Findings revealed several challenges encountered during the implementation of the experiment. These challenges include that:

- Some learning objectives did not align with the supporting content, meaning that learning designers did not correctly map the content with learning objectives.
- Some learning activities/exercises did not seem to deliver the desired outcomes.
- Some of the content was not packaged into smaller chunks that learners can digest and transfer into knowledge and application.
- Some of the images, graphics, animations and other learning aids integrated into the lessons did not seem to add value or facilitate learning.

Benefits of using Version One ILD Model

The main benefit of using version one of the ILD model to design and develop a module one of the 3-module exemplary learning object was to raise awareness of the importance of applying learning theory principles when creating learning objects. Learning designers attempted to extract and apply principles derived from the information process and cognitive load theories. This effort shows that they know the importance of using learning theory principles in designing learning objects.

Problems Faced with using Version One ILD Model

Problems faced with using version one of the ILD model include that:

- Version one of the ILD model did not specify the seven learning design principles extracted from the information processing and cognitive overload theories. Instead, it indicates applying information processing and cognitive load theories (see figure 11). However, it does not name the seven learning principles to help learning designers use when designing module one of the 3-module exemplary learning object.
- Learning designers struggled to extract and apply the learning theory principles on time.

Development Process of the Version Two ILD Model

Version two of the iterative learning development (ILD) model was developed in collaboration with practitioners. Feedback from peer reviewers, students, and the instructor was used to improve the effectiveness of version two of the ILD model (see figure 18). The seven learning theory principles extracted from information processing and cognitive load theories were added into version two of the ILD moel. These principles suggest examining the content, removing extraneous information, mapping the content with learning objectives, and packaging the content into smaller chunks.

The first four principles were extracted from the information processing theory, and the last three were derived from the cognitive load theory. Below is a brief description of how each principle must be used:

- IPT-1 and CLT-2 suggest that learning designers must examine the content and remove extraneous information that overwhelms learners’ working memory and distracts them from learning critical information. Then, they must map the remaining content with learning objectives.

- IPT-2 and CLT-1 suggest that learning designers must chunk the content into bite-size pieces of information that learners can digest and transfer into their working memories.
- IPT-3 suggests that learning designers must create exercises to help learners rehearse critical information they need to master. These learning activities could be reflective/brainstorming activities to challenge learners to recall essential information or abstract exercises that trigger learners' critical thinking to deepen their understanding of the new concept. In addition, learning designers must develop performance-based activities to help learners transfer knowledge into applications provided that it is applicable.
- IPT-4 suggests that learning designers must integrate images, graphics, maps, animations, etc., into learning content to help learners visualize and recall critical information.
- CLT-3 suggests that learning designers must package the content in a format that provides an appropriate level of difficulty based on learners' prior knowledge to ignite mental resources devoted to constructing schemata in long-term memory.

Implementing Feedback from Version One Development

Table 6 depicts the feedback collected during the development and implementation of version one and how it was addressed to improve version two of the ILD model.

Table 6

Implementing Feedback from Version One Development

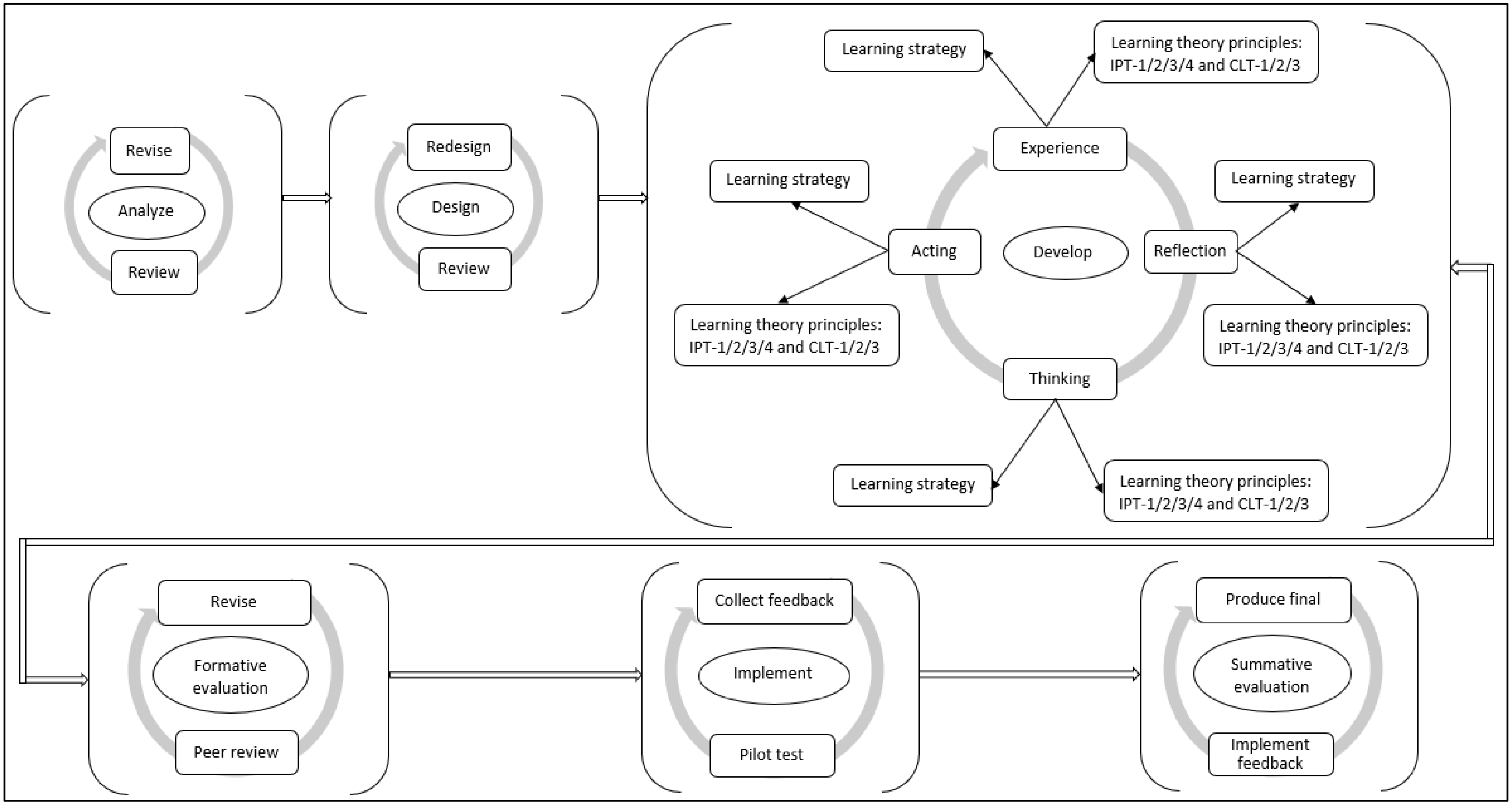
Feedback from Version One Development	How it was Addressed in Version Two
Findings revealed that version one of the ILD model did not provide expected guidance to learning designers to apply the seven learning theory principles extracted from the IPT and CLT in the design of module one content. Version one did not specify which principle to apply at what stage.	The learning theory principles were labeled clearly in version two of the ILD model to help learning designers remember which principle to apply at what stage.
Findings revealed that version one of the ILD model did not provide expected guidance for learning designers to chunk the content into bite-size pieces of information. Figure 14 shows a sample of reading materials with extraneous details. For example, learning designers used 209 words and two charts to describe IP addresses. After several iterations between the peer reviewers, learning designers, and subject matter experts, the word count was reduced to 103 without losing the concept's meaning.	A brief description of how to apply IPT-2 and CLT-1 principles was added to version two of the ILD model to help learning designers reflect upon when designing learning objects. In addition, an orientation workshop was conducted to reiterate the importance of applying these principles when packaging learning objects into manageable chunks.
Some of the learning objectives did not align with the supporting content. This misalignment means that learning designers did not correctly map the content with learning objectives.	A brief description of how to apply the IPT-1 was added to version two of the ILD model to highlight the importance of mapping the content with learning objectives. In addition, the idea of mapping was reiterated during the orientation workshop.
Some of the images, graphics, animations and other learning aids integrated into the lessons did not seem to add value or facilitate learning.	A brief description of the IPT-4 was added to version two of the ILD model to help learning designers understand the importance of creating multimedia assets relevant to the learning objectives. In addition, the IPT-4 was reiterated during the orientation workshop.

Version Two of the ILD Model

Figure 18 depicts a version of the iterative learning development (ILD) model.

Figure 18

Version Two of the ILD Model



Note. Version two of the ILD model

Testing Version Two of the ILD Model by Developing Module Two

The design-based research (DBR) method proposes conducting iterative cycles of testing and refinement of the intervention. Two types of iterations were performed throughout the development of the ILD model. The first iteration was administered by creating module two of the 3-module exemplary learning object using version two of the ILD model. The second iteration was conducted during the module's implementation in a real classroom at Gollis University. Feedback provided by practitioners during the content development and delivery was used to improve version three of the ILD model.

Developing Module Two using Version Two of the ILD Model

Module two was developed using version two of the ILD model. Learning designers created module two content after module one was implemented in a real classroom at Gollis University. Feedback received from peer reviewers, students, and the instructor during module one development and implementation was used to improve version two of the ILD model. Finally, learning designers continued to work with subject matter experts (SMEs) at Gollis University to develop module two content.

Participating Learning Designers. Learning designers (n=5) continued to participate in the design and development of module two. Three learning designers developed the content in collaboration with SMEs at Gollis University. One learning designer oversaw the development process, performed peer-review, conducted workshops, and facilitated review meetings. And one learning designer conducted peer-review and provided feedback to developers.

Workshop Two for Learning Designers. A second workshop was conducted to orient learning designers with version two of the proposed ILD model (see figure 18). The model consists of six interconnected phases: analyze, design, develop, formative evaluation, and summative evaluation. The development phase was updated based on feedback received during version one development and implementation. The seven learning theories extracted from IPT and CLT were added to the development phase of version two. This phase suggests applying these seven principles when designing learning objects. In addition, the development phase encourages using appropriate learning strategies for the learning content. Table 3 provides a list of proposed learning strategies. The orientation workshop also addressed the importance of selecting appropriate learning strategies for the learning content.

Designing Module Two Content using Version Two of the ILD Model. Using the findings of the analysis report produced during module one development, learning designers developed a blueprint (see table 8) for module two development. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies. Learning designers used this blueprint to develop module two content.

Module Two Description. Module two focused on the functions of short-range and long-range wireless technologies. In addition, it described wireless standards and how to plan and implement a Secure Wireless Network. Best practices for evaluation and presentation were provided in facilitated discussions and reinforced with practical exercises. Module two contained three lessons. Table 7 provides a brief description of each lesson in the module.

Table 7

Module Two Schedule

Module	Lesson	Description	Reference Material
Module 2	M.2: Lesson 1: Types of Wireless Technology/Short and Long Range	Lesson 1 provides an overview of short-range and long-range wireless technologies.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 139—70; 254—264; 273—279; 309—318). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.
	M.2: Lesson 2: Planning for a Wireless Network	Describes how to plan and implement a Secure Wireless Network.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 175—197). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.
	M.2: Lesson 3: Wireless Standards	Lesson 3 examines wireless standards.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 139—170). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.

Module Two Detailed Design Blueprint. Table 8 shows a detailed design description of module two. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies. Learning designers used this blueprint to develop module one content.

Table 8

Detailed Design Blueprint

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
Module 2	M.2. Lesson 1: Types of Wireless Technology/ Short and Long Range	Identify the types of short-range and long-range wireless technologies	Short-range Wireless Long-range Wireless	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 139—70; 254—264; 273—279; 309—318). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	450 mins
	M.2. Lesson 2: Implementing Wireless LANs	Develop a plan and implement a Secure Wireless LANs	Evaluate Wireless LAN requirements Plan and Design the Wireless LAN Pilot Testing Installation and Configuration Operation and Support A Case Study	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 175—197). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive,	500 mins

(continued)

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
						Suite 400, Burlington MA 01803.	
	M.2. Lesson 3: Wireless LAN Standards	Define wireless standards	The 802.11 WLAN Standards The 802.11 MAC Layer 802.11 PHY Layer 802.11 Enhancements Other WLAN Standards	Flipped classroom. Lecture Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 139—170). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	4 50 mins

Note. Table 8 shows a detailed design blueprint of module two.

Creating Module Two Content using Version Two of the ILD Model. Module two was developed in collaboration with SMEs at Gollis University. This module consisted of three lessons. Each lesson has reading materials, exercises, and exam questions. In addition, they created storyboards and used Doodly software to develop whiteboard animation videos. The videos contained pictures, graphics, animations, text, voiceover, and subtitles in each video to help understand the new concept. Feedback from students and instructors during module one implementation was used to improve subsequent versions of the ILD model.

Learning learners created reading materials, exercises, assessments, and lecture notes. Several iterations of revision were conducted for quality assurance purposes before producing the final version. Activities were designed to help learners understand the content, and assessments were used to measure students' learning gains. In addition, exam questions were used to assess the strengths and weaknesses of the course so that learning designers and instructors could improve the quality of subsequent learning objects.

Testing Version Two of the ILD Model by Implementing Module Two

Module two was implemented in an ICT classroom at Gollis University to test the effectiveness of the version two ILD model. Students were surveyed during the experiment to measure their satisfaction regarding the flow, organization, and content chunking of module one. In addition, the instructor was interviewed to capture his feedback regarding the flow, organization, and content chunking. Feedback from the instructor and students was used to refine subsequent versions of the ILD model and improve the quality of the following modules.

Participating Students

A total of 32 learners, males (n=24) and females (n=8) from various socioeconomic backgrounds, participated in the experiment.

Delivery Procedures

The flipped classroom strategy was used to deliver module two. Students could watch the instructional videos, complete online quizzes, and read learning materials before attending in-person sessions. The instructor presented the content during in-person sessions, answered questions, and facilitated exercises. In each lesson, students completed three reflective, abstract, and performance-based activities. Reflection exercises were designed to help learners reflect on the content and rehearse the critical information. Abstract exercises were designed to trigger learners' critical thinking. These exercises were scenario-based activities where learners worked in groups to brainstorm and find solutions.

Challenges of using Version Two ILD Model

Version two of the ILD model was used to design and develop the content of module two. Findings revealed that version two suggested all seven learning theory principles equally apply to every experiential learning cycle stage. For example, version two of the ILD model suggested that IPT-1/2/3/4 and CLT-1/2/3 equally apply to the concrete experience, reflective, abstract, and acting stages. This design flaw impeded learning designers' ability to effectively use each learning theory principle when and where it is applicable.

Challenges Faced during Content Development

A formative evaluation was conducted throughout the development of module two content to measure the effectiveness of the version two ILD model. Every learning object (e.g., instructional video) created by the learning designers was reviewed by peer reviewers on time. Each learning object went through several iterations of revisions and refinement. Peer reviewers checked the flow, organization, and content chunking of each learning object in the module. The intent was to ensure that learning designers apply learning theory principles in the design and development of module two. Findings revealed that version two of the ILD model has a design flaw, which impeded learning designers' ability to effectively apply each learning theory principle when and where it is applicable. Version two of the ILD model suggested that learning designers must equally apply IPT-1/2/3/4 and CLT-1/2/3 in all four stages of the experiential learning cycle. However, further analysis of the learning theory principles confirmed that all seven principles are not equally applicable to all four stages of the ELC.

In addition, findings showed that learning designers slightly improved the flow and organization of the reading content. However, there was a lot of extraneous information in the reading content. For example, in lesson one of module two, learning designers used 233 words to explain WiFi security. However, iterations between peer reviewers, learning designers, and subject matter experts reduced the word count to 97 without losing the concept's meaning.

Challenges Faced during Implementation

A summative evaluation was conducted after implementing each module in a real classroom at Gollis University to measure the effectiveness of the proposed ILD model. Findings revealed several challenges encountered during the implementation of the experiment. These challenges include that:

- Some of the content was not packaged into smaller chunks that learners can digest and transfer into knowledge and application.
- Some of the images, graphics, animations and other learning aids integrated into the lessons did not seem to add value or facilitate learning.

Benefits of using Version Two ILD Model

The main benefit of using version two of the ILD model was that learning designers became well acquainted with what principle to apply in what stage. Version two added a list of the seven learning theory principles into the development phase of the ILD model. In addition, version two briefly described how to apply each principle in all four stages of the ELC.

Problems Faced with using Version Two ILD Model

The main problem faced with using version two of the ILD model was applying all seven learning theory principles to every stage of the experiential learning cycle. This design defect obstructed learning designers' ability to use each learning theory principle to what stage it is applicable.

Development Process of the Version Three ILD Model

Version three of the iterative learning development (ILD) model was developed in collaboration with practitioners. Feedback from peer reviewers, students, and the instructor was used to refine version three of the ILD model (see figure 19). The seven learning theory principles were revised and added to version three of the ILD model. Each principle was added to associated stages. For instance, IPT-1/2/3/4 and CLT-1/2/3 were added to the concrete experience stage. In addition, the IPT-3 and CLT-3 apply to the reflective observation and active experimentation stages. And CLT-3 applies to the abstract conceptualization stage. Version three of the IDL model was updated to reflect these changes.

Implementing Feedback from Version Two Development

Table 9 depicts the feedback collected during the development and implementation of version two and how it was addressed to refine version three of the ILD model.

Table 9

Implementing Feedback from Version Two Development

Feedback from Version Two Development	How it was Addressed in Version Three
Findings revealed that version two of the ILD model proposed that all seven learning principles are equally applicable to every stage of the ELC. This design defect obstructed learning designers’ ability to apply each learning theory where it is relevant. For example, learning designers lost focus on packaging the content into manageable pieces of information. In lesson one of module two, learning designers used 233 words to explain WiFi security. Through iterations between peer reviewers, learning designers, and subject matter experts, the word count was reduced to 97 without losing the concept's meaning.	Version three of the ILD model was updated to reflect feedback received during the development and implementation of version two of the ILD model. In every ELC stage, only applicable principles were added. For example, the IPT-3 and CLT-3 were added to the reflective observation and active experimentation stages. The other five principles were removed as they did not apply to these stages. Learning designers were oriented on how to use version three of the ILD model. Changes in the development phase of the IDL model were emphasized during the third orientation workshop.

(continued)

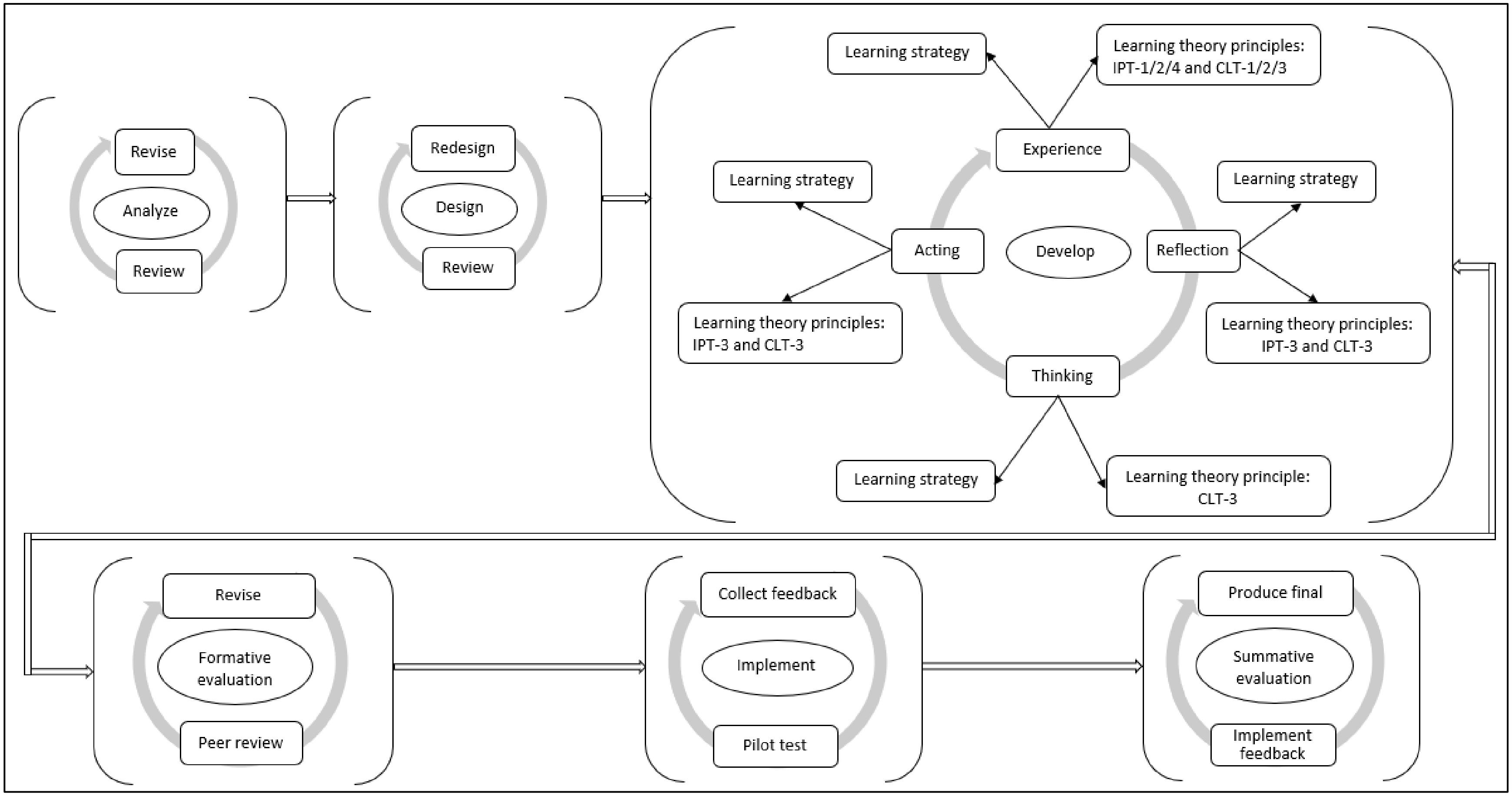
Feedback from Version Two Development	How it was Addressed in Version Three
Some of the images, graphics, animations and other learning aids integrated into the lessons did not seem to add value or facilitate learning.	A brief description of the IPT-4 was added to version three of the ILD model to help learning designers create multimedia assets relevant to the learning objectives. In addition, the IPT-4 was reiterated during the orientation workshop.

Version Three of the ILD Model

Figure 19 shows the final version (i.e., version three) of the iterative learning development (ILD) model.

Figure 19

Version Three of the ILD Model



Note. Version three of the ILD model

Testing Version Three of the ILD Model by Developing Module Three

The design-based research (DBR) method proposes conducting iterative cycles of testing and refinement of the intervention. Two types of iterations were performed throughout the development of the ILD model. The first iteration was administered by creating module three of the 3-module exemplary learning object using version three of the ILD model. The second iteration was conducted during the implementation of module three in a real classroom at Gollis University. Feedback from practitioners during the content development and delivery was used to improve the ILD model.

Developing Module Three using Version Three of the ILD Model

Module three was developed to test the effectiveness of the proposed ILD model. Participating learning designers (n = 5) used version three of the ILD model and created module two content. Learning designers were oriented on how to use version two of the ILD model. The importance of applying learning theory principles was emphasized during the orientation workshop.

Module three was developed after module two was implemented in a real classroom at Gollis University. Feedback from peer reviewers, students, and the instructor during the development and implementation of module two was used to improve version three of the ILD model. Finally, learning designers continued to work with subject matter experts (SMEs) at Gollis University to develop module three content.

Participating Learning Designers. Learning designers (n=5) continued to participate in the design and development of module two. Three learning designers developed the content in collaboration with SMEs at Gollis University. One learning designer oversaw the development process, performed peer-review, conducted workshops, and facilitated review meetings. And one learning designer conducted peer-review and provided feedback to developers.

Workshop Three for Learning Designers. A third workshop was conducted to orient learning designers with version three of the proposed ILD model (see figure 19). The model consists of six interconnected phases: analyze, design, develop, formative evaluation, and summative evaluation. The development phase was updated based on feedback received during the development and implementation of version two. Changes in the development phase of the IDL model were emphasized during the third orientation workshop. In addition, the development phase encourages using appropriate learning strategies for the learning content. Table 3 provides a list of proposed learning strategies. The orientation workshop also addressed the importance of selecting appropriate learning strategies for the learning content.

Designing Module Three Content using Version Three of the ILD Model. Using the findings of the analysis report produced during module one development, learning designers developed a blueprint for module three development. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies. Learning designers used this blueprint to develop module three content.

Module Three Description. Module three focused on examining wireless network security and how to identify and solve networking problems in WLANs. At the end of module three, learners completed a capstone on setting up and configuring a wireless local area network (WLAN) using Linksys E900 Wireless Router. Module three consisted of two lessons and a case study. Table 10 provides a brief description of each topic in the module.

Table 10

Module Schedule

Module	Lesson	Description	Reference Material
Module 3	M.3: Lesson 1: Wireless Network Security	Lesson 1 examines wireless network security.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 205—239). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.
	M.3: Lesson 2: Wireless LAN Troubleshooting	Lesson 2 describes how to identify and solve networking problems in WLANs.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 241—247). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.
	M.3: Lesson 3: Case Study	Lesson 3 describes how to set up and configure Wireless Router using Linksys E900.	

Module Three Detailed Design Blueprint. Table 11 shows a detailed design description of module three. The blueprint outlines the titles of lessons and topics of the module, learning objectives, and instructional and assessment strategies.

Table 11

Detailed Design Blueprint

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
Module 3	M.3. Lesson 1: Wireless Network Security	Define wireless network security	The Hacking Threat WLAN Security WEP – Wired Equivalent Privacy Encryption Wi-Fi Protected Access – WPA IEEE 802.11i and WPA2 WLAN Security Measures Wireless Hotspot Security VoWLAN and VoIP Security	Flipped classroom. Lecture. Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementation* (pp. 205—239). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	400 mins
	M.3. Lesson 2: Wireless LAN Troubleshooting	Identify and solve networking problems in WLANs	Analyzing Wireless LAN Problems Troubleshooting using WLAN Analyzers Bluetooth Coexistence with 802.11 WLANs	Flipped classroom. Lecture. Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Rackley, S. (2007). *Wireless networking technologies. From principles to successful implementatio*	400 mins

(continued)

Module	Lesson Titles	Learning Objectives	Topics and Subtopics	Instructional Strategy	Assessment Strategy	Content Source	Timing
						n (pp. 241—247). Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Suite 400, Burlington MA 01803.	
	M.3. Lesson 3: Case Study	Set up and configure a wireless LAN using Linksys E900 Wireless Router	Set up and configure WLAN	Flipped classroom. Lecture. Facilitated/guided discussion. Individual exercise or activity. Group/team exercise or activity. Homework.	Instructor/peer observation and feedback. Quiz. Knowledge checks. Presentations.	Course materials	

Note. Table 11 shows a detailed design blueprint.

Creating Module Three Content using Version Three of the ILD Model. Module three was developed in collaboration with SMEs at Gollis University. This module consisted of two lessons and a case study. Each lesson has reading materials, exercises, and exam questions. In addition, learning designers created storyboards and used Doodly software to develop whiteboard animation videos. The videos contained pictures, graphics, animations, text, voiceover, and subtitles in each video to help understand the new concept. Feedback from students and instructors during module two implementation was used to improve the ILD model.

Learning learners created reading materials. Several revisions were conducted to the reading materials of each lesson before producing a final version. In addition, they created exercises to help learners understand the content. Finally, they developed exam questions to help students reflect on coursework. The exam questions were designed to assess the strengths and weaknesses of the course so that learning designers and instructors can measure students' learning gains.

Testing Version Three of the ILD Model by Implementing Module Three

Module three was implemented in an ICT classroom at Gollis University to test the effectiveness of the version three ILD model. Students were surveyed during the experiment to measure their satisfaction regarding module three's flow, organization, and content chunking. In addition, the instructor was interviewed to capture his feedback regarding the flow, organization, and content chunking. Feedback from the instructor and students was used to refine the ILD model.

Participating Students

A total of 32 learners, males (n=24) and females (n=8) from various socioeconomic backgrounds, participated in the experiment.

Delivery Procedures

The flipped classroom strategy was used to deliver module three. Students watched the instructional videos, completed online quizzes, and read learning materials before attending in-person sessions. Then, the instructor presented the content during in-person sessions, answered questions, and facilitated exercises. In each lesson, students completed two types of exercises: reflective and abstract. Reflective exercises were designed to help learners reflect on the content and rehearse the critical information. Abstract exercises were designed to trigger learners’ critical thinking and deepen their understanding of the new concept. These exercises were scenario-based activities where learners worked in groups to brainstorm and find solutions.

Challenges of using Version Three ILD Model

Version three of the ILD model was used to design and develop the content of module three. Findings revealed extraneous information in some reading materials. For example, in lesson two of module three, learning designers used 134 words to describe how to set up a Linksys Wi-Fi router using manually. Through iterations between peer reviewers, learning designers, and subject matter experts, the word count was reduced to 110 without losing the concept's meaning. However, this could be considered a significant improvement compared to module two.

Challenges Faced during Content Development

A formative evaluation was conducted throughout the development of module three content to measure the effectiveness of the version three ILD model. Every learning object (e.g., instructional video) created by the learning designers was reviewed by peer reviewers on time. Each learning object went through several iterations of revisions and refinement. Peer reviewers checked the flow, organization, and content chunking of each learning object in the module. The intent was to ensure that learning designers apply learning theory principles in the design and development of module three. Findings revealed extraneous information in some reading materials. However, learning designers significantly improved chunking the content while using version three of the ILD model.

Challenges Faced during Implementation

A summative evaluation was conducted after implementing each module in a real classroom at Gollis University to measure the effectiveness of the proposed ILD model. Findings revealed that some of the content was not packaged into smaller chunks that learners can digest and transfer into knowledge and application.

Benefits of using Version Three ILD Model

Version three of the ILD model helped learning designers identify which principle to apply at what stage of the experiential learning cycle. This clarity helped designers focus on applying the principles without spending time identifying what principle to use in what stage.

CHAPTER V

Findings

This chapter describes the findings of the iterative testing and refinement cycles of the proposed ILD model. The design-based research (DBR) method suggests conducting iterative testing and refinement of the intervention. Two types of iterations were performed throughout the study to measure the effectiveness of the proposed ILD model. First, the ILD model was used to design a 3-module learning object. The development of the ILD model underwent several iterations of testing and refinement while developing a 3-module learning object. Feedback provided by peer reviewers was used to improve the effectiveness of the ILD model. Second, the 3-module learning object was implemented in the class at Gollis University to measure the effectiveness of the ILD model. Students completed survey questionnaires, and the instructor was interviewed during and after the implementation of each module to capture their feedback regarding the module's flow, organization, and content chunking.

Description of the ILD Model Development

Design-based research (DBR) is not in itself a methodology but a systematic research approach (Herrington et al., 2005) aimed at improving learning by conducting iterative cycles of testing and refinement in collaboration with practitioners in real-world settings (Wang & Hannafin, 2005, p.6). The DBR method was used to develop the ILD model. Learning designers tested three versions of the ILD by creating a 3-module learning object. Iterative cycles of evaluation were conducted during the development of each module.

Peer reviewers provided quantitative and qualitative feedback to learning designers throughout the development of module one. For instance, they used a scoring rubric to evaluate the quality of the instructional videos and learning content. In addition, they provided qualitative feedback on reading materials, assessments, etc. Feedback from peer reviewers was used to improve the subsequent versions of the ILD model. The main components of the module included instructional videos, content, and assessment. Each module was revised several times based on peer reviewers' feedback.

Description of ILD Model Implementation

The three versions of the ILD model were used at different times to design the 3-module learning object. The exemplary learning object was then implemented in an ICT classroom at Gollis University to test the effectiveness of the ILD model. Iterative cycles of testing and refinement were conducted. The implementation of the experiment continued for a semester. Students were surveyed after completing each module to measure their satisfaction with the course regarding flow, organization, and content chunking. In addition, the instructor was interviewed to capture his feedback regarding the flow, organization, and content chunking. Feedback from the instructor and students was used to improve the quality of subsequent modules and the effectiveness of the proposed design framework.

Data Collection

Peer reviewers used a scoring rubric to evaluate the instructional videos (see table 13) and learning content (see tables 14 and 15). The scoring rubric for evaluating the instructional videos consisted of six different indicators. These included introduction, content and organization, technical aspects, creativity, closure, and video length.

Reviewers ranked each category as needing improvement, satisfactory, or good. For instance, if the video lacks a central theme, clear point of view, and logical sequence of information, the objective is not clear, and much of the content is irrelevant to the overall message. Then, reviewers ranked the video as needing improvement. However, if the video includes a clear statement of purpose, events and messages are presented in a logical order with relevant information that supports the video's main ideas. Then, reviewers ranked the video as good.

The scoring rubric for evaluating the learning content consisted of two parts. Part one, Table 14, describes the scoring rubric for assessing the application of learning theory principles. Peer reviewers used Table 14 to measure the application of relevant learning theory principles in the design of the 3-module learning object. Reviewers ranked the learning content as needing improvement, satisfactory, or good. For example, if learning designers examined the content, removed all extraneous information, and mapped it with learning objectives, reviewers ranked it as good. If not, they rated it as either satisfactory or needs improvement.

Part two, Table 15, describes the scoring rubric for evaluating the overall design of the learning content. Peer reviewers used Table 15 to assess whether or not the content was chunked into four stages as prescribed by the experiential learning cycle. In each stage, reviewers ranked the learning object as needing improvement, satisfactory, or good. For example, if learning designers created learning objects that provide concrete experiences to learners, reviewers ranked the learning content as good. If not, they rated it as either satisfactory or needs improvement.

The survey questionnaire (see table 12) was used to collect data from students during the module implementation. A Likert-guided scale of one to five was used to develop the survey questions. One and two were signified as negative responses, while four and five were signified as positive responses. Responses in the middle (i.e., three) were signified as neutral. The positive responses were accounted for to measure the effectiveness of the modules. Students were asked to rate the flow, content, exercises, and instructional videos. Google forms were used to deploy the questions to participants. Participants received an email from the researcher soliciting to provide their unbiased feedback. Participants were given assurance that the survey responses were anonymous and their feedback would remain confidential.

Students completed the survey questions after completing the first two lessons of each module. The feedback was provided to learning designers to improve the quality of the subsequent developments. The instructor was interviewed at the same time to give input on his experience interacting with the content and deliver to students. Instructor feedback was provided to learning designers as well. Feedback from students and the researcher used the instructor to improve the ILD model.

An informal interview was conducted to solicit as much feedback as possible from the instructor. Below are some of the interview questions:

1. Were the learning objectives of the module clear to you?
2. Do you think the module content helped students achieve the desired learning objectives?
3. Did you find the course material easy to follow?

4. Did the learning activities and exercises help students learn the learning materials?
5. How would you describe the quality of the instructional videos (e.g., graphics, voiceover, subtitles, overall message)? What would you recommend to change (if any)?
6. How would you describe the quality of the reading materials?
7. Describe the strengths and weaknesses of the module. What could have made the module more effective?

Table 12 shows the survey questionnaire used to collect data from students during the module implementation. A Likert-guided scale of one to five was used to develop the survey questions.

Table 12

Survey Questionnaire

Questions	One	Two	Three	Four	Five
Q1- I found the course material easy to follow.					
Q2: I agree that the learning activities and exercises helped me understand the module.					
Q3- How would you rate the instructional video's quality (e.g., graphics, voiceover, subtitles, overall message).					
Q4- How would you rate the quality (e.g., clarity, simplicity, flow, graphics, etc.) of the reading materials?					
Q5- How would you rate your overall satisfaction with the module?					

Table 13 shows the scoring rubric for evaluating instructional videos. The rubric consists of six different indicators. These included introduction, content and organization, technical aspects, creativity, closure, and video length.

Table 13

Rubric for Evaluating Instructional Videos

Indicator	Needs Improvement	Satisfactory	Good
Introduction	The introduction does not orient the viewer to what will follow. 0–2 points	The introduction is clear and coherent and evokes moderate interest/response from the viewer. 3–4 points	The introduction is motivating and hooks the viewer from the beginning. 5 points
Video content and organization	The video lacks a central theme, clear point of view, and logical sequence of information. The objective is not clear. Much of the information is irrelevant to the overall message. 0–2 points	Information is connected to a theme. The objective is clear to the viewer. Details are logical, and information is relevant throughout most of the video. 3–4 points	The video includes a clear statement of purpose. Events and messages are presented in a logical order, with relevant information that supports the video's main ideas. 5 points
Technical aspects	The video is of poor quality and is unedited. No transitions are added or used so frequently that they detract from the video. There are no graphics, and the images are not well composed. In addition, the text and/or audio has four or more grammar or spelling errors. 0–2 points	The video is edited. Titles and transitions are used for the most part. Most of the video content has good pacing and timing. Graphics are used appropriately. The text and/or audio has 1-2 grammar or spelling errors. 3–4 points	The video is edited. The video runs smoothly from shot to shot. Various titles and transitions are used to assist in communicating the main idea. Images and scenes work well together. Graphics explain and reinforce key points in the video. The text and/or audio have no grammar or spelling errors. 5 points
Creativity	The video is not creative nor focuses on the skills of teaching. 0–2 points	The video displays creativity that is not relevant to teaching. 3–4 points	The video displays creativity that focuses on the skills of teaching. 5 points
Closure	The video ends abruptly and does not convey the theme/message. 0–2 points	The video ends in a manner that will adequately cause the viewer to remember the theme/message. 3–4 points	The video ends effectively and creatively, which will cause the viewer to remember the theme/message. 5 points
Length (2 – 5 min.)	Too long or too short (less than 2 minutes or more than 5 minutes) 0–2 points	NA	Within the timeframe (2 to 5 minutes) 5 points
Total			
Project Grade			

Note. Table 13 shows the scoring rubric for evaluating instructional videos. The rubric was adapted from Liberty University.

Table 14 describes the scoring rubric for assessing the application of learning theory principles. Peer reviewers used Table 14 to measure the application of relevant learning theory principles in the design of the 3-module learning object.

Table 14

Scoring Rubric for Evaluating the Application of Learning Theory Principles

Indicator	Needs Improvement	Satisfactory	Good
IPT-1/CLT-2	The extraneous information was not removed to avoid overwhelming learners' working memory. The content was not dissected and mapped with learning objectives. 0–2 points	Some extraneous information was removed to avoid overwhelming learners' working memory. In addition, some of the content was dissected and mapped with learning objectives. 3–4 points	All extraneous information was removed to avoid overwhelming learners' working memory. The content was dissected and mapped with learning objectives. 5 points
IPT-2/CLT-1	The content was not chunked into bite-size pieces of information to help learners digest the new concept and transfer it into working memories. 0–2 points	Some of the content was chunked into bite-size pieces of information to help learners digest the new concept and transfer it into working memories. 3–4 points	The content was chunked into bite-size pieces of information to help learners digest and transfer the new concept into working memories. 5 points
IPT-3	Reflective exercises were not created for two or more lessons to help learners rehearse critical information about the new concept. 0–2 points	Reflective exercises were created for some lessons to help learners rehearse critical information about the new concept. These exercises were designed to help learners recall essential details. 3–4 points	Reflective exercises were created for all lessons to help learners rehearse critical information about the new concept. These exercises were designed to help learners recall essential details. 5 points
IPT-4	Irrelevant images, graphics, maps, animations, etc., were integrated into the learning contents. These visual materials did not help learners visualize and recall critical information. Or learning content lacked images, graphics, maps, animations, etc., to help learners remember essential details. 0–2 points	Relevant images, graphics, maps, animations, etc., were integrated into some learning contents to help learners visualize and recall critical information. 3–4 points	Relevant images, graphics, maps, animations, etc., were integrated into all learning contents to help learners visualize and recall critical information. 5 points
CLT-3	All content was not packaged into a format that provided an appropriate level of difficulty based on learners' prior knowledge to ignite mental resources	Some of the content was not packaged into a format that provided an appropriate level of difficulty based on learners' prior knowledge to ignite	The content was packaged into a format that provided an appropriate level of difficulty based on learners' prior knowledge to ignite mental resources devoted to constructing schemata in the long-term memory.

(continued)

Indicator	Needs Improvement	Satisfactory	Good
	devoted to constructing schemata in the long-term memory. 0–2 points	mental resources devoted to constructing schemata in the long-term memory. 3–4 points	5 points
Project Grade			

Note. Table 14 shows the scoring rubric developed for evaluating the application of learning theory principles.

Table 15 describes the scoring rubric for evaluating the overall design of the learning content. Peer reviewers used Table 15 to assess whether or not the content was chunked into four stages as prescribed by the experiential learning cycle. In each stage, reviewers ranked the learning object as needing improvement, satisfactory, or good. For example, if learning designers created learning objects that provide concrete experiences to learners, reviewers ranked the learning content as good. If not, they rated it as either satisfactory or needs improvement.

Table 15

Evaluation form for Overall Design of the Learning Object

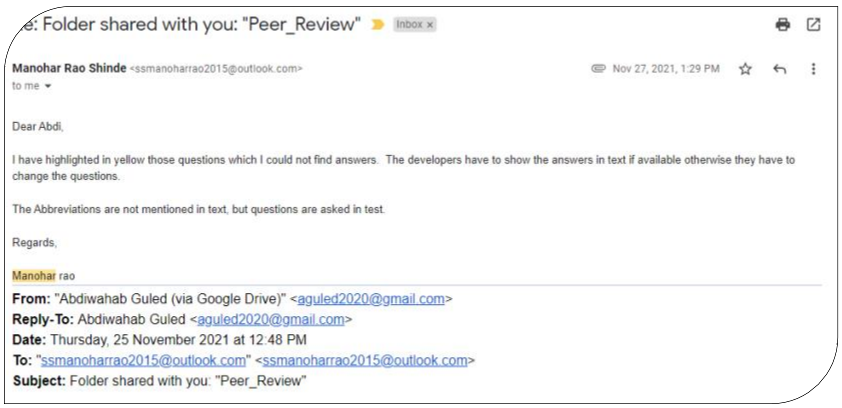
Indicator	Needs Improvement	Satisfactory	Good
Concrete experience	Learning objects created for all lessons were convoluted. They were not designed to provide concrete experiences to learners. 0–2 points	Learning objects that provide concrete experiences were created for some lessons but not all. These learning objects included instructional videos, reading content, lecture notes, etc. However, all lessons did not have 3–4 points	Learning objects that provide concrete experiences were created for all lessons. These learning objects included instructional videos, reading content, lecture notes, etc. 5 points
Reflective exercises	Reflective exercises did not prompt learners to review the new concept. Or reflective activities were not created for two or more lessons in each module. 0–2 points	Reflective exercises that prompt learners to review the new concept were created for some of the lessons but not all. 3–4 points	Reflective exercises that prompt learners to review the new concept were created for all lessons. These exercises were designed to help learners recall critical information about the new concept. 5 points
Abstract exercises	Abstract exercises that trigger learners' critical thinking were not created for two or more lessons in each module. No scenario-based activities were developed. 0–2 points	Abstract exercises that trigger learners' critical thinking were created for some lessons but not all to help learners deepen their understanding of the new concept. No scenario-based activities were developed. 3–4 points	Abstract exercises that trigger learners' critical thinking were created for all lessons to help learners deepen their understanding of the new concept. These exercises included scenario-based activities. 5 points
Performance-based exercises	Performance-based exercises were not created for two more applicable lessons in each module. 0–2 points	Performance-based exercises were created for some applicable lessons in each module but not all. 3–4 points	Performance-based exercises were created for all applicable lessons in each module. These activities may include presentations, hands-on exercises, etc. 5 points
Total			
Project Grade			

Note. Table 15 shows the scoring rubric created for evaluating the overall design of the content based on ELC (Kolb, 1984).

In addition to scoring rubrics, peer reviewers provided qualitative feedback on storyboards, handouts, lecture notes, exercises, and exam questions. They used the track change feature of MS Word to highlight the areas of concern and provide instructions on how to fix them. Figure 20 shows a sample email from a peer reviewer describing feedback provided on exam questions.

Figure 20

Feedback Email



e: Folder shared with you: "Peer_Review" Inbox ×

Manohar Rao Shinde <ssmanoharrao2015@outlook.com> Nov 27, 2021, 1:29 PM
to me

Dear Abdi,

I have highlighted in yellow those questions which I could not find answers. The developers have to show the answers in text if available otherwise they have to change the questions.

The Abbreviations are not mentioned in text, but questions are asked in test.

Regards,

Manohar rao

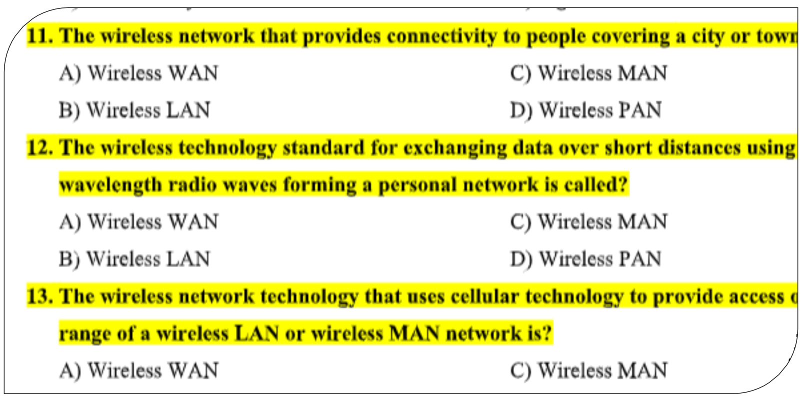
From: "Abdiwahab Guled (via Google Drive)" <aguled2020@gmail.com>
Reply-To: Abdiwahab Guled <aguled2020@gmail.com>
Date: Thursday, 25 November 2021 at 12:48 PM
To: "ssmanoharrao2015@outlook.com" <ssmanoharrao2015@outlook.com>
Subject: Folder shared with you: "Peer_Review"

Note. A sample email from a peer reviewer about feedback on exam questions.

The email reads, "*I have highlighted in yellow those questions which I could not find answers [to]. The developers [must[show the answers in the text if available; otherwise, they [must] change the questions. [For example], the Abbreviations are not mentioned in the text, but questions are asked in the test.*". The reviewer is referring to the feedback shown in figure 17. The reviewer provided feedback on exam questions indicating that some of the questions in the exam were not addressed in the content and that developers need to either update the content or change the questions highlighted in yellow. In addition, reviewers provided feedback regarding the design and organization of the content. Peer reviewers also offered input regarding the flow of the content and how it was chunked throughout the development phase of the exemplary learning object. Figure 21 shows a sample of exam questions reviewed by a peer reviewer and provided feedback to learning designers.

Figure 21

Feedback on Exam Questions


11. The wireless network that provides connectivity to people covering a city or town

A) Wireless WAN C) Wireless MAN

B) Wireless LAN D) Wireless PAN

12. The wireless technology standard for exchanging data over short distances using wavelength radio waves forming a personal network is called?

A) Wireless WAN C) Wireless MAN

B) Wireless LAN D) Wireless PAN

13. The wireless network technology that uses cellular technology to provide access o range of a wireless LAN or wireless MAN network is?

A) Wireless WAN C) Wireless MAN

Note. A sample of exam questions that a peer reviewer reviewed.

Findings

Version One of the ILD Model

Learning designers tested the performance of version one of the ILD model by developing module one of the 3-module exemplary learning object. Findings revealed that version one did not provide expected guidance to learning designers on how to apply learning theory principles. For example, version one did not specify which principle to apply at what stage of the experiential learning cycle. As a result, learning designers struggled to identify and apply learning principles accordingly. Using version one, learning designers failed to chunk the content into bite-size pieces of information. Figure 14 shows a sample of reading materials with extraneous details. Learning designers used 209 words and two charts to describe IP addresses. After several iterations between the peer reviewers, learning designers, and subject matter experts, the word count was reduced to 103 without losing the concept's meaning. In addition, some of the learning objectives did not align with the supporting content. This misalignment means that version one did not provide proper guidance to learning designers on mapping the content with learning objectives.

Module one was implemented in a classroom at Gollis University to test the effectiveness of version one of the ILD model. Students were surveyed to measure their satisfaction with module one. The survey was deployed to 32 students who participated in module one implementation. Twenty-seven (27) students responded to the survey questionnaire. Table 16 depicts module one student survey results.

Table 16

Student Survey Results on Module One

Questions	One	Two	Three	Four	Five
Q1- I found the course material easy to follow.	0	4	5	10	8
Q2: I agree that the learning activities and exercises helped me understand the module.	5	7	0	7	8
Q3- How would you rate the instructional video's quality (e.g., graphics, voiceover, subtitles, overall message).	11	9	5	2	0
Q4- How would you rate the quality (e.g., clarity, simplicity, flow, graphics, etc.) of the reading materials?	6	9	5	4	3
Q5- How would you rate your overall satisfaction with the module?	5	13	5	4	0

In module one, 135 responses were received from 27 students who participated in the survey. Forty-six (46) responses were categorized as positive, while 69 were categorized as negative. The remaining 20 responses were neutral. This feedback was used to improve version two of the ILD model.

In addition, the instructor was interviewed to capture his feedback on the flow, organization, and content chunking of module one. The instructor reported that:

- Some of the learning objectives aligned with the content.
- Some learning activities and exercises did not challenge students to rehearse critical information.
- The graphics, voiceover, and subtitles of the instructional videos need improvement.

Version Two of the ILD Model

Learning designers tested version two of the ILD model by developing module two of the 3-exemplary learning object. Findings revealed that learning designers progressed in applying learning theory principles to a certain extent. For example, learning designers improved the content and organization of the instructional videos. The central theme and logical flow of the videos were clear. They created quality storyboards by removing irrelevant information and simplifying the overall message. They improved the graphics and animations and changed the subtitles from running at the bottom of the screen to showing on the screen as the narrator speaks. However, they did not show much progress in chunking the content of the reading materials. They showed a slight improvement in the flow and organization of the reading content. However, there was a lot of extraneous information in the reading content. For example, in lesson one of module two, learning designers used 233 words to explain WiFi security. Through iterations between peer reviewers, learning designers, and subject matter experts, the word count was reduced to 97 without losing the concept's meaning. This indicated that version two of the proposed ILD model did not provide proper guidance to learning designers on chunking the content into manageable pieces of information that learners can process and transfer into knowledge and application.

Module two was implemented in a classroom at Gollis University to test the performance of version two of the ILD model. In addition, students were surveyed to measure their satisfaction with module two. The survey was deployed to 32 students who participated in module one implementation. Twenty-five (25) students responded to the survey questionnaire. Table 17 depicts module two student survey results.

Table 17

Student Survey Results on Module Two

Questions	One	Two	Three	Four	Five
Q1- I found the course material easy to follow.	0	1	3	12	9
Q2: I agree that the learning activities and exercises helped me understand the module.	2	0	5	10	8
Q3- How would you rate the instructional video's quality (e.g., graphics, voiceover, subtitles, overall message).	0	0	5	13	7
Q4- How would you rate the quality (e.g., clarity, simplicity, flow, graphics, etc.) of the reading materials?	4	7	8	4	2
Q5- How would you rate your overall satisfaction with the module?	3	5	10	4	3

In module two, 125 responses were received from 25 students who participated in the survey. Seventy-two (72) responses were categorized as positive, while 22 were categorized as negative. The remaining 31 responses were neutral.

In addition, the instructor was interviewed to capture his feedback on the flow, organization, and content chunking of module two. The instructor reported that module two slightly improved the flow and organization of the reading content. However, there was a lot of extraneous information in the reading content. This means that learning designers must apply IPT-1/CLT-2 effectively to remove all extraneous information from the content.

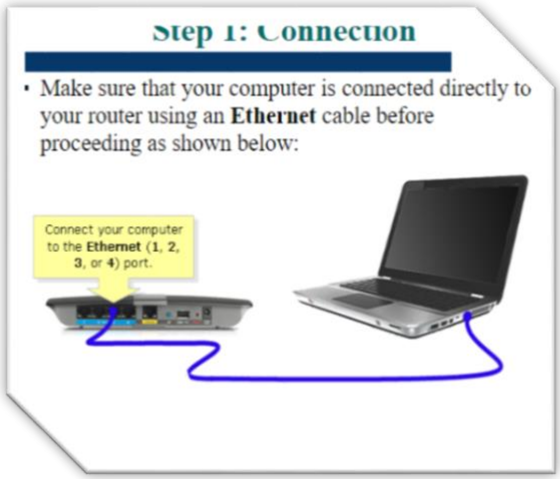
Version Three of the ILD Model

Learning designers tested version three of the ILD model by developing module three of the 3-exemplary learning object. Findings revealed that learning designers made significant progress in applying learning theory principles. The instructional videos showed a clear central theme and logical flow of the overall message. They added animations and enhanced the quality of the graphics. Subtitles were clear, and the voiceover was engaging. In addition, they showed significant progress in chunking the content of the reading materials. For example, in lesson two of module three, learning designers used 134 words to describe how to set up a Linksys Wi-Fi router using manually. Through iterations between peer reviewers, learning designers, and subject matter experts, the word count was reduced to 110 without losing the concept's meaning. This was a dramatic improvement in comparison to module two. They used graphics and a step-by-step process to simplify the concept and help learners understand the topic (see Figure 19).

This indicated that version three of the ILD model added significant value in helping designers chunk the content into manageable pieces of information that learners can process and transfer into knowledge and application. In addition, unlike the previous versions, version three addresses what principle to apply at what stage of the experiential learning cycle. This clarity helped the learning designers to apply learning theory principles effectively. Figure 22 shows an example of manually setting up a Lynksys router.

Figure 22

Setting up a Linksys Wi-Fi Router



Note. Figure 22 shows step one of how to set up a Linksys Wi-Fi router manually

Feedback from learning designers was implemented and used to improve the ILD model. Table 18 summarizes the improvement made by learning designers in chunking the content throughout the development of the three modules.

Table 18

Improvements Made in Chunking the Content During Development

Module	Indicators	Feedback/Improvements
Module one	• Organization • Chunking the content	Peer reviewers provided feedback on the organization and chunking of the content. For instance, videos lacked a central theme and logical flow of information. Irrelevant information was included. Transitions were not used properly. The graphics were not well composed. Subtitles needed improvement. In addition, extraneous information was included in the reading materials. The content was not chunked into smaller pieces of information to help learners process the new concept.
Module two	• Organization • Chunking the content	Learning designers made progress in applying learning theory principles to a certain extent. For example, the content and organization of the videos improved. The central theme and logical flow of the videos were clear. They removed most of the irrelevant

(continued)

Module	Indicators	Feedback/Improvements
		information and simplified the overall message. They improved the graphics and animations and changed the subtitles from running at the bottom of the screen to showing on the screen along with the narration. However, they did not show much progress in chunking the content of the reading materials. They showed a slight improvement in the flow and organization of the reading content. But, there was a lot of extraneous information in the reading content. For example, in lesson one of module two, learning designers used 233 words to explain WiFi security. Through iterations, the word count was reduced to 97 without losing the concept's meaning.
Module three	• Organization • Chunking the content	In module three, learning designers made significant progress applying learning theory principles. The instructional videos showed a clear central theme and logical flow of the overall message. They added animations and enhanced the quality of the graphics. Subtitles were clear, and the voiceover was engaging. In addition, they showed significant progress in chunking the content of the reading materials. For example, in lesson two of module three, learning designers used 134 words to describe how to set up a Linksys Wi-Fi router using manually. Through iterations between peer reviewers, learning designers, and subject matter experts, the word count was reduced to 110 without losing the concept's meaning. That was a significant improvement in comparison to module two.

In the context of this study, the organization refers to the order in which the content was presented. Content chunking refers to packing the learning items into smaller pieces of information to avoid cognitive overload for learners. Learning designers were repeatedly reminded of the learner’s working memory capacity as described by the information processing theory (Atkinson & Shiffrin, 1968).

Module three was implemented in a classroom at Gollis University to test the performance of version three of the ILD model. Students were surveyed to measure their satisfaction with module two. The survey was deployed to 32 students who participated in module one implementation. Twenty-nine (29) students responded to the survey questionnaire. Table 19 depicts module three student survey results.

Table 19

Student Survey Results on Module Three

Questions	One	Two	Three	Four	Five
Q1- I found the course material easy to follow.	0	3	1	12	13
Q2: I agree that the learning activities and exercises helped me understand the module.	3	1	6	8	11
Q3- How would you rate the instructional video's quality (e.g., graphics, voiceover, subtitles, overall message).	0	2	3	9	15
Q4- How would you rate the quality (e.g., clarity, simplicity, flow, graphics, etc.) of the reading materials?	2	4	3	9	11
Q5- How would you rate your overall satisfaction with the module?	0	2	6	14	7

In module three, a total of 145 responses were received from 29 students who participated in the survey. Hundred and nine (109) responses were categorized as positive, while 17 were categorized as negative. The remaining 19 responses were neutral.

In addition, the instructor was interviewed to capture his feedback on module three's flow, organization, and content chunking. The instructor reported that module three significantly improved the flow and organization of the reading content.

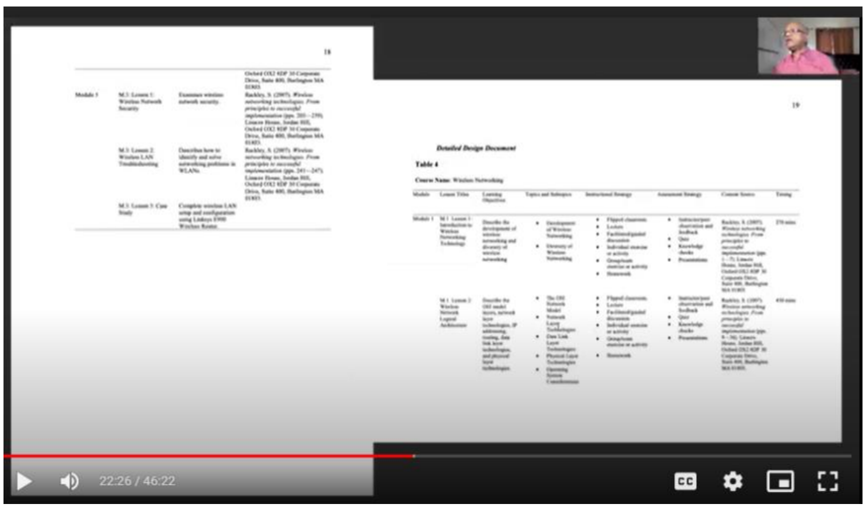
Review Meetings

The feedback provided by peer reviewers was discussed in review meetings. A total of nine review meetings were conducted throughout the development of the 3-module exemplary learning object. That is one review meeting after the completion of each lesson. During meetings, the feedback was dissected, and action plans were created. The action plans were then implemented to improve the proposed ILD model.

Figure 18 shows a review meeting among the peer reviewers and learning designers. During the meeting, each reviewer provided an update on the feedback they provided. Next, learning designers discussed input and how they implemented it. Then, the team lead recapped the meeting by outlining the lessons learned and future action items. Figure 23 depicts a screenshot of a review meeting.

Figure 23

Review Meeting



Note. The screenshot shows a review meeting between reviewers and learning designers discussing the feedback provided by peer reviewers and how to implement it. In addition, the team discussed lessons learned and the next steps.

Table 20 summarizes the review meetings conducted throughout the study.

Table 20

Review Meetings

Task	Module/Lesson	Purpose
Review meeting one	M.1: Lesson 1: Introduction to Wireless Networking Technology	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting two	M.1: Lesson 2: Wireless Network Logical Architecture	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting three	M.1: Lesson 3: Wireless Network Physical Architecture	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting four	M.2: Lesson 1: Types of Wireless Technology/Short and Long Range	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting five	M.2: Lesson 2: Planning for a Wireless Network	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting six	M.2: Lesson 3: Wireless Standards	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting seven	M.3: Lesson 1: Wireless Network Security	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting eight	M.3: Lesson 2: Wireless LAN Troubleshooting	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.
Review meeting nine	M.3: Lesson 3: Case Study	Review feedback from peer reviewers. Develop a plan of action to implement it. Discuss lessons learned and plans for the next steps.

Note. Table 20 summarizes the number of meetings conducted throughout the development of the exemplary learning object.

Conclusion

Survey responses revealed that students rated module one the lowest and module three the highest. For example, 34% of the students rated module one as four and five categories of the Likert's scale, while 51% rated one and two on the scale. In module two, responses improved to the higher fifties, where 58% of the students rated the module as four and five category of the Likert's scale, and 18% rated it as one and two on the scale. In module three, responses subsequently improved, where 75% of the students rated the module as four and five categories of the Likert's scale, and 12% rated it as one and two categories of the scale.

In addition to survey responses, the instructor was interviewed during the implementation of each module. The interview results were in line with the survey responses. The instructor provided regular feedback to learning designers and peer reviewers to improve the quality of subsequent modules.

Feedback from peer reviewers, students, and the instructor was used to improve the subsequent versions of the ILD model.

CHAPTER VI

Conclusion

This chapter summarizes the findings of this design-based research. The study was conducted in four phases, as proposed by Reeves et al. (2005). In phase I, analysis was conducted in collaboration with practitioners in the field, and a preliminary literature review was undertaken to develop the problem statement, research objectives, and questions.

In phase II, the proposed design intervention was developed by conducting a relevant literature review and collaborating with practitioners in the field. In phase III, iterative testing and refinement cycles of the proposed solution were performed. Finally, the iterative learning development (ILD) model was developed in phase IV. The ILD model is a recursive rather than linear process designed to create learning objects grounded in learning theory principles. The DBR method was used to develop the proposed ILD model in collaboration with real-world practitioners. Three iterations of testing and refinement were undertaken to create the final proposed ILD model (i.e., version three). This chapter also provides a summary response to each research question.

Discussion

Research Questions

Q1 – How do you develop a design framework that provides design guidelines for learning designers when designing learning objects grounded in learning theory principles?

The design-based research method was used in the context of educational technology to develop the proposed design framework. The intent was to create a framework that provides design guidelines to novice instructional designers when developing learning objects grounded in educational science.

The experiential learning cycle (ELC) was used as the theoretical framework to develop the proposed design framework as the theoretical framework. The four phases of the ELC were used as the foundation of the design framework. In addition, seven principles derived from information processing and cognitive load theories were used to create the proposed design framework. These principles could help learning designers examine the content, remove extraneous information, map content with learning objectives, and package it into smaller chunks that learners can process without feeling cognitive overload.

To effectively apply the experiential learning cycle and the seven principles derived from the information processing and cognitive load theories, learning designers must use different learning strategies appropriate for the learning content, context, and learner characteristics. Therefore, 18 learning strategies were proposed to incorporate into the design framework (see table 3).

SQ1 – Why do many learning designers overlook the application of learning theory principles in the design of learning objects?

Many learning designers do not apply learning theory principles in the design of learning objects. A survey of 113 learning designers revealed that only half use learning theory principles to make instructional strategy decisions (Christensen & Osguthorpe, 2008). There are numerous learning theory principles. Over the past century, many learning theories have been proposed. However, not all learning theories provide principles pertinent to designing learning objects. Therefore, it is difficult for learning designers to identify and apply relevant learning theory principles to create effective learning objects.

Research indicates that many learning designers encounter difficulties identifying and applying relevant learning theory principles (Yanchar et al., 2010). As a result, learning objects created by professional learning designers are not grounded in learning theory principles. Occasionally, designers overuse technology by adding unnecessary animations or complex graphics. In other cases, they include convoluted paragraphs or fail to simplify the content by chunking it into bite-size pieces of information that learners can digest. Adding unnecessary information or failure to organize the content creates cognitive overload and hinders learners' ability to process the new concept. In addition, existing design frameworks such as ADDIE, SAM, etc., do not provide guidelines on applying learning theory principles.

SQ2 – What learning theories must designers consider when designing learning objects?

After an intense review of the existing learning theories, this study identified experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) as relevant learning theories in the design of learning objects. These theories provide learning principles that are critical for designing practical learning objects.

SQ3 – Why is it important to use learning theory principles to design learning objects?

Relevant learning theories inform learning designers on how learners receive, process, and transform information into knowledge and application. These theories provide principles that help designers understand how learners learn. Knowing how people receive and process information is a critical skill that every learning designer must acquire. To realize this skill, learning designers must develop an in-depth understanding of learning theory principles applicable to designing learning objects. Learning designers with in-depth knowledge of learning theories, instructional design models, and learning technology tools can lead the collaborative course creation process to produce an effective learning object. Therefore, learning designers must apply principles derived from these learning theories to create learning objects (Baruque & Melo, 2004).

SQ4 – How do you use learning theory principles to design learning objects grounded in learning theory principles?

An exemplary learning object was developed to show how to apply learning theory principles when designing learning objects. Refer to chapter III for more details.

Research Limitations

The three versions of the proposed ILD model were tested by developing a module of the 3-module exemplary learning object. Significant feedback was received from students, peer reviewers, and learning designers in each iteration. Feedback was used to improve the ILD model. Version three of the ILD model is considered the final product. Using the final ILD model and developing several courses would be great. However, this study could not develop several courses using the ILD model due to limited resources and time constraints. Future studies may use the third version of the proposed ILD model to design and develop learning materials.

Institutional Review Board

The institutional review board (IRB) application was submitted to comply with the IRB guidelines. Federal regulations require research projects involving human subjects to be reviewed and approved by an IRB. All supporting documentation was attached to the application. After a thorough review, IRB approval was granted (see appendix A).

Literature Review

A literature review was conducted using several online databases to gather peer-reviewed articles, conference papers, and ebooks. These databases included the SHSU academic library, ERIC, EBSCO, and Google Scholar.

Keywords such as design-based research, passive learning, active learning, concrete experience, reflective observation, abstract conceptualization, experimentation, learning objects, learning designers, instructional designers, information processing, cognitive load, experiential learning, etc., were used to search articles in these databases.

The following four major themes emerged from the literature review: a) learning theories that are pertinent in the design of learning objects, b) importance of using relevant learning theory principles in designing learning objects, c) importance of developing clear learning objectives, and d) reasons many designers do not apply learning theory. A brief description of each theme is given below:

Learning Theories That are Germane in the Design of Learning Objects

Cognitive and educational psychology researchers wrote extensively on how learners process information and construct knowledge. However, behaviorists, cognitivists, and constructivists interpret learners' learning differently.

Behaviorists believe that learning occurs through reflexes conditioned by reward and punishment. Therefore, they focus on observable behaviors and how environmental factors influence and shape the behaviors of individuals and animals.

Cognitivists de-emphasize observable behaviors and focus on "complex cognitive processes such as thinking, problem-solving, language construction, concept formation, and information processing" (Snelbecker, 1974). They focus on learners' internal mental structures and how they process information. They argue that learning occurs when learners assimilate and accommodate new information into existing cognitive systems. They emphasize learning through discovery as "major areas of interest in cognitive psychology include language, attention, memory, decision-making, and problem-solving" (Cherry, 2020).

Constructivists argue that learners construct knowledge rather than passively absorbing information (Arends, 1998). They emphasize immersing learners into a community of learning. They encourage collaborative assimilation and accommodation of new information. Constructivists argue learners' prior knowledge influences how they construct meaning from new learning experiences (Phillips, 1995). Constructivism is an approach that encourages learners to participate in the construction of their language actively.

After a thorough review of the existing learning theories, this study identified experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) as relevant learning theories in the design of learning objects. These theories provide learning principles that are critical for designing practical learning objects.

The experiential learning theory was the main theoretical framework for developing the ILD model. The information processing and cognitive load theories were used as supplemental theoretical frameworks. Seven learning theory principles were extracted from the information processing and cognitive load theories and integrated into the design framework to improve its effectiveness. These principles help learning designers organize the content into manageable chunks if used appropriately. In addition, they help learning designers manage learners' cognitive loads when designing learning objects.

Importance of using Relevant Learning Theory Principles

Designing an effective learning object (LO) that engages learners and increases learning outcomes requires an in-depth understanding of learning theories relevant to creating learning objects. Relevant learning theories inform learning designers on how learners receive, process, and transform information into knowledge and application. After an intense review of existing learning theories, this study determined that experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) are relevant in the design of effective learning objects.

These theories provide principles that help designers understand how learners learn. Knowing how people receive and process information is a critical skill that every learning designer must acquire. To realize this skill, learning designers must develop an in-depth understanding of learning theory principles applicable to designing learning objects. Learning designers with in-depth knowledge of learning theories, instructional design models, and learning technology tools can lead the collaborative course creation process to produce an effective learning object. Therefore, learning designers must apply principles derived from these learning theories to create learning objects (Baruque & Melo, 2004).

Learning theory principles set a solid foundation for developing an effective learning object. A house with a weak foundation will probably collapse. Simultaneously, a learning object without a weak basis in learning theory principles will not deliver the desired learning outcome. Unfortunately, however, the sad reality is that most learning designers overlook the learning theory principles when designing a learning object. Instead, they focus on applying process models (i.e., ADDIE, Sam, etc.) and learning technology (i.e., authoring tools), which are essential in their ways.

Importance of Developing Clear Learning Objectives

The first step to developing an effective learning object is to write clear learning objectives. Bloom (1956) proposed the widely used taxonomy (i.e., Bloom's taxonomy), classifying the different learning objectives and skills that learning designers must set before developing effective learning objects. Without clear learning objectives, designers will lose sight of the level of expertise that learners are expected to achieve upon completing the learning object. Therefore, designers must develop terminal and enabling learning objectives based on the findings of the needs analysis report and in collaboration with subject matter experts (SMEs). Terminal learning objectives measure the anticipated level of performance that learners should achieve after completing the learning object. Enabling learning objectives are smaller, more manageable steps that learners must complete to achieve the terminal learning objectives.

Bloom (1956) developed the widely used multi-tier framework in collaboration with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl. The framework is widely used by educators and learning designers around the globe to create measurable objectives. Bloom and his collaborators identified six categories, "all lying along a continuum from simple to complex and concrete to abstract" (Armstrong, 2010). These categories are knowledge, comprehension, application, analysis, synthesis, and evaluation.

Learning designers must apply Bloom's taxonomy to write clear learning objectives when designing a learning object. Learning objectives must be written using verbs proposed by Bloom and his collaborators (1956) and revised by Anderson et al. (2001). Most universities have modified versions of Bloom's list on their websites. An example could be the Center for Excellence in Learning and Teaching at Iowa State University. Learning designers must refer to university websites and review Bloom's updated list to refresh their memories. This study used Bloom's taxonomy to demonstrate how to create clear learning objectives for the exemplary learning object. Participating learning designers created clear learning objectives for each lesson. The content of the 3-module learning object was developed based on learning objectives developed by participating learning designers.

Why many Designers do not apply Learning Theories

Studies have shown that many professionals involved in instructional design activities do not have formal training in learning theories and the science of instruction (Khalil & Elkhider, 2016). Partly, many learning designers lack a deep understanding of learning theories. Some of them are engineers, computer science majors, linguists, etc., who happened to be professional learning designers through experience. These learning designers are usually experts in applying instructional design models and learning technology tools (i.e., authoring tools) to develop courses. However, they do not apply learning theory principles because they lack the expertise on how to extract from relevant learning theories and use them to design effective learning objects grounded in educational science.

Learning theories inform how people receive, process, and transform information into knowledge and application. Thus, learning designers must have a solid foundation in learning theories (Baruque & Melo, 2004) and apply them in the course creation process. If learning designers do not apply learning theories in the design and development processes, the learning object produced may fail to deliver desired learning outcomes. This study created a design framework to help novice learning designers apply learning theory principles to create learning objects that engage learners and potentially increase learning outcomes.

Methodology

This study used the design-based research (DBR) method to develop the proposed ILD model in collaboration with real-world practitioners. In addition, a literature review was conducted to examine relevant learning theories in the design of learning objects and identify principles that learning designers must extract and apply when designing learning objects. Further, using the proposed design framework, a 3-module exemplary learning object was created with subject matter experts (SMEs) at Gollis University. The exemplary learning object was delivered in a real-world classroom. Participants were tested after they had completed each module.

Design-based research (DBR) is a systematic approach to improving learning by conducting iterative analysis, design, development, and implementation in collaboration with practitioners in real-world settings (Wang & Hannafin, 2005, p. 6). DBR may also produce new theories, artifacts, and practices that potentially improve learning and teaching in naturalistic settings (Barab & Squire, 2004). Unlike predictive research designs, DBR compels researchers to collaborate with practitioners to identify a practical problem, develop a solution, implement the intervention, administer several iterative testing cycles to refine the solution, and generate design principles.

Iterative Learning Development Model

The iterative learning development (ILD) model is a recursive rather than linear process designed to develop learning objects grounded in learning theory principles. The DBR method was used to create the proposed ILD model in collaboration with real-world practitioners. In addition, a literature review was conducted to identify learning theory principles relevant to the design of effective learning objects. Three iterations of testing and refinement were undertaken to create the final proposed ILD model (i.e., version three). In phase, I, version one of the ILD model was developed and tested in collaboration with practitioners. In phase II, version two of the ILD model was created. Challenges encountered during the development of version one were addressed, and feedback from practitioners was used to update version two of the ILD model. In phase III, the final version (i.e., version three) of the ILD model was created. Challenges faced during the development of version two were addressed, and feedback from practitioners was used to update version three of the ILD model.

Description of the ILD Model

The DBR method was used in the context of educational technology to develop the iterative learning development (ILD) model. The goal was to generate a design framework that could help novice instructional designers to create effective learning objects that would potentially enhance learning gains in a "naturalistic setting" (Barab & Squire, 2004). The ILD model is a recursive rather than linear process designed to develop learning objects grounded in learning theory principles. The model aims to provide design guidelines for learning designers to apply learning theory principles when creating learning objects. ILD suggests using the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop learning objects grounded in educational science. Three iterations of testing and refinement were conducted to establish the ILD model. In each iteration, the ILD was tested by creating a module of the 3-module exemplary learning object. Finally, the module was implemented in a real classroom in the information and communications technology (ICT) faculty at Gollis University Gollis University to test the effectiveness of the ILD model. Feedback from practitioners during the development and delivery of the module was used to improve the ILD model. The development and implementation of the experiment continued for 28 weeks.

Findings

Findings revealed successive improvements in the effectiveness of the ILD model. Version one did not provide expected guidance to learning designers to apply learning theory principles effectively when designing objects. Module one content contained a higher proportion of extraneous information, misalignment between learning objectives and associated content, and irrelevant multi-media. Version two helped designers improve module two's overall flow and organization. However, there was a lot of extraneous information in the reading content. This means that learning designers did not apply IPT-1/CLT-2 effectively to remove all extraneous information from the content. Finally, version three of the ILD model showed higher performance than previous versions. Using version three, learning designers showed significant progress in removing extraneous information, mapping content with learning objectives, and packaging content into manageable chunks that learning designers can process without feeling cognitive overload.

Recommendation

This study recommends that novice learning designers use the proposed ILD model. The model was designed to help learning designers apply learning theory principles when designing objects. Creating an effective learning object (LO) requires applying learning theory principles. Learning theory principles instruct learning designers to design learning objects (Baruque & Melo, 2004) grounded in educational science by chunking the content into bite-size pieces of information that learners can process and transform into knowledge and application.

The ILD model is grounded in experiential learning theory (Kolb, 1984) and seven principles extracted from the information processing theory (Atkinson & Shiffrin, 1968) and cognitive load theory (Sweller, 1988). Research shows that many learning designers do not apply learning theory principles in the design of learning objects. For example, a survey of 113 learning designers revealed that only half use learning theory principles to make instructional strategy decisions (Christensen & Osguthorpe, 2008).

Partly, many learning designers lack a deep understanding of learning theories. In addition, existing instructional design models such as ADDIE do not guide how to apply learning theory principles when designing objects. Therefore, the ILD model is an alternative for learning designers to develop learning objects grounded in educational science.

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APPENDIX A

Approved IRB

Date: 6-11-2022

IRB #: IRB-2021-306
Title: Applying Learning Theory Principles in the Design of Effective Learning Objects
Creation Date: 9-10-2021
End Date:
Status: Approved
Principal Investigator: Abdiwahab Guled
Review Board: SHSU IRB
Sponsor:

Study History

Submission Type Initial	Review Type Exempt	Decision No Human Subjects Research

Key Study Contacts

Member Donggil Song	Role Co-Principal Investigator	Contact song@shsu.edu
Member Abdiwahab Guled	Role Principal Investigator	Contact axg148@shsu.edu
Member Abdiwahab Guled	Role Primary Contact	Contact axg148@shsu.edu

APPENDIX B

Permission Letter from Somaliland Ministry of Education

JAMHURIYADDA SOMALILAND
Wasaaradda waxbarashada &
Sasyniska Xarunta Waxbarashad
Gobolka Togdheer

RE PUBLIC OF SOMALILAND
inistry of education & Science
Togdher regional
Education Office

Email:togeduc@hotmail.com(Digaale999@hotmail.com) Tell:- 0634448891/ 0634438125

REff: W.W&S/GT/ 184/2021

Date: 18.09. 2021

To Whom It May Concern,

This correspondence confirms that the Regional Ministry of Education and Science in Togdheer Region, Somaliland, granted a permission to Abdiwahab Guled, to conduct the research: *Applying Learning Theory Principles in the Design of Effective Learning Objects*" in collaboration with Gollis University.

Mr. Guled, the principal investigator will work closely with Gollis University, Burao Campus to conduct this study. He will assist Gollis University to develop an exemplar learning object that is grounded in educational science. An iterative cycle of testing and refinement of the solution will be conducted to ensure a successful implementation of the study.

Sincerely,

Name: Ibrahim Digaale

Signature:

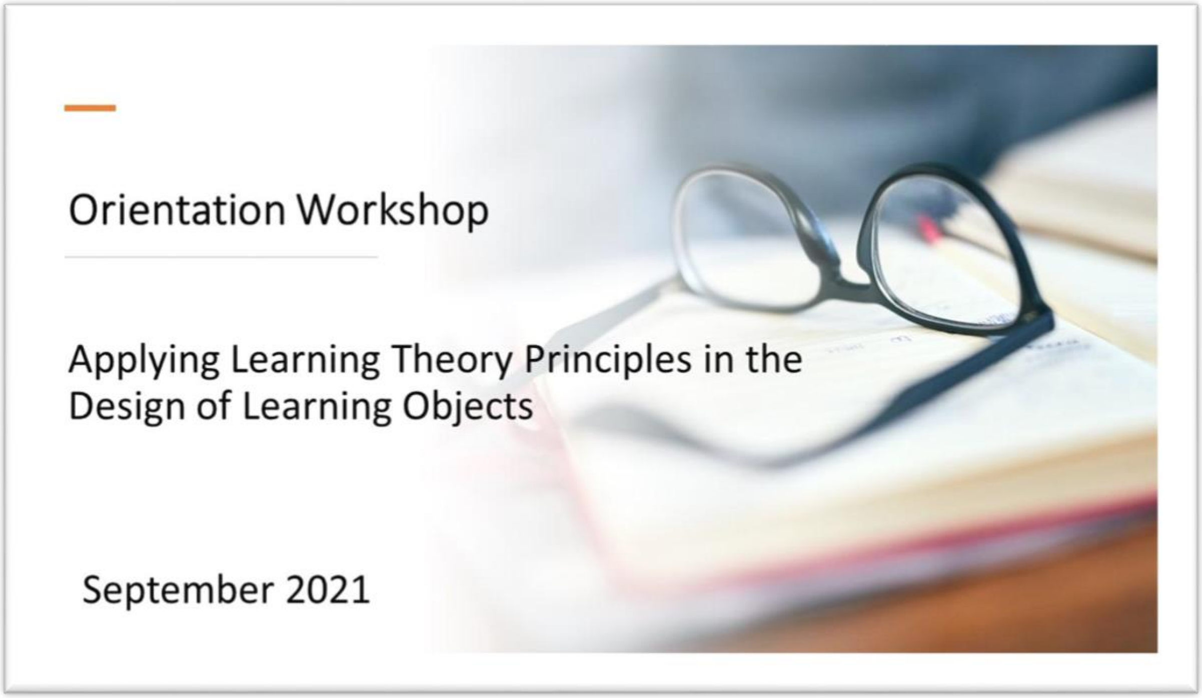
Title: R-E-O - Togdher

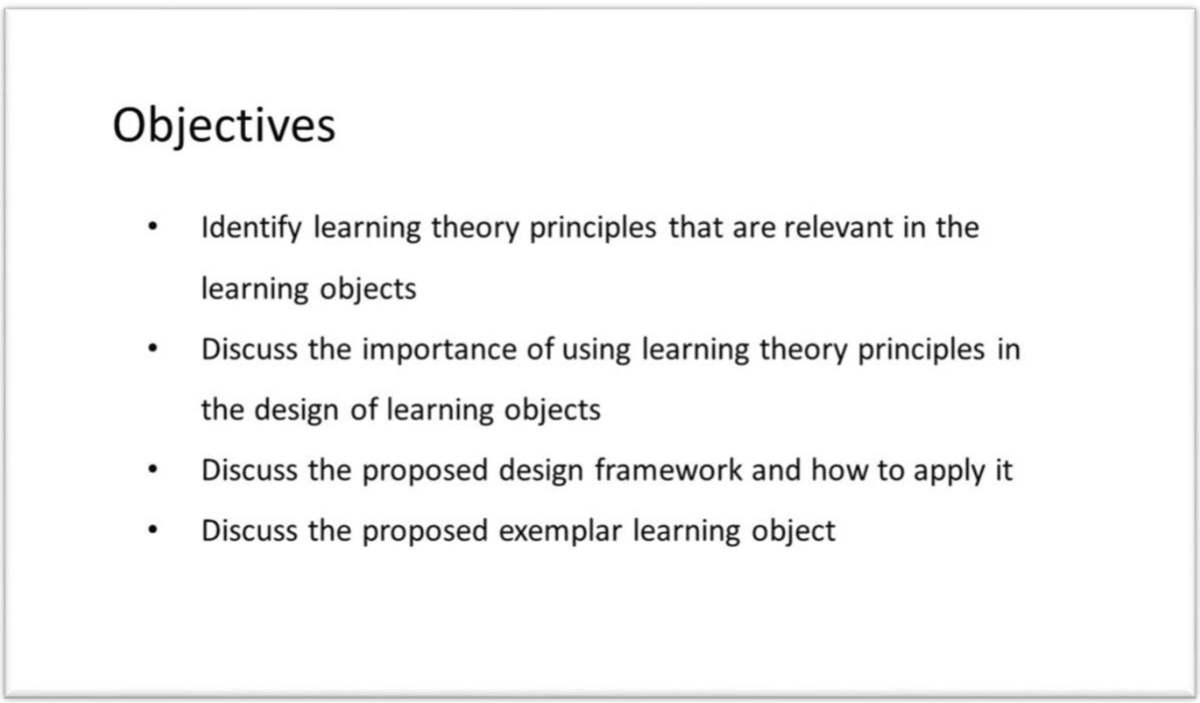
Date: 19/09/2021

W. WAXBARASHADA IYO SAYNISKA G TOGDHEER
TOGDHEER REGIONAL EDUCATION OFFICER

APPENDIX C

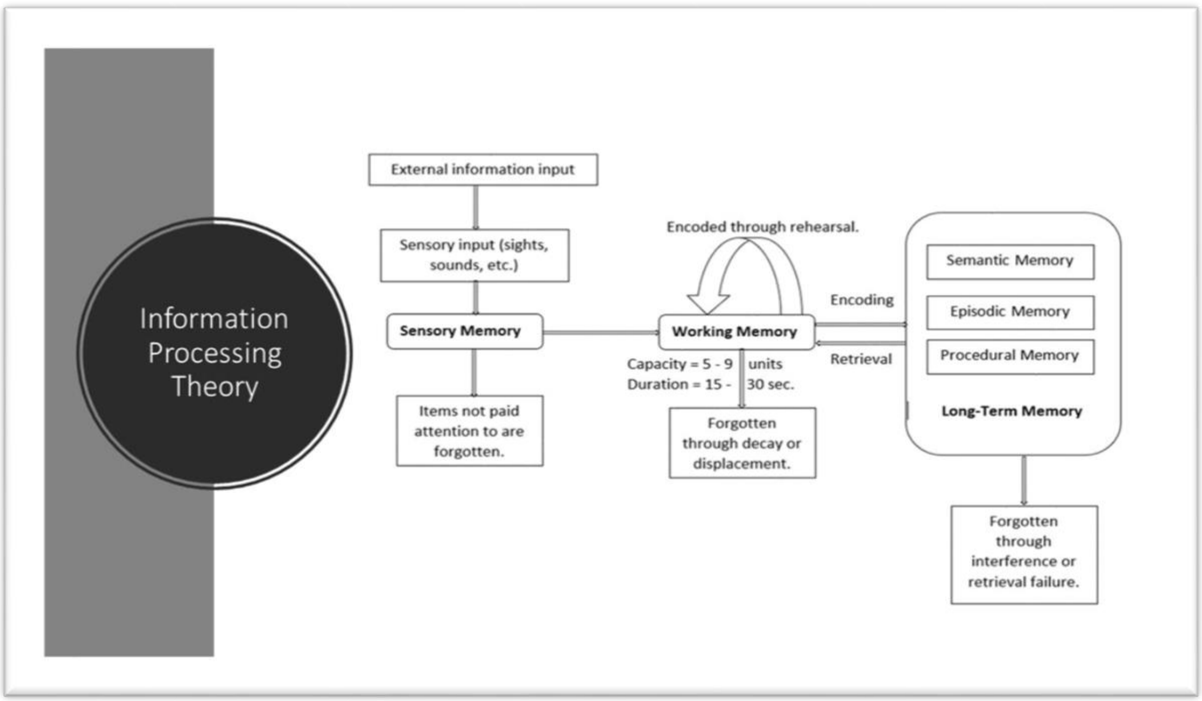
Orientation Workshop

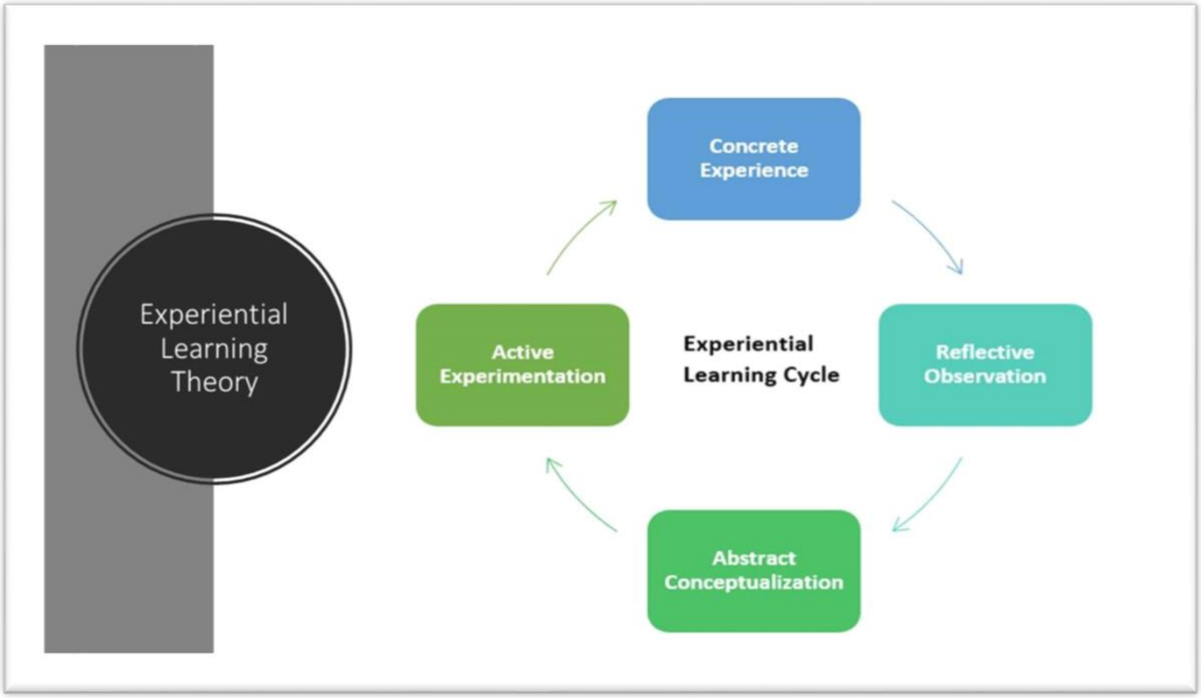


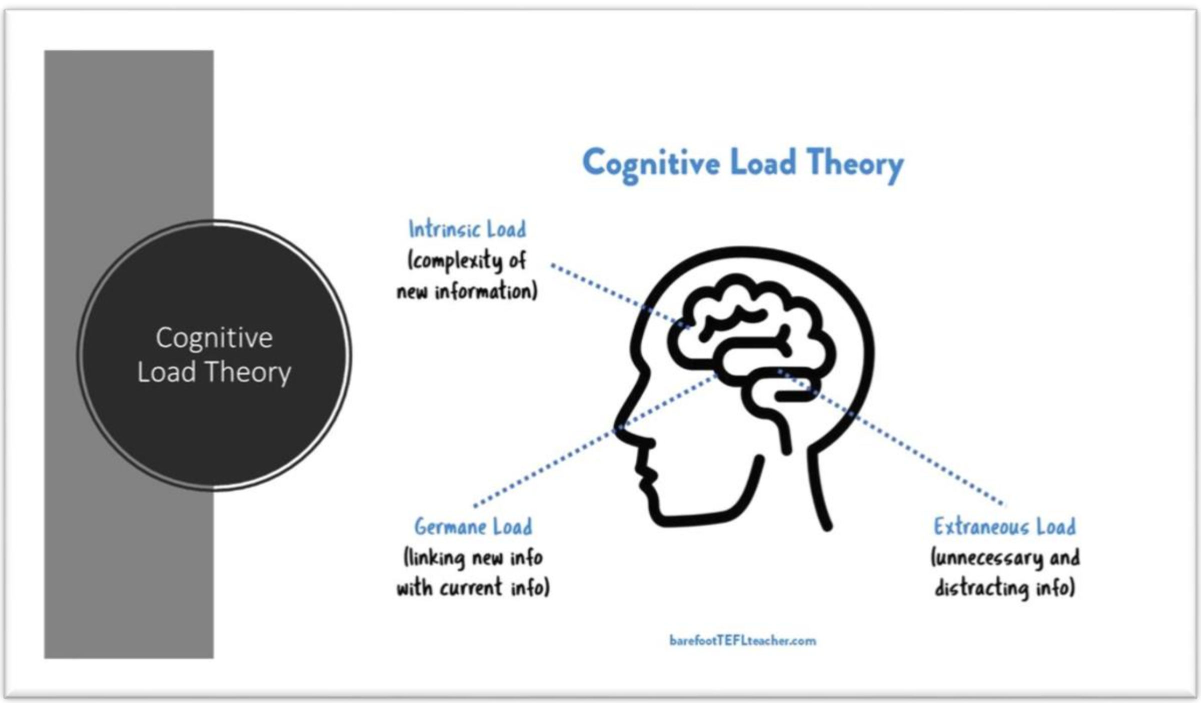


Learning Theories that are Germane in Designing Learning Objects

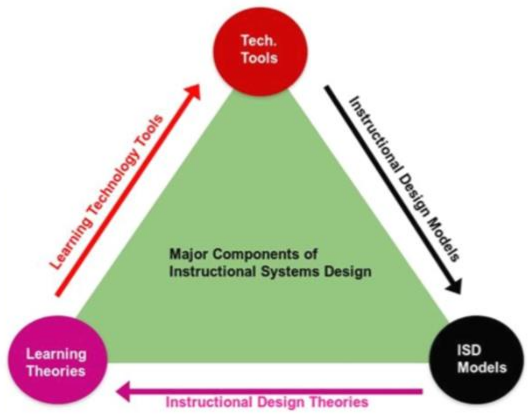
1. Information Processing Theory
2. Experiential Learning Theory
3. Cognitive Load Theory




Experiential Learning Theory
Concrete Experience
Reflective Observation
Abstract Conceptualization
Active Experimentation
Experiential Learning Cycle


Cognitive Load Theory
Cognitive Load Theory
Intrinsic Load
(complexity of new information)
Germane Load
(linking new info with current info)
Extraneous Load
(unnecessary and distracting info)
barefootTEFLteacher.com

Importance of Using Relevant Learning Theory Principles



Application of Learning Theory Principles

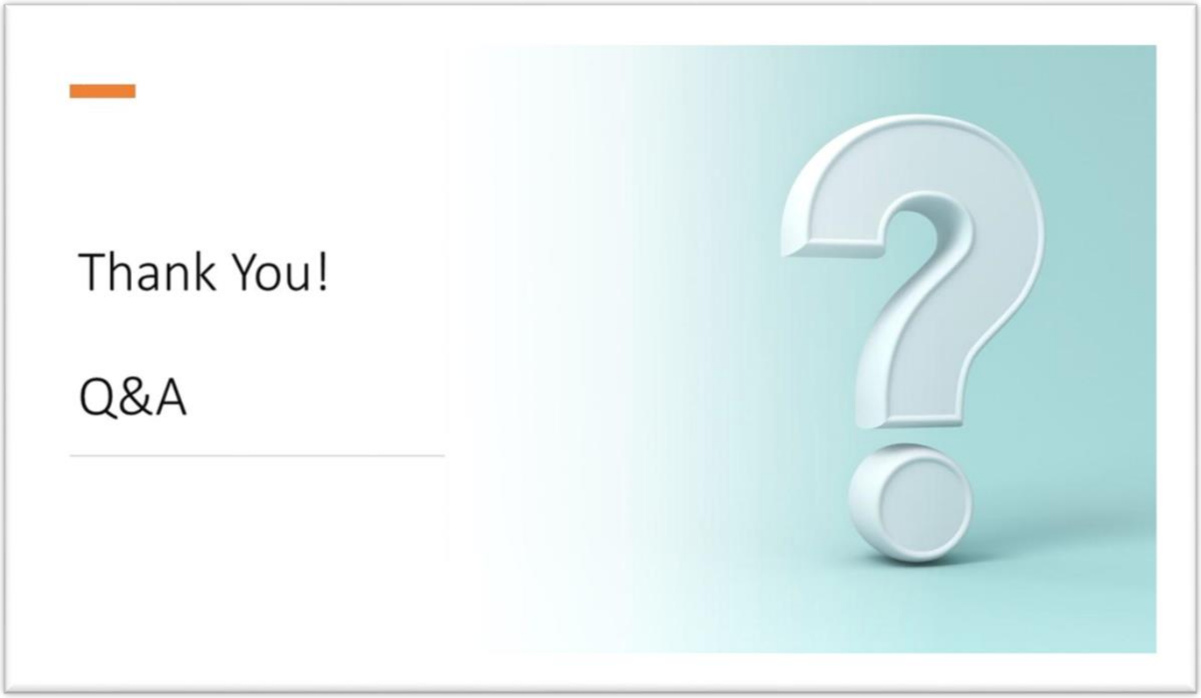
- How will IPT be used in the design of the exemplar learning object?
- How will ELC be used in the design of the exemplar learning object?
- How will CLT be used in the design of the exemplar learning object?

Proposed Design Framework

- Refer to the PDF file
  - File name: Proposed Design Frame
    - ✓ (ref: pages 44 to 53 of the proposal)

Exemplar Learning Object

- Refer to the PDF file
  - File name: Proposed Design Frame
    - ✓ (ref: 53 to 70 of the proposal)


Thank You!
Q&A

APPENDIX D

Sam Houston State University, Huntsville, TX

CONSENT PERMISSION TO PARTICIPATE IN RESEARCH AS A STUDENT

Applying Learning Theory Principles in the Design of Learning Objects

Principal Investigator (PI) Abdiwahab Guled, a Doctoral candidate in Instructional Systems Design and Technology, and Faculty Sponsor Dongill Song, Ph.D. from the Department of Library Science and Technology at Sam Houston State University (SHSU) are conducting a research study.

You were selected as a possible participant in this study because you have met the following selection criteria. First, the participant must be a freshman student at the faculty of information and communications technology (ICT) at Gollis University. Second, the participant must be registered for the wireless networking course delivered from November 2021 through January 2022 at the Burao campus. Based on the above criteria, your faculty nominated you as a potential participant in the research study. However, please note that your participation in this research study is voluntary.

Why is this study being done?

The study intends to create a design framework that guides learning designers to apply learning theory principles when designing learning objects. The study will examine the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop the proposed design framework. Professional learning designers will create an exemplary learning object using the proposed design framework. The learning object will be implemented in a real classroom at the faculty of information and communications technology (ICT) at Gollis University. As a participant, you will be exposed to the exemplary learning object. During the experiment, you will complete various learning activities that could increase your learning experience.

What will happen if you take part in this research study?

If you agree to allow us to participate in this study, we will ask you to:

- Actively participate in classroom discussions
- Complete assignments as directed by your instructor
- Take a test at the end of each module. You will take a 3-module learning object.

During the experiment,

- Several iterations of testing will be conducted to refine the design framework.
- The research location will be in a classroom in the faculty of information and communications technology (ICT) at Gollis Univesity.

How long will you be in the research study?

- The experiment will continue for 28 weeks. Therefore, your full participation is expected throughout the study.

Are there any potential risks or discomforts that you can expect from this study?

- There are no anticipated risks or discomforts that you will experience throughout this study.

Are there any potential benefits if you participate in this study?

The proposed design framework is expected to dramatically increase your engagement and learning outcomes. In addition, the results of the research will contribute to the body of knowledge in the field of instructional technology. The proposed design framework will help professional learning designers to apply learning theory principles when designing learning objects. Applying learning theory principles will enable learning designers to create effective learning objects that could potentially increase learning outcomes.

What other choices do I have if I do not participate?

There is no effective alternative if you do not want to participate in the study. You could choose not to participate in the research at any time without any negative consequences.

Will information about my participation be kept confidential?

Any information obtained in connection with this study that can identify your identity will remain confidential. It will be disclosed only with your permission or as required by law. Confidentiality will be maintained using anonymity. Your participation record will be kept by Abdiwahab Guled, the Principal Investigator, in safe cloud-based storage.

What are my rights if I take part in this study?

- You can choose whether or not you want to participate in this study, and you may withdraw your permission and discontinue your participation at any time.
- Whatever decision you make, you will have no penalty and no loss of benefits to which you were otherwise entitled.
- Your decision whether or not to participate will not affect your current or future relations with Sam Houston State University and Gollis University. If you decide to participate, you are free to withdraw at any time without affecting those relationships.

Who can I contact if I have questions about this study?

- **The research team:**

If you have any questions, comments, or concerns about the research, you can talk to one of the researchers. Please contact:

Abdiwahab Guled, Principal Investigator
Email:
Dr. Dongill Song, Faculty Sponsor
Email:

- **SHSU Office of Research and Sponsored Programs (ORSP):**
  If you have questions about your rights while taking part in this study, or you have concerns or suggestions, and you want to talk to someone other than the researchers about the study, please call Sharla Miles, Research Compliance Administrator at (936) 294-4875 or write to:

Office of Research and Sponsored Programs
Institutional Review Board
ATTN: Sharla Miles, CIP
ORSP-SHSU Box 2448
Huntsville, TX 77341-2448

You will be given a copy of this information for your records.

NAME AND SIGNATURE OF RESEARCH PARTICIPANT

____
Your Name

____ _______________________
Signature Date

SIGNATURE OF PERSON OBTAINING CONSENT

____ _______________________
Name of Person Obtaining Consent Contact Number

____ _______________________
Signature of Person Obtaining Consent Date

APPENDIX E

Sam Houston State University, Huntsville, TX

CONSENT PERMISSION TO PARTICIPATE IN RESEARCH AS A LEARNING DESIGNER

Applying Learning Theory Principles in the Design of Learning Objects

Principal Investigator (PI) Abdiwahab Guled, a Doctoral candidate in Instructional Systems Design and Technology, and Faculty Sponsor Dongill Song, Ph.D. from the Department of Library Science and Technology at Sam Houston State University (SHSU) are conducting a research study.

You were selected as a possible participant in this study because you have met the following selection criteria. First, the participant must have experience designing and developing learning objects using instructional design models, learning technologies, and learning theory principles. Second, the participant must be willing to collaborate with subject-matter experts (SMEs) and other learning designers to design effective learning objects. Third, the participant must be willing to use the design framework proposed by the PI to create a learning object grounded in educational science. Based on the above criteria, you have been selected as a potential participant in the research study. However, please note that your participation in this research study is voluntary.

Why is this study being done?

The study intends to create a design framework that guides learning designers to apply learning theory principles when designing learning objects. First, the study will examine the experiential learning theory (Kolb, 1984), information processing theory (Atkinson & Shiffrin, 1968), and cognitive load theory (Sweller, 1988) to develop the proposed design framework. Then, as a professional learning designer, you will create an exemplary learning object using the design framework proposed by the IP. Finally, the learning object will be implemented in a real classroom at the faculty of information and communications technology (ICT) at Gollis University.

What will happen if you take part in this research study?

If you agree to allow us to participate in this study, we will ask you to:

- Work closely with SMEs, peer reviewers, and editors to create an effective learning object
- Design and develop specific components of the proposed exemplary learning object
- Implement feedback received from practitioners throughout the study

During the experiment,

- Several iterations of testing will be conducted to refine the design framework.
- The research location will be in a classroom in the faculty of information and communications technology (ICT) at Gollis Univesity.

How long will you be in the research study?

- The development and implementation of the experiment will take about 28 weeks. Therefore, your full participation is expected throughout the study.

Are there any potential risks or discomforts that you can expect from this study?

- There are no anticipated risks or discomforts that you will experience throughout this study.

Are there any potential benefits if you participate in this study?

Your name will be mentioned in the acknowledgment section of the study. The proposed design framework is expected to dramatically increase learners' engagement and learning outcomes. In addition, the results of the research will contribute to the body of knowledge in the field of instructional technology. The proposed design framework will help professional learning designers to apply learning theory principles when designing learning objects. Applying learning theory principles will enable learning designers to create effective learning objects that could potentially increase learning outcomes.

What other choices do I have if I do not participate?

There is no effective alternative if you do not want to participate in the study. You could choose not to participate in the research at any time without any negative consequences.

Will information about my participation be kept confidential?

Any information obtained in connection with this study that can identify your identity will remain confidential. It will be disclosed only with your permission or as required by law. Confidentiality will be maintained using anonymity. Your participation record will be kept by Abdiwahab Guled, the Principal Investigator, in safe cloud-based storage.

What are my rights if I take part in this study?

- You can choose whether or not you want to participate in this study, and you may withdraw your permission and discontinue your participation at any time.
- Whatever decision you make, you will have no penalty and no loss of benefits to which you were otherwise entitled.
- Your decision whether or not to participate will not affect your current or future relations with Sam Houston State University and Gollis University. If you decide to participate, you can withdraw at any time without affecting those relationships.

Who can I contact if I have questions about this study?

- **The research team:**

If you have any questions, comments, or concerns about the research, you can talk to one of the researchers. Please contact:

Abdiwahab Guled, Principal Investigator
Email:

Dr. Dongill Song, Faculty Sponsor
Email:

- **SHSU Office of Research and Sponsored Programs (ORSP):**
  If you have questions about your rights while taking part in this study, or you have concerns or suggestions, and you want to talk to someone other than the researchers about the study, please call Sharla Miles, Research Compliance Administrator at (936) 294-4875 or write to:

Office of Research and Sponsored Programs
Institutional Review Board
ATTN: Sharla Miles, CIP
ORSP-SHSU Box 2448
Huntsville, TX 77341-2448

You will be given a copy of this information for your records.

NAME AND SIGNATURE OF RESEARCH PARTICIPANT

____
Your Name

____ _______________________
Signature Date

SIGNATURE OF PERSON OBTAINING CONSENT

____ _______________________
Name of Person Obtaining Consent Contact Number

____ _______________________
Signature of Person Obtaining Consent Date

APPENDIX F

EXERCISE: Module 1 Lesson 3: Wireless Network Physical Architecture

Delivery Note

Time allotted for this exercise: 30 minutes
Exercise: 15 minutes
Presentation: 10 minutes
Debrief: 5 minutes

Note. This exercise will use a learning activity called "scale-up." This learner-centered approach allows learners to work in groups to discuss specific questions regarding the content. Research shows that scale-up pedagogy improves learning outcomes compared to traditional courses. This activity will help learners to deepen their understanding of the content by reviewing it to answer specific questions given below.

Directions:

- Divide learners into four groups (i.e., groups A D)
- Have each group review their assigned topic thoroughly
- Have each group write down their answers to each question
- Have them select a presenter to present their findings to the classroom

Topics Vs. Groups

No.	Topics	Groups	Questions
1.	Wireless Network Topology	A	1. What is a wireless network topology? 2. Describe the following wireless network topologies: a. Point-to-point connections b. Star topology c. Mesh topology 3. What are the pros and cons of wireless network topologies?
2.	Wireless Network Interface Card (NIC) Access Point (AP)	B	4. What is the function of a wireless network interface card (NIC)? a. Provide an example of NIC devices 5. What is the function of an access point (AP)?

	Wireless LAN Switches or Controllers		a. Provide an example of AP devices 6. What are the other names for wireless LAN switches?
3.	Wireless LAN Arrays Zigbee Wireless MAN Devices	C	7. Describe some of the functions of wireless LAN switches 8. What is the function of wireless LAN arrays? 9. What is Zigbee? a. Provide examples of Zigbee devices and their functions 10. Name four wireless MAN devices and describe their functions.
4.	Traditional Fixed Gain Antennas Smart Antennas Common Type of Bluetooth	D	11. Describe the traditional fixed gain antennas a. Provide an example of traditional fixed gain antennas 12. Describe smart antennas 13. What is the function of a switched beam antenna? 14. What is the function of an adaptive array antenna? 15. What are the most common types of Bluetooth? a. Provide examples of Bluetooth devices and their functions

APPENDIX G

GOLLIS UNIVERSITY RESEARCH CENTRE, BURAO CAMPUS

"Gollis University Empowers its Students as Professional Leaders Committed to Make a Positive Difference"

www.gollisuniversityburco.com Email: info@gollisuniversityburco.com

29th October, 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam:

RE: PERMISSION TO COLLABORATE WITH MR. ABDIWAHAB GULED ON HIS RESEARCH EXPERIMENT

This correspondence confirms that Gollis Universityis delighted to collaborate with Abdiwahab Guled on his research of "*applying experiential learning cycle in the design of learning objects.*"Gollis University provides educational services to college students in a variety of disciplines, including school of medicine and health sciences, engineering, business and economics, social sciences, etc. This population is mixed and includes males and females from a variety of socio-economic backgrounds. Gollis University is pleased to provide Mr. Guled full support during the experiment.

Gollis University will work with Mr. Guled to conduct a needs analysis of a practical problem and develop an intervention using existing design principles and technological innovations. Gollis University will then, implement the intervention in real classrooms with the intent to address the practical problem in the learning environment. An iterative cycle of testing andrefinement of the solution will be conducted.We will help Mr. Guled to obtain participant consent if needed. Our experienced subject matter experts (SMEs) and instructors will work closely with Mr. Guled to ensure a successful implementation of the study in our University.

We are fully committed to help Mr. Guled in his research in every way possible.

Dauda W. Jamada
Director, Gollis University Research Centre (GURC)
jamadadauda@gmail.com / director.gurc@gmail.com
+252-63-4271957

VITA

ABDI GULED — Senior Instructional Designer

An entrepreneurial and innovative executive with proven success in creating award-winning instructor-led and eLearning courses. Innate ability to design and develop highly engaging and effective e-learning and instructor-led training (ILT). Proficient in building lines of communication to identify opportunities that increase productivity and maximize results. Deft at devising and executing proactive strategic plans to accomplish business goals. Well-developed knowledge of adult learning theories, learning technology tools, and programming languages. Track record of developing learning materials based on the needs and interests of targeted audiences. Skilled in creating training materials to enable implementation and accelerate the adoption of products. An accomplished leader with exceptional communication, interpersonal, relationship building, analytical thinking, and pressure handling skills.

Areas of Expertise include:

- Instructional Design Models
- Adult Learning Theories
- Knowledge of authoring tools
- Needs Analysis
- Operations Management
- Assessments and Evaluations
- Professional Writing
- Project Management
- Forward-thinking

Professional Experience

SAUDI ARAMCO TRAINING AND DEVELOPMENT (T&D). · Saudi Arabia · 2019 to present.

SR. INSTRUCTIONAL DESIGNER

Work with proponents to conduct job task analysis to identify the performance gap of the target audience. Then, design and develop technical training programs that respond to the performance gaps of trainees. Develop line-specific training, operations, crafts, and maintenance programs of instructions (POIs). Develop immersive virtual reality scenarios to add value to the said POIs.

MANAGEMENT CONCEPTS INC. · Virginia · 2018 to 2019

Sr. Instructional Designer

Spearhead a group of designers to create professional development training programs for private and public employees (U.S. Federal Government). Focus on human elements of requirements by conducting needs analysis while developing and implementing training programs as per client needs. Identify the need to improve instructors' skillset and organize training sessions to enhance performance. Provide high-level guidance regarding document control system requirements and maintain LMS instructor course materials. Create a current state of learning material by reviewing prior training courseware.

Key Accomplishments:

- Transformed technical information into professionally written content through proactive management and developing compelling instructional material.
- Utilized the ADDIE model to design and develop instructor-led and online training programs.
- Created award-winning instructor-led and eLearning courses for US Government agencies, dramatically increasing employee performance.
- Deployed instructional learning theories to design and develop instructionally sound courses that provoked new thinking and challenged learners to build new skills.
- Collaborated with subject matter experts (SMEs) to develop innovative courses that respond to learners' needs.

BOB'S DISCOUNT FURNITURE (BDF) · Washington DC · 2015 to 2017

Instructional Designer

Devised instrumental evaluation strategies to produce exceptional content by identifying learning objectives and evaluating performance outcomes. Supervised overall aspects of LMS functions, including monitoring course content, course approvals, and evaluations to ensure timely completion of processes. Created, published, archived online, instructor-led courses, assigned training curricula, monitored accounts and maintained system parameters. Collaborated with subject matter experts to identify performance gaps, design, and develop training courses by using the ADDIE model.

Key Accomplishments:

- Established an evaluation framework to organize evaluation questions, outcomes, indicators, data sources, and collection methods, validating content quality, business impact, and scalability.
- Developed instructor-led and eLearning programs for sales departments that improved sales associates' performance by 2% within 12 months.

OPERATIONS MANAGER · 2011 to 2014

Spearhead a team of professionals by the company's core values and vision. Optimized efficiency and productivity through exceptional store inventory, warehouse, and outlet management.

Key Accomplishment:

- Analyzed reports to identify opportunities for improving sales and profitability, which resulted in enhancing the performance of warehouse and outlet associates by 1%.

Education Development Center (EDC) · Washington DC · 2006 to 2010

EDUCATION ADVISOR

Led monthly education coordination meetings for more than 20 international, UN, and local agencies. Liaised with the USAID mission and networked with civil society organizations, local government officials – Ministry of Education (MOE) in Somalia, and other local partners to manage project activities. Delivered security briefings and humanitarian efforts to the USAID office in Nairobi to reestablish the governance structures in Somalia.

Key Accomplishments:

- Developed 2000 interactive radio instruction (IRI) lessons for grades 1 to 5 students in Somalia.

- Met the company's strategic aims by formulating an effective strategy to implement, monitor, and evaluate desired results.
- Deployed strategic ideas to create a five-year training plan for practicing teachers on IRI methodology.
- Coordinated with MOE and local partners to train 7K+ teachers.

Entrepreneurial Experience

Founder/CEO for MAANFUR ACADEMY, a startup coding academy

Teach professional web development courses.

Key courses: HTML5, CSS, and JavaScript.

Website: https://www.maanfur.net/

Education & Training

D.Ed. in Instructional Systems Design and Technology

SAM HOUSTON STATE UNIVERSITY (SHSU), Huntsville, TX **|** Continued

Masters in Instructional Technology

SAM HOUSTON STATE UNIVERSITY (SHSU), Huntsville, TX **|** 2017

BS in Business Administration

PENN FOSTER COLLEGE, Scranton, PA **|** 2015

I.T Skills

MS Office Suite **|** Adobe Captivate/Prime **|** Articulate 360 **|** HTML5 **|** CSS **|** JavaScript.