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Design of Instructional Modeling Language for Learning Objects and Learning Objects’ Repositories

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DESIGN OF INSTRUCTIONAL MODELING LANGUAGE FOR LEARNING OBJECTS AND LEARNING OBJECTS' REPOSITORIES

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ABSTRACT

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The advancement of technology has provided tools to write instruction in every discipline. However, the concepts of automation in the field of instruction is still not used. Teachers around the globe spend countless hours in editing lengthy texts in creating syllabi and reusable components, which are the Learning Objects (LOs). The software developers also experience time-consuming process to decipher the concepts of instruction before it is written.

LOs provide a potential mechanism for the educators and software developers to refine curriculum development that uses common components such as exams or syllabi. While the concept of LOs came from software engineering, there is no object modeling language, as it exists in the form of Unified Modeling Language (UML) in the field. UML has been widely used in the field of software engineering for decades. It uses notations to depict the complex objects thus making it easier for the developers to understand the requirements of a software.

A similar instructional modeling language (IML) designed by the author is introduced in this dissertation with the purpose of establishing a proof of concept regarding the IML and web repository. IML makes use of acronyms and notations to depict tasks, such as creation of syllabi, reusable components such as exams, exercises, and homework. A software idea using IML is proposed as a tool for the future for educators across the globe in this research. The research also investigates the concept of the use of LOs' web shared repository. These concepts were demonstrated with a prototype for a proposed software to high school teachers. Teachers shared positive feedback about the proposed software and thought it will eliminate many hurdles in the design of instruction, save time, and provide enormous opportunities to share LOs through web repositories.

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CHAPTER I

INTRODUCTION

Background

Object in software engineering is defined as something that holds some attributes and behaviors (Rumbaugh, Jacobson, & Booch, 1999). For example, a human being is an example of a class (which is a group of objects) in software engineering. That means each one of us is an object (an instance of a class). Some of its attributes are height, weight, color of the hair, etc. Whereas, some of human being's behaviors would include eating, sleeping, working and so forth. Another example of an object is a course offered at a school; related to software specifically, it might be in a registration system. The attributes of a course are name, number, title, etc. One of the behaviors that could be done for a course is *add*. That means a course could be added by a student to his or her list of courses in which s/he registers for a given semester.

This concept of object was introduced in the fields of instructional design and educational technology from software engineering. In this context, they are called as learning objects (LOs; Alonso, López, Manrique, & Vines, 2008). To design objects in software engineering a modeling language called unified modeling language (UML) is used. Objects are designed by using symbols and pictures, which are easy to understand and then programmed in a software. UML was designed to simplify the process of objects design (Rumbaugh et al., 1999). Learning objects (LOs) in instructional design or educational technology are defined as anything that can be used, re-used or referenced in technology (Dowens, 2004). The idea of learning object comes from the field of software engineering and has the same general premise of using a representation (symbols and pictures) of the object to recall the more complex details of the object (Alonso et al., 2008). The requirement for their definition, whether they are digital or non-digital, is that they can be used and re-used infinitely. This re-usability is the key element to the learning objects' function. While LOs were introduced in the field of Educational Technology from their counterparts in software engineering, no similar modeling language like UML exists for LOs. Additionally, one might think that because we are immersed in a digital context and the expansion of information technology includes insurmountable digital communications, LOs are only digital and in digital contexts. However, there are places in the global context where objects are most relevant in a non-digital format, and learning happens in a non-digital fashion. However, for the purposes of this manuscript, it is assumed that we are discussing digital media and referring to digital objects. Once the proposed language IML is implemented in a software with access to web repositories – students and educators could learn like any software through their prior understanding of any software and then it will become a norm. This will incorporate all the traditional theories of learning such as cognitivism, constructionism, discovery learning and behaviorism.

Problem of the Study

Instructional design theory is about understanding what conditions are necessary for a learner to reach specific instructional goals, acquire specific knowledge and skill, or demonstrate specific learning outcomes (Merrill, 2007). While information technology has provided significant number of tools for instructional design that includes designing curriculum, writing exams, quizzes, reading lists, and home works, online instruction, and Learning Management Systems (LMS), the process of writing all of the above instruction still remains the same. It includes a lot of writing, editing, and instructor or program specific details. A reader has to go through the whole syllabus before finding out what is included. Teachers keep creating the same exams across the globe thus spending a lot of time. LOs can be explained as creation of all of the tools mentioned above in the offering of a course. Hence, all of the components that are included in offering of a course or training, which could be re-used, are LOs. As multimedia is incorporated more and more to syllabi, the instructional design has become more complicated. It is a nightmare for the software developers as well to go through the details of a syllabus before programming and uploading everything into an online environment. While there are some approaches to specify the contents of LOs, there is no such notation which can imitate UML and model them conceptually. Most of the modeling notations in educational technology are either old fashioned or borrowed from other disciplines such as UML. How the LOs are represented, how LOs can be used in repositories, and is there a unified modeling language that could be understood by instructional designers, students, faculty, and software developers when designing a course? There are no answers to these questions yet. These questions should be addressed to make the use of LOs productive for all the stakeholders.

Purpose of the Study

LOs for instruction design provide a promise of faster and easy-to-understand method. Learning objects (LOs) are good tools for instructional design. They are easy to be modified once instruction is complete. Many authors have approached them differently. What is lacking in instructional design is a design tool that will help the educators to build their course materials (LOs). Educators need to prioritize the concept of education because it is not about spending all of their time and energy in building the contents but to convey the knowledge to the students in the best possible way as well.

A new concept cannot be understood easily. The concept of LOs and Instructional Modeling Language (IML) is still new to educators. Incomplete conceptual knowledge and misconceptions seriously impede learning (Mayer, 2002). Provision of certain conceptual tools or models is believed to have a positive effect on the concept of learning (Dawson, 2004). IML can reduce the complexity that revolves around the concept of instructional design. Another area, which is becoming very popular in academic settings is LOs' repositories (Carrión, Gordo, & Sanchez-Alonso, 2007). LOs are already being stored as repositories and used by many educational institutions. These LOs' repositories are stored on a website and could be shared by teachers at different levels in the academia. For example, a learning exercise on mathematics problems for 5th grade (which is a LO) in Denver could be stored on a website (a LOs' repository) and shared by another 5th grade teacher in Africa, or a video on brain surgery (another LO) could be stored on a medical school's website (another LOs' repository) and shared by medical students across the world and re-used many times.

UML included graphical notations like the shape of a rectangle, a circle, a diamond, and the connecting arrows, etc. similar to a data flow diagram (DFD), which helped in the design and understanding of the requirements of software. This in turn helped programming the software in the subsequent steps by the Information Technology (IT) developers. While software engineering has benefited greatly from UML, a modeling language like UML is absolutely needed in the field of educational technology. Most of the instructional design is done through editing lengthy text over many iterations. The purpose of this research was to incorporate the various aspects of instructional design, especially the design of syllabi (including exams, home works, quizzes, lessons, etc.) and how LOs could be used to represent them. The idea of LOs was also extended to store and represent LOs' repositories. LOs' repositories could play a very important role in learning. LOs' repositories concepts are explained and how they could be stored for knowledge sharing and their representation on a website.

The purpose of this research was to introduce a new instructional modeling language (IML) designed by the author. The idea of using IML is for a better and time saving instructional design. The proposed IML will make use of few graphical shapes (similar to UML) but mostly acronyms, as we will be dealing with many LOs because the field of instructional design is expanding. There is a lot that could be done in the field of instructional design with the help of LOs. IML has been introduced to simplify the process of designing and launching a course. It has been introduced as a counterpart of UML. Only a few graphical shapes are used in IML to minimize the cognitive load on the learner.

The second part of this research was to make use of a LOs' repository. The repository can also be designed by using IML just like any instructional material. Until today most of the instructional design is done by spending countless hours of writing, editing, and posting texts online. Since, IML will save hundreds of hours spent by teachers to design their curriculum – this saving could be utilized to design, store, and share LOs. These LOs could then be posted in a shared repository online by participating school teachers. The LOs created could be shared and used by students as well, as recommended by their teachers. These LOs will be available to the teachers and students from kindergarten through higher education round the clock. The teachers will be able to edit their LOs, create curriculum, share, and post their LOs at the common repository on their intranet website. This will also provide a wealth of information and an unlimited chance to learn a concept, which would otherwise be impossible in the traditional classroom settings for every student. Hence, the purpose of this research was multi-fold. First, the researcher introduced a new language (IML) in the field of instructional design and expanded on the use of LOs' repositories for a wealth of knowledge sharing. Secondly, the author did a pilot study to find out whether IML would save time in the design of instructional materials. Thirdly, to what extent sharing of LOs' repository would increase knowledge and productivity of teachers. Fourthly, how easy it was to learn and use IML?

Research Questions

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language?

Rationale/Significance of the Study

The problem of lacking a common ground for education technologists where they can find and use LOs has been dragged into the other LOs related technologies as well, such as, LOs repositories. Since there is no agreed upon definition or a graphical notational language, the researchers have found other weak areas where attention is required. In the recent studies about LOs, there had been attempts to unify different learning object definitions (McGreal, 2004). Carrión et al. (2007) wrote in their research paper, “These studies show that learning-oriented entities in a repository have a high variability on its characterizations. The non-existence of a common vocabulary, as well as the coexistence of different learning object definitions, point out the need of flexible repositories that can fit all existent conceptualizations.” While we have a working definition for *learning object*, but the notion of a modeling language is non-existent. If we run a search in Google to find a definition for a modeling language for learning objects, we get all sorts of pictures and diagrams telling us the fact that there is no standardized modeling language available for LOs yet. A modeling language will also cater for the repositories’ conceptualizations that Carrión et al. (2007) are talking about.

There is no doubt that if we have an easy to understand graphical model for LOs and repositories, it would enhance the understanding of the educators and students alike. It would also help software engineers to develop code around the courses that they develop. Once we have a better understanding of LOs, we can use them to our advantage. Churchill (2014) pointed out the following about a conceptual model:

- “Students learn better with visuals and text than with text alone.
- Affordances of today’s representational technology enable the design of conceptual models in interactive multimedia form.
- Interactive and visual representation can support concept learning.
- Conceptual models for concept learning are important form of a learning object.

- Learning technology designers should utilize multiple representations when designing conceptual models (e.g., image and text)."

It is obvious that concepts are best understood through images instead of long explanations of texts. This is the motivation behind the IML, which has been addressed in this research. Once we have a notational language, then the concepts of LOs could be easily understood and standardized. Churchill (2014) included an image in his research paper about trigonometry where students could utilize the power of image and change variables to see the changes in the image for better understanding. There are disciplines such as medical sciences and trigonometry where long textual explanations would fail unless supported by graphical illustrations.

While software engineering benefited greatly from UML, a similar modeling language like UML is needed in the field of educational technology. Most of the instructional design is done through painful editing and repetitive duplicate work. This prompted the author to research various aspects of instructional design, especially the design of syllabi and their contents and how LOs could be used to represent them. LOs' repositories could play a very important role in learning. The research was extended to the use of LOs' repositories and how they could be stored for knowledge sharing and representation.

Summary

Objects played a very significant role in the understanding and implementation of software. This led to the designing of UML. LOs were introduced as counterpart of objects. Designing syllabus and course material pose a time-consuming problem. LOs could help us reduce the complexity, time, and resources. Software engineers have used the concept of objects and Object Oriented Programming (OOP). They have used UML for designing their software. While LOs are used in the designing of instruction, no counterpart of UML has been defined. This research included an introduction of a new design language (IML) for educators. IML can be used easily and standardized for the benefit of educators around the globe. LOs could be stored at a website repository where they can be saved and shared thus saving countless hours leading towards the need of a solution towards important research questions (Siddiqui, 2015).

This research compared the use of IML to UML and provided the best solution for the benefit of instructional designers, educators, and academic community. The methodology provided in this research establishes a sound step-by-step process for the professional community in the field of educational technology without going through all the complexities of software engineering. With the IT industry advancing so fast, it becomes imperative to use the powerful ideas of software engineering without losing the integrity of another discipline like educational technology and the professionals associated with it. A pilot study and later followed by a complete interpretive qualitative study was done to evaluate the IML prototype by the author. During this study, teachers from a private high school were interviewed and presented with IML because of their experience in creating course material (LOs) on a regular basis. Themes were recognized throughout the study to list the findings of this research. Educators at all levels are the beneficiaries of IML and LOs' web repositories.

Definition of Terms

Class. A class in software engineering is a template, which has attributes and behavior.

For example, a "human being' is a class which has attributes like color of hair, height, and weight, etc. It has behaviors like eating, sleeping, walking, etc. A class is group of objects.

Instructional Modeling Language (IML). An acronym and graphical notational-based modeling language designed by the author to depict the LOs in the field of instructional design. This would help instructional designers, students, faculty, and software developers alike to understand the structure of instructional material (Siddiqui, 2015).

Learning Object (LO). It is a counterpart of object used in the field of instructional design. It is defined as any entity that could be re-used in the field of instructional design.

LOs Repositories. Online repositories of LOs that could be shared through web technology.

Object. An object is an instance of a class. For example, for a class human being, "John Doe" is an object. Since it is an instance of a class, it has attributes and behavior like a class.

Object Oriented Programming (OOP). The development of software using programming languages that allow the use of objects. For example, Java, Python, etc.

Unified Modeling Language (UML). A graphical notational language, which is used to depict the relationship of objects, classes, and other software engineering entities. This helps the software developers and engineers understand the requirements of a software (Rumbaugh et al., 1999).

Web 2.0 Technology. The new web sites that use dynamic content and social media.

CHAPTER II

LITERATURE REVIEW

Instructional Modeling Language (IML)

Background

While LOs got their existence through their counterparts' "objects" in software engineering, objects have a standardized modeling notation. It is called as unified modeling language (UML) that has been used for almost two decades (Rumbaugh et al., 1999). UML had been proven a success for software engineers, modelers, and programmers with similar graphical notations (as IML) in a single agreed upon language that they could see visually and understand it. UML has revolutionized the software industry because of its vast usage. Unfortunately, while we have defined the counter part of objects as learning objects (LOs), we do not have a counter part of UML in the field of educational technology.

According to Balatsoukas, Morris, and O'Brien (2008), "The structure and composite nature of a learning object is still open to interpretation. Although several theoretical studies advocate integrated approaches to the structure and aggregation level of learning objects, in practice, many content specifications, such as SCORM, IMS Content Packaging, and course authoring tools, do not explicitly state the aggregation level or granularity of learning content." This leads to the researcher idea that it is time to come up with a modeling language that could fill up the gap that had been created because of the lack of a modeling language. This modeling language is called instructional modeling language or IML and is presented in this research. This language promises to help reduce the design time needed to write syllabus, other descriptions of the parts of a course, and any of the contents of a course. It would also lead to the concept of LOs' repositories where LOs could be stored on a website and shared globally using Web 2.0 technology.

What is Learning?

Before we dig deeper into the definition or the use of LOs, let us understand the motivation behind them. Whether it is the traditional style of teaching or using LOs, it comes down to the question, why do we need different approaches in instructional design? One can guess the obvious answer that it is all about learning. Then it can be asked how do we define learning? There are many theories behind learning but at the very basic level, the term *learning* is used to refer to "the knowledge acquired through a process of gaining knowledge or skill by studying, practicing, being taught, or the activity of someone who has learnt through any of the process above" (De Houwer, Barnes-Holmes, & Moors, 2013, p. 639). De Houwer et al. defined learning as "functional" changes in the learner's behavior as a result of experience. It can easily be argued that we would like to see a change in behavior of the person doing a certain task, but it could only be done through giving that person the essential tools of knowledge and it use. Without the proper knowledge and the proper tools, one cannot perform their job and this change in behavior is not completely implemented.

Theories of Learning

Before making a connection of LOs with the theories of learning, let us understand what are these theories based on? Or what are main characteristics of the learning theories? Watson published *The Behavioral Learning Theory* in 1913, which was responsible towards the movement of behaviorism (Overskeid, 2008). Behaviorism in psychology is defined as observable, measurable, outward behavior which is worthy of scientific behavior (Bush, 2006). That means behavioral learning is related to the change that it has caused to an individual after learning had occurred. This change is observable. According to Bush (2006), in behavioral learning, it is believed that all students can learn given appropriate environmental influences. Therefore, a stimulus of learning given to a student will produce a change that occurred in student's behavior and it is measurable. The scientists who supported behaviorism were obviously not interested about how the learning occurs in the human mind. Instead, they wanted to only study the behavior as it is related to certain stimulus.

Behaviorism stayed as the main theory of learning for decades until there was a paradigm shift towards cognitivism. In 1948, Edward C. Tolman's rats that were used for experiment showed evidence of cognitive mapping (Bush, 2006). Scientists were constantly trying to find out the relationship between cognition and learning. One of the observations was that cognition is related to the learning of a language and this existed in terms of concepts and processes in the brain (Chomsky, 1957). In cognitivism, the human mind acts as a reference for knowledge while constructivists see the human mind as a filter of the real world to generate its own reality (Ertmer & Newby, 2013). That means babies learn the language of their parents without much of a stimulus. Researchers in other disciplines were studying similar cognition theories. The theory of computer science, artificial intelligence and cybernetics was gaining popularity (Bush, 2006). There seemed to be a paradigm shift in terms of learning which was not measurable rather it was based on cognition. Cognitivism deals with the states of brain, activities, and processes to make sense of something.

After cognitivism, there was a paradigm shift towards constructivism. Constructivism was studied by Jean Piaget and Lev Vygotsky who were psychologists by profession and were studying cognitive development (Rummel, 2008). Their study provided the basis of constructivism. Constructivists' view of learning about children was the development of knowledge through participation. Piaget believed that that cognitive development was through observation and experimentation. Vygotsky viewed learning as a social process through interaction with the members of the culture (Rummel, 2008). The proponents of constructivism viewed learning as a search of meaning. Constructivism also helped predict what students will understand at different stages of development (Rummel, 2008). It means if you were provided with instruction that is built on top of each other as a consequence of learning, you would have a better understanding of the whole learning process. Therefore, experience of a learner played an important role in learning when we look at the theoretical foundation of constructivism. Constant experimentation and observation were the key element for learning in constructivism.

How the Shifts Have Affected Our Decisions?

The paradigm shifts from behaviorism to cognitivism, and cognitivism to constructivism have affected in our decisions to understand learning. Overtime researchers found that learning was not limited to any outward behavior. For example, in our everyday education - when we teach a subject or a game to a group of students – we tend to pick the best from the group to represent our school's teams and competitions. That means while behaviorism played a role and the outcomes were measurable, we still thought that some of the elite group from a larger students' population would perform better than their fellow classmates. This shows that we also believed that the cognition was better developed in certain students than others. Overtime, we realized that most of us make such decisions like picking the best students regardless of our knowledge of the learning theories that lie underneath our decisions. In our traditional classrooms, students learn differently and may perform at various levels proving that cognition was present in them and it was not observable. Not all students could be trained in the same way. Even some professions are not meant to be for everyone. For example, some students will perform well in mathematics and others in medicine and so forth. This shows that while we all have similar physiology and characteristics as humans, there are some inherent qualities, which differentiate us from each other. These qualities contribute as to how we perceive a certain problem and solve them differently. It seems like the way our brain is wired, the kind of genes that we inherit from our parents, and our prior observations and experience is an important part of our future learning in life.

Learning cannot be limited to behaviorism only. We could train a dog to respond on known external variables. However, the dog might not respond if an extra variable is added to a scenario. Here cognition becomes very important where humans can solve a problem in a new scenario. Rotfeld (2007) suggested that behaviorism is an invention of psychologists since they ignored human thought and cognition. The researcher does not totally agree with Rotfeld and would not disqualify behaviorism altogether. The researcher still respects the motivation behind behaviorism. Being an old school of thought, behaviorism provided a good starting point to look into the theory of learning. Most of the trained dogs and young children demonstrate behaviorism. That means they could be trained to perform basic functions based on a known stimulus. The stimulus could be blowing whistle for a dog to come towards you or singing a lullaby for a baby to sleep. However, this type of learning is limited to the number of stimuli and responses. These stimuli do not address the ability to solve newer problems.

In a similar way, constructivism is very well practiced in the modern world and in the third world countries as well. Constructivism teaches us that learning can happen from experience, observation, and social interaction. That means, students should be allowed to solve newer problems based on their own learning and experience. The modern form of learning is taking this approach. In the third world countries where sometimes there is no formal school available to the larger population, most of the decisions are made by the elderly who are at the top of the hierarchy in the social setup. This phenomenon had been the de facto for centuries until the education reached to the remote parts of the world. It shows that while the people living in those parts of the world are not aware of the learning theories, they were in fact using learning concepts for centuries. This approach is very much true even in the modern world today. The discovery learning is a form of constructivism and is practiced in the research institutions all over the world. The same concept had been practiced in the third world countries without formal educational settings.

Brown (2006) stated in his paper,

> According to a behavioristic view of learning, a learning result is indicated by a change in the behavior of a learner. According to a constructivist view, learning is seen as the individualized construction of meanings by the learner. Neither of these views can be regarded as exclusively right or wrong. It is, however,

> necessary to know that constructivism is presently accepted as the more relevant of the two and that education policies, education models and education practices focus on constructivism.

The stimulus-response is the main ingredient in behaviorism and instructional design depends on workplace or classroom containing the right stimuli to get the desired behavior. That means if a stimulant is not available, then the desired behavior may not happen (Altuna & Lareki, 2015). These paradigm shifts were the call of the time when learning was taking place. Every paradigm shift seemed logical at a certain time and that is fine because all theories start from somewhere. It is the research, which takes us from one point to another. The best thing in humans who are involved in any research is that we keep on looking for the newest and the quickest answers to our problems in every discipline of life.

In essence, the paradigm shifts were recognized as a form of learning in our research as the educationists tested the existing paradigm and could not explain the new phenomenon. However, the three paradigms existed and were used by the educational and non-educational community indirectly. Therefore, a constant research is essential to recognize and practice the new theories. The paradigm shifts opened our mind to incorporate all the aspects of learning in our curriculum. In other words, the shifts affected our decisions about learning. Therefore, most of the new curriculums are incorporating constructivism (Agostinho, Bennett, Lockyer, & Harper, 2011). This proves that the paradigm shifts affect our learning institutions considerably. Those days are gone where students were tested on the same concepts that they learnt over and over again and, in some cases, they even memorized them. The newer constructivism approach puts students in a challenging mode where they are tested on different concepts and questions enabling them to apply their knowledge and observations. The focus of deciding what to teach has been changed from stimulus-response (S-R) model to cognition and applying the knowledge that had been learnt overtime (constructivism).

LOs could be taught in using all of the theories of learning. First, they could be designed for certain level and discipline. For example, we could design LOs for grade level 1 mathematics. These LOs are basic concepts and could use the concepts from constructivism, cognitivism, and behaviorism. Most math teachers would agree that this approach could be used up to higher level of grades as well. That means, LOs does not affect the paradigm of learning but it would enhance the methodology of learning. We could still follow one learning theory or the other, but it is the way that we deliver instruction will change. This is an incredible contribution from LOs' point of view.

Debate about the Definition

There is a lot of debate about the definition of LOs. For example, as Merrill, Li, and Jones (1991) wrote, "In addition to the various definitions of the term "learning object," other terms that imply the general intention to take an object-oriented approach to computer-assisted instruction confuse the issue further. Gibbons, Nelson, and Richards (2000) used the term instructional object and define it as any element "that can be independently drawn into a momentary assembly in order to create an instructional event" (p. 27). According to Metros (2005), in order for a digital source to be considered as a learning object it "must include or link to:

1. a learning objective
2. a practice activity, and
3. an assessment."

Metros also believes like many other researchers that the definition of learning objects is subject to interpretation. The NSF–funded Educational Software Components of Tomorrow (ESCOT, 2000) call them "educational components." The Multimedia Educational Resource for Learning and Online Teaching (MERLOT, 2000) call them "online learning materials.". First of all, while we have borrowed the concept from software engineering, we have not completely satisfied the definition as it applies to computer scientists. On top of it, authors are using different names for the same thing. This would definitely confuse everyone. The people coming from the information technology background might be able to make some sense out of it but people from other disciplines will need a lot of explanation to grasp the idea. Since, LOs is still relatively new in the field of educational technology--it needs standardization on the definition and naming conventions.

In order to facilitate the use of LOs in the industry throughout the world, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) formed in 1996 to develop and promote instructional technology standards (LTSC, 2000). If we do not have these standards, then educational institutions and other organizations around the world would have no way of assuring the interoperability of their LOs. There is another project, which was started by the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE, 2000), which started with the financial support of the European Union Commission. This project deals with LOs. During the same time, another project called the Instructional Management Systems (IMS, 2000) Project was just beginning in the United States, with funding from Educom. The ARIADNE project used the term “pedagogical documents” for LOs. The Apple Learning Interchange (ALI, 2000) simply refers to them as “resources.” The main focus of these organizations was to come up with technical standards to support the idea behind LOs. It is interesting to note that while all of these organizations were talking about the same thing (LOs), they were defining them differently. It seems like all of these organizations were conforming to the Learning Technology Standards Committee’s term “learning objects” for the small instructional components. It is time for the educational community to agree on one single, comprehensive, and practical definition of learning objects. For the rest of this paper, the researcher will be calling them learning objects (LOs) or Reusable learning objects (RLOs) and abide by the definition of Learning Technology Standards Committee as described in the beginning.

The definition of an “object” has been agreed in the field of information technology and everyone in that field has benefited one way or the other from its concept. It has standardized the modeling and programming efforts of software engineers. There are many concepts that evolved out of the objects as well. Object Oriented Programming (OOP) is done through object-oriented languages (OOL). Some of the OOL are Java, C#, Python, etc. The first OOL is generally acknowledged to be Simula-67, developed in 1967. However, the concept did not gain popularity until 1980s and 1990s when some of the later languages such as Smalltalk, Objective C, C++, etc. appeared (Rumbaugh et al., 1999). An OOL must have certain characteristics, such as, Encapsulation, Inheritance, Polymorphism, and Dynamic binding in order for it to be considered an OOL (Craig, 2007). These concepts are beyond the scope of this research since they fall into the category of computer science and software engineering; however, they are worth mentioning.

For example, C programming language is not an OOL because it does not have all of the above characteristics. C is older than Java. OOL was a new concept compared to the traditional procedural languages like C. This is a clear proof that software engineering has invested in many concepts generating billions of dollars' worth of software using objects. The same could happen in educational technology; however, researchers seem to get stuck on the definition. If we expand on the concept of LOs, we should be able to replicate the expansion of "objects" in information technology with LOs in educational technology as well.

What is an Object?

When we talk about object, we should also know about the term "class. A class is group of objects; therefore, it has attributes and behaviors as well. The class serves as a template. (Rumbaugh et al., 1999). Example of a class is a "Course" offered in a school. The objects could be various courses that this class is made of, for example, "MATH 101," "ENG 101," and so forth. Whereas, "MATH 101" and "ENG 101" are both attributes named "course number" and "Basic Math" and "Basic English" are also attributes for "course name." Similarly, "Take_Test ()" is a behavior. This concept can be depicted in software engineering by a simple object diagram using UML as in Figure 1.

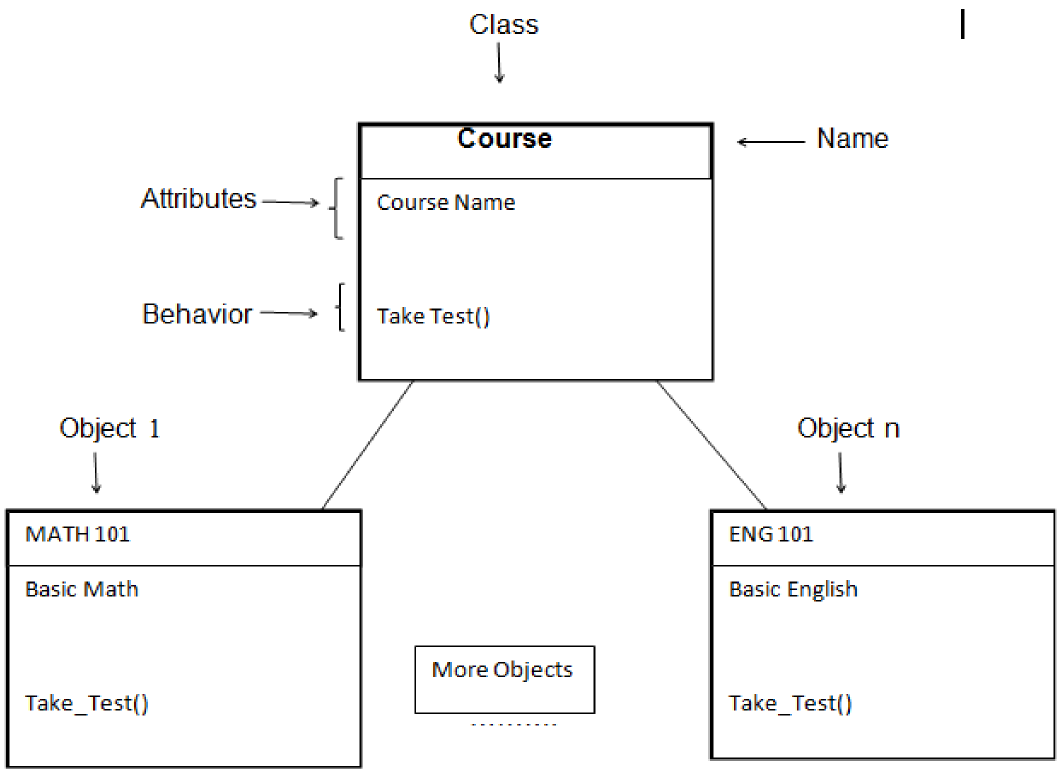

Figure 1. Showing "class" and "objects" in software engineering using Unified Modeling Language (UML).

What are Learning Objects (LOs)?

LOs in instructional design are anything that can be used, re-used or referenced in technology. For example, a unit test is a LO because it can be re-used by different school teachers for the same grade. The idea of a LO was originally borrowed from an "object" in software engineering. Object in software engineering is defined as something that holds some attributes and behaviors. LOs provides a sense of modularity, which could be developed independent of the syllabus, grade level, and location. It is something that is developed by a subject matter expert (SME) and could be plugged into any curriculum depending on the need.

In a nutshell, just like UML opened up the doors to depict object-oriented concepts such as polymorphism, encapsulation, inheritance, and dynamic binding (Rumbaugh et al., 1999)--IML will be able to capture all the educational technology related concepts as they arise. These object-oriented concepts are beyond the scope of this paper as they are used in software engineering, but they are mentioned here to ponder upon the expanded domain of IML as well.

For example, the above example of software objects could be translated into IML. It can be done in a much easier way as shown in Figure 2. Note that the second figure is understandable by educators and software developers alike. It seems like it shows more information, however, the LOs within the rectangles will be represented by acronyms, which simplifies the process of designing since they could easily be remembered unlike their counter- part graphical notation in UML. In other words, the IML designed by the researcher can be converted to a software application that could automate the barriers faced by teachers into a solution. The software built for IML and LOs could be merged with Learning Management Systems (LMS) like Blackboard etc. and shared through website LOs' repositories.

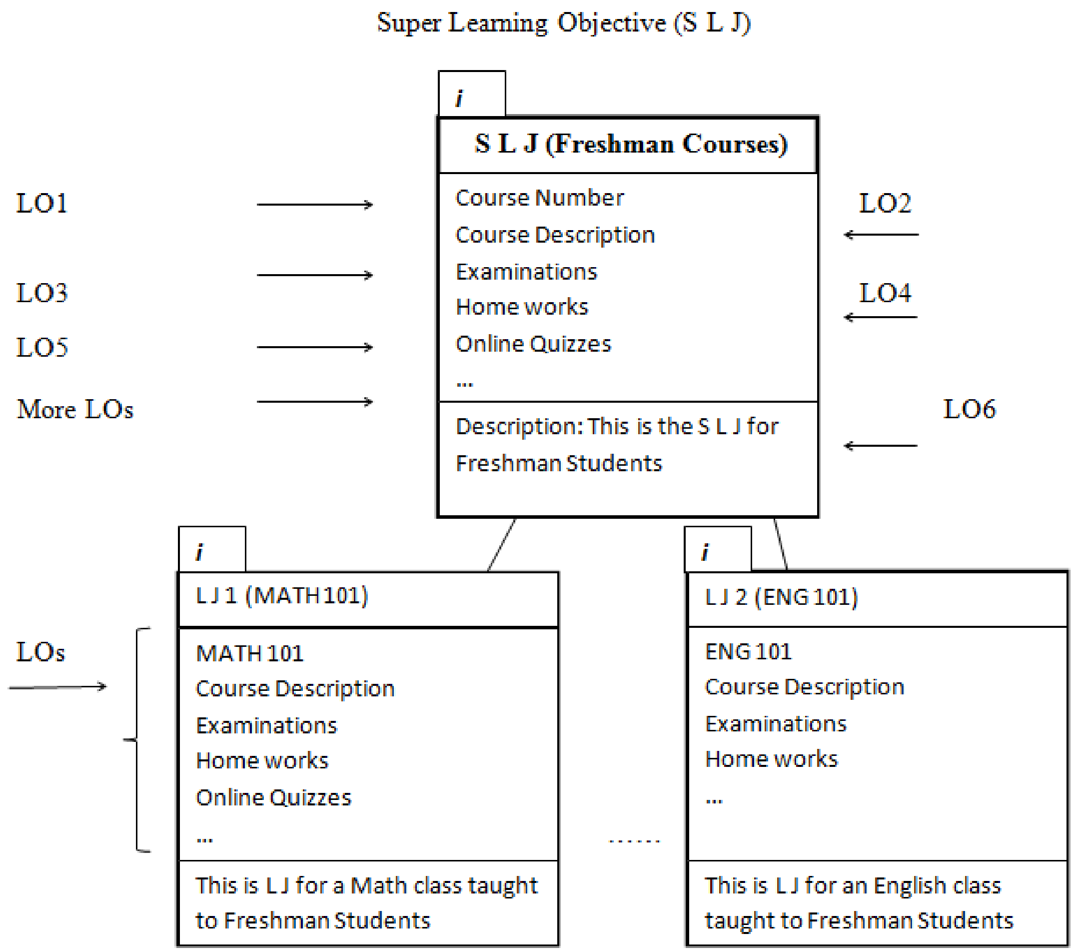

Figure 2. Showing Learning Objects (Los) in the proposed Instructional Modeling Language (IML).

Role of Learning Objects

LOs can play a very important role in the field of educational technology. In fact, LOs are already contributing in learning. Most of the educational industry is moving towards LOs in the recent days. Before the concept of LOs was introduced, most of the educational technology software was designed by using java or other object-oriented programming languages. That means the software engineers had to translate user requirements from long text and explanations to objects and then program in it. With the introduction of the concept of LOs in educational technology, the software engineers will be able to understand the requirements better thus saving time and money to write the software for it. Learning objects are used in educational technology because they are small and focused form of units, which could be built for better learning and reusability.

Akpinar (2007) described that LOs are digital assets and presents analysis of many studies where reflective action instructional design (RAID) and learning object review instrument tools were used. Akpinar (2007) also recommends intensive use of tools to free LOs design from the personal learning traits of instructional designers who never used LOs. LOs design should be looked as a different paradigm where the instructional designers will have to look at the design of instruction in a newer way (Akpinar, 2007). It seems like another paradigm shift is in progress with LOs. This is the time where all the learning paradigms seem to merge into a self-defining unit called as LOs. LOs are not about designing long, boring, and sometimes non-essential contents of a course. It is a self-sufficient piece of instruction, which meets the learning demands of the audience in a shortest possible manner. LOs could be created using some of the commonly used tools such as: word processing, HTML editors, graphics tools, and so forth. These tools will help create a one complete shareable object. Akpinar (2007) suggests that the number, quality, and orientation of screen elements loaded in a lesson are an issue for the development of LOs. For effective learning, screen design should reflect a balance between learner attributes, cognitive load, content factors, and the processing requirements. The effects of RAID and learning styles on senior educational technology students' design and development of LOs using leaning management systems (LMS) were studied by Akpinar. Their quality of LOs with different set of parameters, such as number of assets, text density, and number if instructional elements, etc. were also of interest in the creation of LOs (Akpinar, 2007). LMS are another way to create LOs. It seems like LOs could be created by any software tool, which allows the creation of a smaller, focused, effective, and reusable learning unit.

There is no doubt in my opinion that LOs role is far reaching in the field of educational technology. LOs are proved to be cost effective and easy to be used and re-used. Billings (2010) talks about Reusable learning objects (RLOs). RLOs are pre-developed digital learning activities that can be integrated into lessons, modules, and courses. In other words, they are already built LOs. The author claims that several repositories have nursing-specific RLOs waiting to be used by nurse educators (Billings, 2010). This is another proof that learning objects (LOs) have touched almost every discipline of learning and seems to be the future of educational technology. One of the examples given by Billings (2010) is the comparison of two nurse educators. For example, nurse educator A is assigned to teach “acid-base balance” to a group of nursing students. After developing learning outcomes, the educator reviews the content in a variety of textbooks and then spends hours organizing the content for the learners and making graphic-rich PowerPoint slides to present during a lecture. Nurse educator B has to teach the same content. After determining the learning outcomes and evaluation criteria, nurse educator B searches an electronic database for an appropriate reusable learning object (RLO), integrates it into the lesson plan, and assigns it to the learners to complete prior to having a clinical application with a patient. Billings (2010) has made a clear distinction that the use of RLOs is cost effective and more practical approach when it comes to learning. The researcher thinks the future of educational technology lies in

LOs and their widespread use. It has given a promise to many educators in almost every discipline. The challenge will be to leave the old habits, learn a new concept of LOs, and apply it. Once this challenge is met, it will be much efficient to use LOs.

Alharbi, Henskens, and Hannaford (2011) has published a paper about the emerging technology that has been introduced to the instructional design community as something that could be re-used. It specifically focuses on the instruction of computer science and the factors that are related to learning objects (LOs). These factors include growth of LOs over time, user ratings, and personal collection. The LOs were retrieved from The Multimedia Educational Resources for Learning and Online Teaching (MERLOT). It is a repository for LOs from different disciplines. There are many suggestions given in the paper as to how to improve LOs as it applies to computer science. The authors gave a strong reason to use LOs (Alharbi et al., 2011). This is because they are not easy to develop, however they are better to be re-used. LOs are a new form of instructional approach and they provide flexibility in learning.

Computer science is a diverse and developing discipline, which involves studying different abstract concepts. LOs could provide a means to cover a vast area of backgrounds for the students. Examples of LOs given included images, animations, audio files, simulations or even a combination of different media types. Learning Object Repositories (LORs) are online inventories where LOs are stored along with their meta data. Meta data means data about data. Hence, here the data were about LOs' repositories. This makes it easier for the users to find and re-use them. MERLOT organizes the repositories into nine categories. These categories are as follows:

- Academic Support Services
- Arts
- Education
- Humanities
- Mathematics and Statistics
- Sciences
- Technologies
- Social Sciences, and
- Workforce Development.

This research was exciting in a way that it opened a discussion on the huge repositories of LOs. These LOs are not limited to just one area. It depends what needs to be included. Almost every discipline could be taught using LOs. This work is exciting and has brought the LOs into the spotlight. The element of sharing will make learning easy for everyone who has access to a computer and the Internet. The above nine categories are very broad. They could be further split into specific sub-categories as the demand and number of LOs grow, for example, computer science, electrical engineering, etc.

Krauss and Ally (2005) reported on a case study where learning objects were processed and evaluated to understand the therapeutic principles of drug administration. This study discussed the challenges and issues that are related using interactive media software. There were two main purposes of this study. One was to analyze and document the process of learning objects (LOs) and the other was to evaluate the outcome of allying these practices. These purposes were achieved by examining the theories of learning that influence the design of LOs and the instruments that can be used to assess the quality of LOs. This information was very useful for the instructional designers. Therapeutic principles of drug administration are one of the most complex areas of teaching. Normally, this subject is taught from a textbook with minimum time for a lecture. The students need to memorize the principles without a deeper understanding. This study involved a group of experts, such as: an instructional designer, a programmer, a media designer, and a subject matter expert. Macromedia's Flash MXTM software tool was used to design an interactive online module where students learnt the concepts by changing the variables for the drugs and their effects on the blood (Krauss & Ally, 2005). For example, patient's age, weight, etc. could be changed through this software tool to get the appropriate dosage. By playing with this software on different values for the variables, students will be able to understand the therapeutic principles of drug administration. This is another proof of the flexibility and opportunity that LOs provide in learning. This concept of changing the variables to understand the effects on the drug formula resembles the constructivism-learning paradigm. There is a lot of experimentation and observation involved which helps the students to learn the very essential concepts of drug administration. The tool was studied by Krauss and Ally (2005) and it is another reason to believe that LOs will contribute enormously in the online learning, which is the fastest growing industry in the academia today.

Shared Repository for Learning Objects (LOs)

The beauty of LOs is in its reusability. These LOs could be stored in a shared repository. This repository could be shared by the participating schools and teachers. It is a time saving phenomenon for all teachers. Al Musawi, Asan, Abdelraheem, and Osman

(2012) conducted a research study, which was about a model for an inquiry-based learning environment using learning objects (LOs). They applied the model to examine its impact on students' learning. The study showed that a well-designed learning environment using LOs could enhance students' learning experiences. The proposed model was applied to an undergraduate course offered by the faculty of education, Sultan Qaboos University, Turkey in 2009. The results in the research indicated that the implementation of the web-based inquiry-learning model was successful. This research was adequate to learning setting. The authors claimed that this model of learning helped most students to manage the tools and techniques used during the course. Some of the positive aspects of this web-based course were freedom on the construction of presentations. This allowed students to explore creativity on the subject domain; and independent learning together with presentations contributed to preserve the uniqueness and value of each student's production. The LOs' repository and other educational resources helped the students' learning by providing them with numerous LOs to choose according to their needs. It was pointed out by the research study that LOs have a bright future in terms of its usage and LOs would contribute tremendously in "knowledge economy." Most of the existing educational systems are based around LOs because of their ease of use and re-usability.

Doorten, Giesberg, Janssen, Daniels, and Koper (2004) provided a good start for educators who want to convert the existing contents that exist in the academia into LOs. Their paper addressed the issue of how to use the existing content in the realm of learning objects (LOs). This issue is addressed at the individual and at the organizational level as well. They covered the process that is involved in converting the contents into reusable

LOs. Doorten et al. (2004) pointed out the standards that should be followed in the process of converting non-object-oriented design into LOs especially as it relates to IMS (2002) Global Learning Consortium. The increasing popularity of e-learning has caused the use of reusable content (LOs) for the economic reasons. There are two companies mentioned in the paper who are using object-oriented design for e-learning. They are Netg and Cisco. The smallest reusable object is a topic, which consists of a learning objective, a learning activity, and an assessment. Doorten et al. (2004) listed some of the attributes of a LO, which includes modularity, transportability among different platforms, non-sequential, single learning objective, should be accessible to broad audience, etc. Doorten et al. (2004) quoted Open University of the Netherlands, which has developed educational materials that enhance pedagogic neutrality, reusability, and personability, etc. It is obvious that reusability is utilized in every discipline and that is something, which was not very well practiced until the introduction of LOs.

Reusable Learning Objects (RLOs)

The terms for LOs and Reusable Learning Objects (RLOs) have been used interchangeably in many researches. One of the researches done on the conversion of existing teaching materials to LOs is by Alsubaie and Alshawi (2009). In their research, they first defined the concept of LOs. According to them, the new concept is about Reusable Learning Objects (RLOs) where education material is broken down into smaller chunks called as learning objects. These smaller chunks are easier to design and decipher. Since this is a new technology, there are not enough guidelines to take pedagogic material and create RLOs. They introduced the lifecycle for the creation of RLOs and walked the reader through it. Traditional material had been notorious for being difficult to convert into other mediums thus it had limited use. They presented the Learning Object Construction Cycle (LOCC) that takes the traditional pedagogical materials and convert it into RLOs through a five-step process. The LOCC process has the following five steps (Alsubaie & Alshawi, 2009):

Step 1: In the first step, it is suggested to use preplanned key instructional objectives to select and organize the selected traditional pedagogic material into distinct groups. This is to guarantee that the specific material covers the syllabus for each group. If the material does not fulfill the criteria, then the material is recycled back to the top of the model (LOCC). The rejected material could be utilized for other modules if it is still useful. If the material is accepted, then we proceed to the Step 2.

Step 2: In this step, the successful material from Step 1 is divided to see if it meets the instructional objectives and if we could arrange it in a pedagogical sequence forming feasible lessons using the standard guidelines. If the material is not enough, it is discarded from the LOCC model but recycled back for some other module. If there is enough material to meet the objectives, it is sent to the Step 3.

Step 3: The pedagogical content from Step 2 is examined to see if it has self-contained pedagogical material segments. If there are no self-contained material segments, then the material is recycled back at the beginning of Step 2. If there are self-contained material segments, then they are tested to see if it has a single pedagogical outcome. If there is no single unique learning outcome, then the material is recycled back at the beginning of Step 2 where it could be used for other learning materials. If the learning material has a single outcome, it is sent to Step 4.

Step 4: The material is tested against the RLOs mapping criteria. Some of the criteria for the learning material to become RLO is that it should have the ability to be sequenced so that the learning experience is enhanced, be reusable, could be transferable across different media, flexible in terms of its format, help reduce cost in publishing and be maintainable. If the material does not qualify to be RLO, it is recycled back at the beginning of Step 3 to be integrated and reprocessed at the lesson level. If the material meets the RLOs requirements with learning outcome, it is classified as an RLO material and sent to Step 5.

Step 5: This step creates a successful RLO, which could be shared across multiple platforms and disciplines and is ready to be used among various instructional systems.

Alsubaie and Alshawi (2009) acknowledged that in the current technological driven digital information age and its key facilitator, the Internet, education is a field, which is being digitally transformed. They suggested that by combining the power of these technologies and using them with the way people learn, offer today's learners' unprecedented and unparalleled access to potentially thousands of courses worldwide. One of the current methods that is generating interest is in the area of RLOs. They used the same idea about RLOs, which is to break education material into smaller chunks of material that can be readily digested and more easily learnt by learners. Furthermore, the process of creating and developing courses using RLOs gives learners the option to select courses that are based on the learners personalized needs. The LOCC and the global access of courses with greater flexibility was the focus of Alsubaie and Alshawi (2009).

A sample-learning object LO is shown in Figure 3. This LO is about a finite automaton. Finite automaton is an abstract theoretical model of a physical or mental machine with a memory. Finite automaton is used as a modeling tool in different disciplines, including computer science, engineering, linguistics, or biology (Han & Kramer, 2009). It could be represented as a mathematical structure, a visual state transition diagram as in Figure 3, or a transition table. The idea of a transition table of transition diagram is to move from one state to another based on a certain input symbol. Figure 3 makes us move from one state to another when the input is two letter characters.

The state diagram could be demonstrated through computer software like Figure 3. This LO is explained through its states. There are 8 states from q1 through q8. The states which are double lined (q1 and q8) are acceptable states. Please note that q1 is the initial (start) state as well. That means if an input string (set of characters) take the user to either q1 or q8 then the string is accepted. The states q2 through q7 are transition or intermediate states. The students are expected to enter at least 5 words separated by spaces. Hence, if a student enters ci, nc, ci as the first word. Therefore, starting from q1, ci will take us to q2. From q2, nc will bring us back to q1, and then ci again will take us to q2, which is not an accepting state. However, three more words like nc, ci, nc will bring it back to q1 which is an accepting state. Another accepting state will be ci, cv, ep, pv, ae, aa, ca which will take us to q8 which is an accepting state, and so forth. If the student does not understand, he or she could click on solution and the learning object (software) will provide the solution. The software also has a test button to test the LO (software). The above example illustrates a LO for the acceptance of states or otherwise on a certain input. This LO might be a little complex for some readers. A simple LO could be implemented for elementary school students to teach them how to add two numbers.

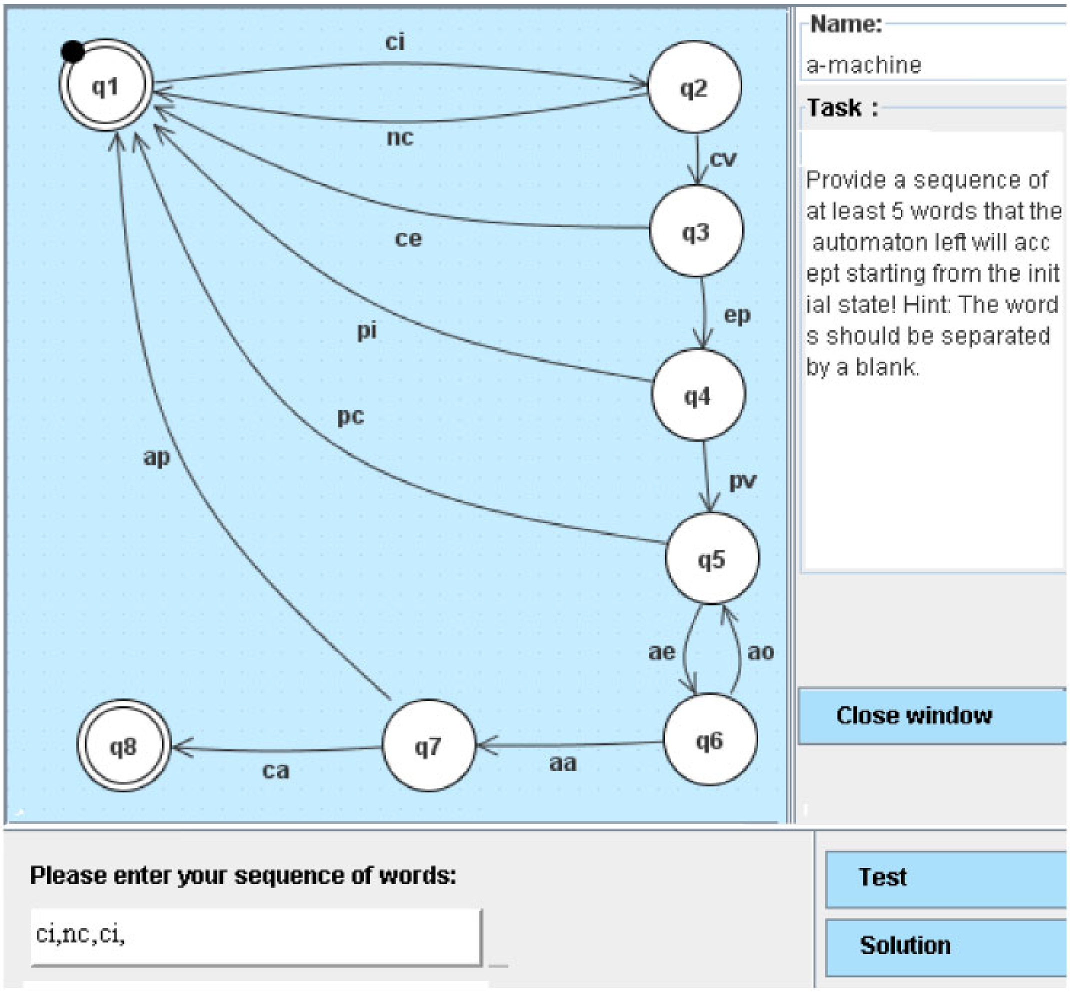

Figure 3. Sample Learning Object shown through a state transition diagram. Adapted from "Generating Interactive Learning Objects from Configurable Samples," by P. Han and B. Kramer, 2009, IEEE *International Conference on Mobile, Hybrid, and On-line Learning*.

Limitations of LOs

LOs like any other concept or product come with its own limitations. Not every LO which is built will have a high standard. Poor quality LOs are also in the market and could be improved right from the time of its design. Barton, Currier, and Hey (2003) described about the quality of LOs as it relates to metadata. Specifically, they researched about the creation and the quality of metadata repositories. They acknowledged the importance of meta data and their use over the web. However, they argued that the creation of the repositories had been overlooked. The creators of the LOs' repositories probably have not followed the standards carefully; hence, the creation of these repositories warrants attention. They surveyed three UK based case studies where human generated meta data repositories were looked at. They recommended this area for future research and how the users of these repositories will use the search engine to find the kind of learning objects (LOs) that they are looking for. They mentioned the use of LOs and the learning object economy where the teachers would be able to share LOs and save cost for minimizing the effort for re-doing the same work. The LOs created in the metadata for the study were checked for their usage and their quality. About 46% of LOs created were of poor quality and not usable. The quality for LOs was checked against duplication, terminology with the standards, and default values. The authors talked about the split of metadata collection into two categories. The first one dealt with the educational practitioners who were responsible for entering basic metadata. The second one was about information scientists who were responsible for classification and more technical quality check for those LOs that were already entered. A good quality would stay and be re-used until a new concept or technology replaces the old LO. However, a poor quality LO would need to be edited and changed thus wasting a lot of time and resources.

Another challenge to LOs and the field of instructional design is the development of taxonomy development. LOs could be categorized based on many characteristics, such as sequence, scope, and structure. It is hard to think what different types of learning objects might exist without a proper taxonomy. The challenge that instructional designer will have is that can LOs be meaningfully differentiated? The development of taxonomy has historically accompanied instructional design theories (Bloom, 1956). This challenge will remain as we are going to build LOs and accumulate too many in the next few years. One of the problems with technology in general is that there is too much information out there. The same problem is going to affect the creation of LOs as well. Unless we plan carefully, LOs will be available everywhere and the challenge for the students will be which LOs do they need. The teachers must have good understanding of what kind of LOs are available and test them thoroughly before they will be able to recommend to their students. The quality, objectives, and the ease-of-use will play critical role in the use of LOs.

Just like any product or software, there should be some quality control for making sure that the LOs created are of good quality and guaranteed to be used and re-used. Vargo, Nesbit, Belfer, and Archambault (2003) came up with a concept of Learning Object Review Instrument (LORI). It provides a common review format for making comparisons among RLOs (thus LOs) for the users to pick a good quality RLO and something they are looking for. After following LORI model, evaluators can rate and comment about the LOs/RLO using nine separate categories. These categories are listed below (Sinclair, Yin-Kim, & Hagan, 2013):

- content quality
- learning goal alignment
- feedback
- adaptation

- motivation
- presentation
- interaction usability
- accessibility
- reusability, and
- standards compliance

The above nine categories are explained in the following Figure 4:

Category	Description
Content Quality	Veracity, accuracy, balanced presentation of ideas, and appropriate level of detail
Learning Goal Alignment	Alignment among learning goals, activities, assessments, and learner characteristics
Feedback and Adaptation	Adaptive content or feedback driven by differential learner input or learner modeling
Motivation	Ability to motivate, and stimulate the interest or curiosity of, an identified population of learners
Presentation Design	Design of visual and auditory information for enhanced learning and efficient mental processing
Interaction Usability	Ease of navigation, predictability of the user interface, and the quality of UI help features
Accessibility	Support for learners with disabilities
Reusability	Ability to port between different courses or learning contexts without modification
Standards Compliance	Adherence to international standards and specification

Figure 4. Learning Objects Categories. Adapted from "A Practice-Oriented Review of Learning Objects," by J. Sinclair, Y. Yin-Kim, & S. Stephen, 2013, *IEEE Transactions on Learning Technologies*, p. 180.

Figure 4 is a good explanation of the nine categories, but it seems subjective. The items that are being checked against to be a good RLO depend on the qualification of the rater who would determine passed or failed for an RLO. More research is needed to make this process more objective. It is obvious that LOs are going through their refining process. While everyone is excited to use this new concept, the researchers want to make sure that these LOs/RLOs are designed with high quality and testing. There should be guidelines available for new educators as to how to design a LO? This is another area, which needs to be researched. There is definitely one clear observation so far that learning objects and the discipline of computer especially the area of object-oriented programming. As Fernandez-Manjon and Sancho (2002) wrote:

> The idea behind learning objects is clearly grounded in the object-oriented paradigm: independent pieces of instruction that may be reused in multiple learning contexts and that fulfil [sic] the principles of encapsulation, abstraction and inheritance. (p. 7)

Conclusion

The definition of LOs has been debated in various disciplines. The use of LOs which are called as RLOs as well is a relatively new concept and has gained popularity because of its positive feature about re-usability. Re-usability could save billions of dollars' worth of hard work that goes into the designing of home works, quizzes, exams, and other learning materials. These LOs should be stored at a common repository where a teacher or students could search under a certain category and benefit from it. LOs could be shared across the globe and are cost effective. They are focused form of units, which would enhance the learning of students. LOs could still be used in the learning theories, such as, behaviorism, cognitivism, and constructivism. While LOs definitions are still debatable, they have already made it to the industry and systems are built which utilize the use of LOs. Just like any other new concept or a product, LOs have their own limitations. Poor quality LOs will not make it to the repository. Many suggestions and standards are in the process to be finalized to make sure that LOs meet high quality standards.

CHAPTER III

METHODOLOGY

The Purpose

The purpose of this study was multi-fold. A new instructional modeling language (IML) designed by the author was introduced and its use for the designing of learning objects (LOs) by educators was studied. This creation of LOs was further researched to incorporate the concept of web repositories and its benefits. These small explorations warrant deeper investigation; thus, a proof of concept research design was proposed for this dissertation.

Proof of Concept

A proof of concept is intended to test an idea for viability. In this study, the concept under scrutiny was the idea of a software prototype before it is built. It includes a visual representation of the thought process and the mechanics in a logical order. The prototype allows for the exploration and vetting of the idea and procedures of the software to establish the concept as warranted based on the feedback and testing. It is used to introduce the researcher's idea and gain backing by experts in the field through the dissemination process. The software development details for the proposed software in this study is not included in this research and is beyond the scope of instructional design. The researcher feels like the innovative idea behind the IML and Web Repositories is the need of the future for the academia at all levels. This opinion has been reached after the idea was accepted and presented at the AECT conference in 2015. The presentation was well received and then the author did a pilot study at a local private school to further verify the concept. The author has taken into consideration the existing barriers that exist in the field of educational technology and how the proposed software by the use of IML to design LOs and store in a web repository could rectify those barriers. The beneficiaries of this proposed software are faculty and students as well. The proposed software for the IML and web repositories can be explained in a sequence of steps as depicted in the Figures 5 and 6 below:

The use of Learning Objects (LOs), which is a relatively new concept, has gained popularity because of its positive feature about re-usability. Re-usability could save billions of dollars' worth of hard work that goes into the designing of home works, quizzes, exams, and other learning materials which are called Learning Objects. The researcher proposes that these LOs should be stored at a common repository where a teacher or students could search under a certain category and benefit from it. LOs could be shared across the globe and are cost effective. They are focused form of units that would enhance the learning of students. While LOs definitions are still debatable, they have already made it to the industry and systems are built which utilize the use of LOs. A proof of concept verifies the need of such as proposed software in the academia today. Just like any other new concept or a product, LOs have their own limitations. Poor quality LOs will not make it to the repository. Many suggestions and standards are in the process to be finalized to make sure that LOs meet high quality standards.

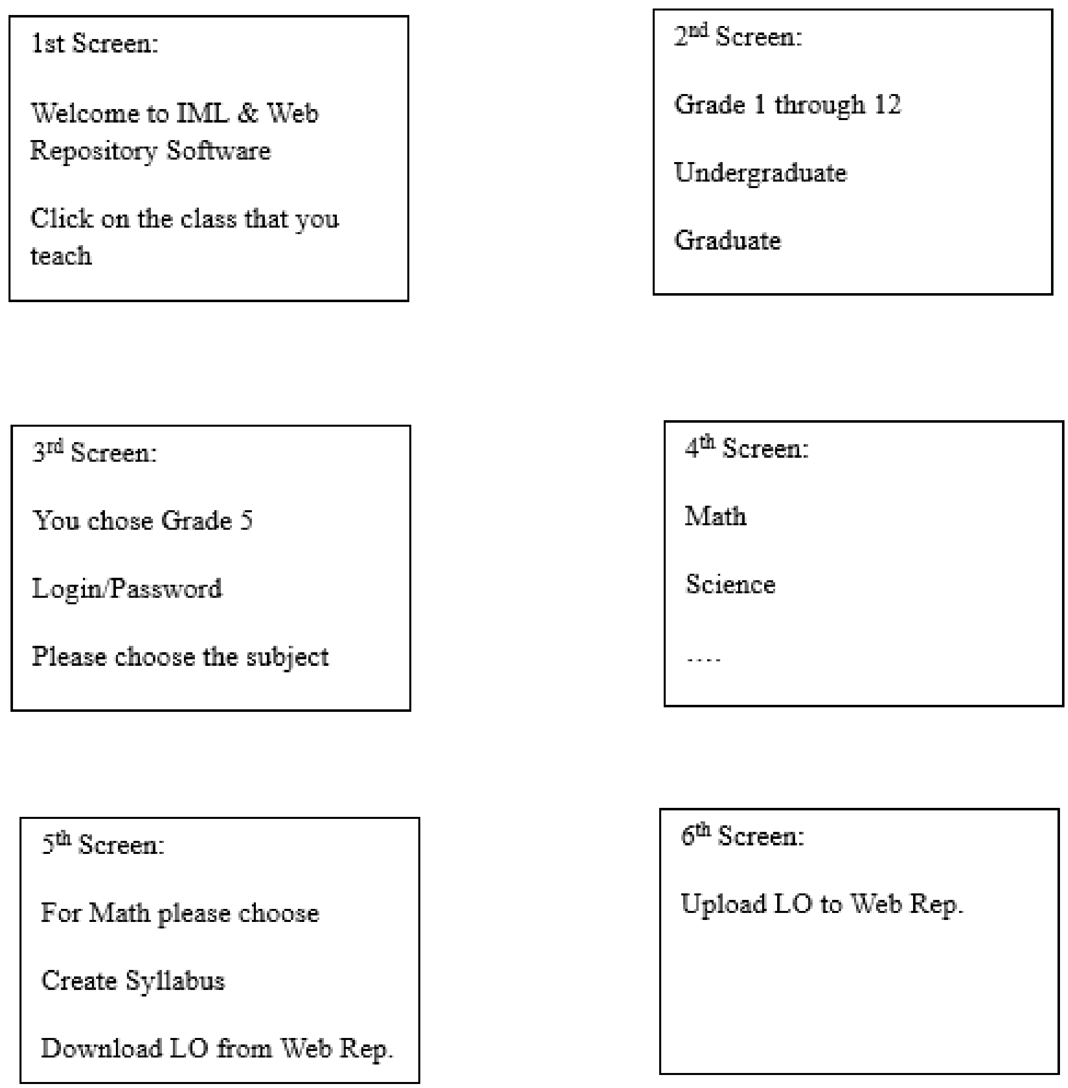

Figure 5. Faculty's view of Learning Objects (Los) and web repository.

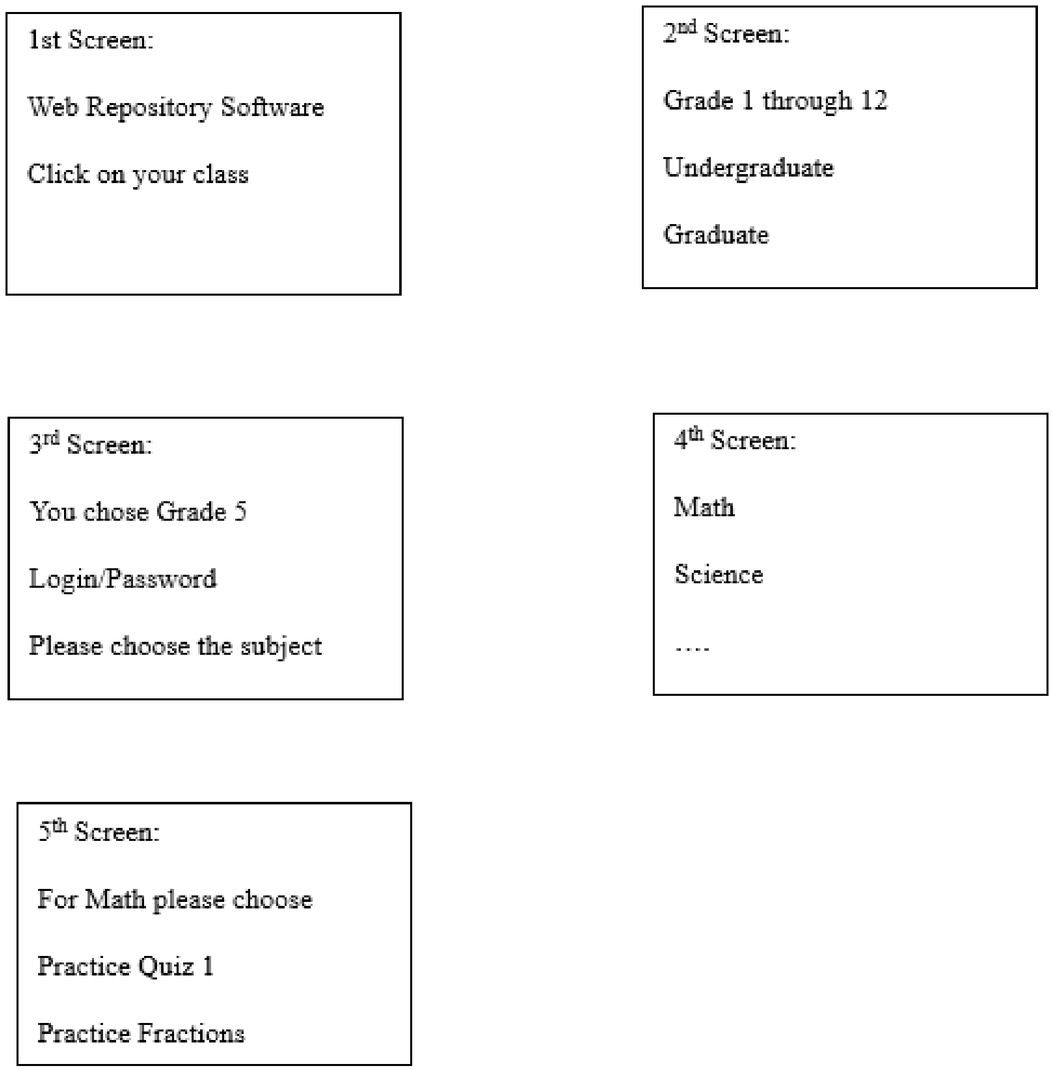

Figure 6. Students' view of Learning Objects (Los) and web repository.

While LOs exist in the industry there is no modeling language to represent them making it a concept that is interpreted differently by many vendors who are writing software in this area. A modeling language like IML provides a great promise for standardization and an easy to understand process to define the requirements for better software tool that could be used by teachers at all levels. This tool would automate the process of creating LOs thus saving time that could be better utilized by the teachers to provide a quality education to students. The power of LOs' repositories could be expanded across the globe to provide 24x7 online tutorials and videos. Knowledge can be shared in the field that are very crucial to human survival and was un-thinkable before.

Research Questions

This research sought answers to the following research questions:

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language (IML)?

Theoretical Framework

Maxwell (2012) defined theoretical framework as the "system of concepts, assumptions, expectations, beliefs, and theories that supports your research." In other words, it helps the researcher to frame his or her research. As a researcher in the field of Educational Technology, The researcher wanted to understand the perceptions and barriers that educators have in building efficient course material using my modeling language (IML) prototype. Since this prototype involves the knowledge and reality that they would construct through their human experience and interaction, this research used the theoretical framework of constructivism (Rummel, 2008).

Constructivism is a learning theory that was originally found in psychology, which explains how people might acquire knowledge and learn (Bada & Olusegun, 2015). Therefore, it has direct application to education. The theory explains that learning among humans is through constructing knowledge and meaning from their experiences. This constructivist view of learning places the learner as an active agent in the process of knowledge acquisition. This conception of learning has their historical roots in the work of Von Glasersfeld (1995) and many others. It has been proposed by Von Glasersfeld (1995) that there are implications of constructivist theory for instructional developers and pointed out that learning outcomes should focus on the knowledge construction process and that learning goals should be determined from authentic tasks with specific objectives.

Constructivism for teaching and learning is based on the idea that cognition (learning) is an outcome of "mental construction." That means, students learn by building new information on what they already know. Many constructivists believe that learning is affected by the context in which an idea is taught and what students believe and attitudes towards learning. Originally, the theory of constructivism was discovered in psychology. Constructivism explains how people might acquire knowledge and learn and is directly related to the field of education. Constructivists also believe that humans construct knowledge and meaning from their previous experience.

The review of recently published works on educational psychology or teaching methods shows that teachers do not recognize how learning is viewed or defined during cognitivism (Yilmaz, 2008). The researcher thinks the difficulty in understanding cognitivism is due to the fact that we are talking of how our brain processes information. The theory of cognitivism as a learning theory can be traced back to the early twentieth century. There was a paradigm shift when scientists could not explain why and how individuals make sense of and process information (i.e., how the mental processes work). That means it was the limitations of behaviorism that spawned the cognitive movement (Yilmaz, 2011).

There are two big contributing personalities when it comes cognitive theories. One is the individual cognitive trend deriving from Piaget's studies and second is the sociocultural trend based on Vygotsky's works (Deubel, 2003). Piaget believed that the process of learning and knowledge by humans is done through making sense of our environment and experience. Because of his background, he believed that cognitivism is a result of biological concepts. He thought that the process of intellectual and cognitive development is similar to a biological act that means an adaptation to environmental demands (Gillani, 2003). In a way, the researcher could relate his thoughts to Chomsky state machines where our brain is in different states depending on the type of input (signal) that we receive which ultimately is related to our prior experience and environment.

This research was based on something that the author felt is compelling to understanding through visuals. For the educators, the researcher felt the learning happened through a mixture of constructivism (their prior experience and participation) and cognitivism (processing in the brain). This opinion was drawn based on the interview question about their learning, observation and drawing a conclusion through informal chat. As Churchill (2014) pointed out, visuals help the reader better understand a conceptual model. The IML proposed in this research used many graphical notations and acronyms to make the LOs easy to represent and understand. The researcher incorporated a similar approach as used by UML in a software design.

Researchers' Stance

The researcher had a master's degree in computer science. The researcher had been teaching Computer Science or Software Engineering courses as an adjunct faculty for over 10 years. One of my areas of interest in Computer science is Object Oriented Programming (OOP). Once the researcher started his coursework in educational technology, the researcher came across the concept of LOs. My interest from computer science triggered me to learn more about LOs. Upon further research, the researcher found out that there is no modeling language in existence for LOs. The researcher started my research on the creation of IML and presented my paper in the 2015 AECT conference.

The teachers around the world spend countless hours in building their syllabi, quizzes, exams, home works, lessons, etc. Once built, these parts of the course material which are referred as LOs in this research are shared only on limited basis and through personal acquaintances only. LOs can be easily represented by using an instructional modeling language like IML. The concept of instruction modeling language and LOs could be used in a software and website repositories. The researcher believed that the design of IML and LOs repositories would increase productivity among educators around the globe thus enabling more time for educators to promote and deliver teaching.

Method

The purpose of this research was to introduce a new instructional modeling language to potentially alleviate the challenges that educators face in designing LOs and establish a shared repository for easily using learning objects in educational contexts. The challenges of educators were recognized through research, talking with teachers, and personal teaching experiences. This research is a proof of concept to address these challenges through IML and LO use.

First, the prototype of the IML and LO was created and refined. Beta testing of the IML and LO concepts and interviews was the primary data collection method in a pilot study to establish the prototype. In the current research, interviews were conducted with teachers and administrators, within an educational institution. These interviews allowed for expert opinion to be given and affordances and constraints of the IML and web repositories were collected. The guidelines in this research were followed as specified by the Institutional Review Board University of Northern Colorado where any harm or discomfort anticipated by the participants was not greater than other everyday situations.

Participants

Ten participants from the educational technology field associated with K-20 education participated in this study. Two participants had administration backgrounds, and the remaining 8 were instructors. Participants were adults over the age of 18 who reside in the United States and who have experience in teaching and designing curricular materials in high school contexts. They were invited to participate because they met the selection criteria of experience with technology and curriculum development (Creswell, 2012). These participants varied in their background, one had BA in education, one BA in history, one MA in education, one BA and MA in education, one BS in biology, one BA and certificate in English, one BA in ECE, one certificate in ECE, one Ph.D. in instructional design, one master's in international management, and one had BS in home economics, BA in English, minor in teacher education.

Sampling

The sampling methodology used for this research was both purposeful and convenience sampling. A sample is a portion of a larger population or what we call a universe (Tailor, 2005) and the author wanted a group of participants (teachers and administrators) who had prior knowledge of computer software and have designed a curriculum in their education career so that they were likely to provide critical feedback about the prototype. Convenience sampling is defined as a type of nonprobability or nonrandom sampling. In this category of sampling, members of the target population meet certain practical criteria, such as easy accessibility, geographical proximity, availability, or the willingness to participate in a research (Dörnyei, 2007). The author chose this sampling method in order to collect meaningful information from the participants.

Procedure

After approval of the IRB, the researcher started the process of data collection. This study had a broad perspective in terms of its usage and benefit; however, for this study the researcher limited my data collection to 10 participants, who were the purposeful sample recommended by the school principal. The researcher explained the process of pre-questionnaire, IML prototype (sample), and post-questionnaire. Before getting into the specific questions about the barriers that the teachers face and the IML prototype, The researcher gathered information about the participants' educational background and demographics. The participants read and signed the consent form that included a brief information about the researcher's study and the measures that he would take to keep all participants anonymous (Appendix D).

The author had served in the private school's Board of directors in the past and had personal acquaintances with the Principal of the school. After getting the approval through IRB at UNC, the author contacted the principal through email and explained his research, consent forms, and the intent to conduct the study at the school. The principal identified the teachers and administrators who had prior computer knowledge and had worked on at least one curriculum project that he thought would be available to test the prototype and participate in the interviews. Since the principal had observed and was aware of the responsibilities of the teachers and the administrators, he helped select the purposeful sample of participants for this research.

Once the participants were identified, the following procedures were completed:

1. Schedule meeting day and time that all participants could attend
2. Conducted first meeting on site at school with individual participants (throughout day).
   a. Reviewed summary of research and collected consent forms
   b. Administered pre-questionnaire
   c. Interviewed participants based on the pre-questionnaire to clarify barriers in day to day curriculum work
3. Conducted a demonstration in a whole group meeting after school hours
   a. Introduced IML and demonstrated
   b. Provided opportunity for all participants to use prototype in group setting
4. Participants had personal opportunity to work with the prototype on their own

5. Administered Post questionnaire and interviewed individual participants (throughout day)

During the first meeting, the researcher collected the signed consent forms from the participants and explained the process of the research. The researcher interviewed them individually and asked questions from the pre-questionnaire. The researcher held scheduled meetings with the participants in the school conference room. The questions in the pre-questionnaire were focused on listing the barriers that exist in their day-to-day work as it applies to designing the curriculum and course materials.

After the school was over, the participants were asked to come as a team for a presentation about the LOs, IML, and web repositories which is the research topic for the proposed software. These activities happened on the same day when the researcher met with them for the pre-questionnaire. The researcher helped the participants understand the concept of LOs, IMM, and web repositories through a demonstration about the prototype. The files used by the researcher was copied on the participants' laptop and they were asked to work with the prototype to get a better understanding of the proposed software. The files used in the proof of concept are included in the Appendix C.

During the final meeting, the researcher met with the participants based on their schedules and administered the post-questionnaire and final interview. The questions that were designed for the post-questionnaire were similar to pre-questionnaire. The interview questions were focused on the potential of the proposed software in resolving their existing barriers in the design of curriculum and course materials.

Setting

The interviews were conducted at a private high school in Aurora, Colorado. Once the approval was granted to the researcher, he set up the first appointment with every teacher and the IML prototype's demonstration on the same day. All the 10 interviews and the IML presentation was done in their multi-purpose room with the exception of one participant, which was done in a coffee shop on the researcher's laptop. The prototype was installed on all the 10 teachers' laptop for easy demonstration and understanding. Creswell (2012) asserted that qualitative researchers collect data in a natural setting that typically involves "face-to-face interaction" and the researcher is instrumental in "collecting data through examining documents, observing behavior, or interviewing participants." The researcher was very diligent about examining the documents to identify the themes, observing behavior during the prototype demonstration and interviewing the participants during the pre and post-questionnaire phases.

All the ten face-to-face interviews and the presentation took approximately 50 minutes per participant. The participants were selected from Denver Metro area. These interviews were conducted at a private high school, which was convenient to the participants. Participants' willingness was the only thing that was considered for this research. Data Collection was through semi-structured interviews. The questions in the interview were open ended. All interview responses were written by hand and transcripts were made.

Data Collection

The signatures on the consent forms by the participants, pre-questionnaire and the presentation was done in the first meeting. Each of pre and post questionnaires were done individually to a time and schedule when the teachers were available. The questions were asked during the interviews based on the pre and post questionnaires. Notes were taken, and then converted to transcripts afterwards. The whole process took approximately 50 minutes per participant as described in the preceding section.

Interviews were transcribed and notes were written down on paper for later translating them into transcripts. The interview responses were hand written and then transferred to Word documents. After the author collected the data, he conducted analysis using interpretive qualitative method. Additionally, the author extended the scope of data study through identifying themes.

The study focused on the challenges that educators face in designing course materials that have been defined in this research as LOs and how they could be resolved by using IML and LOs' repositories. The data were collected through semi-structured interviews whose purpose was to learn of the challenges that educators face in developing curriculum and if they could overcome any of those challenges by using IML and LOs' repositories.

Pre-questionnaire and semi-structured interview. The opening interviews were planned to be fifty to sixty minutes long. The research concept and its application were explained to the interviewee. The pre-questionnaire included the following questions:

i. What are the challenges you currently face when you design curriculum?

ii. List few barriers in designing instructional materials?

iii. What methods do you currently use to design curriculum and instructional materials?

iv. List few methods, if any, to share instructional materials with your peers?

v. What level do you teach at?

vi. How do you learn new computer concepts?

Interviews discussed the questionnaire and were recorded and transcribed. Pseudonyms were used for all participants in this study to keep the identity of the participants. After the interviews, participants were introduced to the IML prototype as described in the procedures.

Post-questionnaire and semi-structured interview. The closing interview was planned to be 50-60 minutes. The discussion followed the questionnaire, as in the opening interview and was centered on the use of the IML prototype and the concept LOs' repositories. They were asked to reflect on the IML tool as an approach in creating a sample syllabus (group of LOs) for their class. They were given the post-questionnaire to comment on the use of IML and LOs' repository.

Here is the Post-questionnaire survey after introducing IML and LOs' Repository:

Here is the Post-questionnaire survey after introducing IML and LO's Repository:

i. Comment on the sound logic/research of the prototype for the IML and LO's Repository?

ii. Comment on the understanding and ease-of-use of the prototype?

iii. How do you think your role as an instructional designer would be improved by using IML?

iv. Comment on the product's success in the future of educational technology?

v. Comment on the product's help in the improvement of knowledge, testing strategies, and educational technology?

vi. Comment on the collaboration for the students, teachers, and businesses by using LOs' repositories?

vii. Comment on the product's increase in cost savings?

viii. Comment on the product's increase in students', teachers', and industry trainers' performance?

ix. How did you learn the LOs, IML, and Web repositories today?

x. Suggest at least three improvements in the design of IML?

Sample of Instructional Modeling Language (IML) Prototype

Acronym for LOs	Explanation of LOs
LJ	Learning Objective
LJn	Learning Objective Number (= Course, e.g., LJ1)
SLJ	Super Learning Objective
LO	Learning Objective
LO_cd	LO Course Description
LO_de	LO Descriptions
LO-E	LO Examination
LO_en	LO Examination Number such as 1, 2, 3, etc.
LO_h	LO Home Works
LO-n1	LO Course number
LO_n2	LO Course Name
LO_oq	LO Online Quiz

Data Analysis

During the analysis phase, central points about the barriers of their existing course material building process and the advantage from IML prototype were identified. The researcher established the major themes and subthemes from the data that were collected regarding the process of creating course material (LOs). Qualitative researchers use an emerging qualitative approach to inquiry, the collection of data in a natural setting sensitive to the people and places under study, and data analysis that is inductive and establishes patterns or themes (Creswell, 2012). The data were not analyzed statistically and there was no hypothesis in this study.

Most of themes from the pilot and future studies can be categorized by an analysis of words, word repetitions, key-indigenous terms, and key-words-in contexts (D'Andrade, 1995). Some of the themes recognized in the pre-questionnaire phase during the pilot study were the consumption of time, lack of an automated tool, and lack of sharing of course material. Within these themes, there were sub-themes that were identified. Themes can be identified by recognizing categories or repetitive phrases (Creswell, 2012). The consumption of time was related to lengthy texts and lack of computer knowledge, for example. During the post-questionnaire phase of the pilot study, ease-of-use, time saving, and knowledge sharing themes were identified. The intent of the full study was to better understand these initial ideas.

The responses of the questionnaire did not require any detailed demographic data. All raw data, interview questionnaires, responses by the participants, and suggestions will be kept in a locked file cabinet by the researcher and will be erased or destroyed three years after the completion of the study. The digital data only included responses and did not require to be handled in any protective way except for the publication of the research. The consent forms will be retained by the Research Advisor for a period of three years and will be destroyed after that.

Data analysis is the process of bringing order, structure, and interpretation to the mass of collected data (Marshall & Rossman, 1999). Only then, one can understand the meaning of data. The data were pulled apart and then put together in a meaningful manner (Creswell, 2013). This study uses qualitative methods of analysis. Data were collected to capture perceptions and experiences; it was used to establish themes through analysis to better understand the concepts and ideas of the participants. In an interpretive study, a researcher tries to make sense of the information participants provide and understand their perspective in that snapshot of time, changes led to what other changes?; Hill, Thompson, & Williams, 1997).

The author incorporated a pre-questionnaire, introduction to the IML prototype, and a post-questionnaire approach as done in my pilot study. On analyzing transcripts, the author focused on breaking down the data into discrete codes and sorted them into categories (Glaser & Strauss, 1967). The author used the transcripts numerous times to reduce data times and identified data and themes through categorization (Creswell, 2013). The author also built a concept map to describe the challenges that the teachers face in designing course material (LOs).

Trustworthiness

One of the most important parts in this paper is data trustworthiness. Trustworthiness establishes the reliability and validity in qualitative research (Creswell, 2013). First, the interview questions were reviewed by a qualitative research specialist to be sure the interview contents were appropriate. Second, in order to enhance the trustworthiness in the research, the researcher used triangulation, member check, and peer examination. All original hand-written interviews were accessible for verification. The target population for the IML prototype was the educational technology community, including educators and administrators in schools. The questionnaires needed a careful design focusing on the barriers (pre-questionnaire) and their solution (post-questionnaire) through LOs, IML, and web repositories. After the data were collected through the interviews, it was analyzed using qualitative methods based on the refinements after the analysis of the pilot study data. These methods identified teachers' perceptions, ideas, and experiences about the model. The findings were shared with participants to ensure that representation of their ideas was accurate.

To provide trustworthiness, my role as a researcher was very important. The researcher had been teaching for more than 10 years in the field of computer science. The researcher came across the same barriers that are faced by any educator when it comes to the preparation of instructional design and course materials. The researcher always thought that there is a way to help reduce these barriers. My Master's degree in Computer Science helped me understand the object-oriented programming the ideas around modeling and design of a software. This led to my presentation on the invention of IML, LOs and web repositories in the AECT 2015 conference in Indianapolis. To improve the trustworthiness on my research, once researcher started collecting data the school principal made sure that the participants have experience in instructional design and computer software so they can answer the interview questions. While there are many areas that address trustworthiness, the researcher will explain the aspects of credibility, transferability, dependability, and confirmability to build trustworthiness in my research.

Credibility

Credibility can be defined as the confidence that can be placed in the truth of the research findings (Macnee & McCabe, 2008). It establishes whether the research findings represented plausible information drawn from the participants' original data and was a correct interpretation of the participants' original views (Graneheim & Lundman, 2004).

To provide credibility to my data and trustworthiness, the researcher provided the teachers with the transcripts of their answers to confirm and understand their own responses. This process is called as member checking (Angen, 2000). Angen (2000) lists the following benefits of member checking:

- It provides an opportunity to understand and assess what the participant intended to do through their own action.
- Gives participants opportunity to correct errors or misinterpretations
- It provides the opportunity to give additional information
- Gets respondent on the record.
- It provides an opportunity to summarize preliminary findings.
- It provides respondents the opportunity to assess adequacy of data and preliminary results as well as to confirm particular aspects of the data.

Transferability

Transferability is defined as the degree to which the results of qualitative research can be transferred to other contexts with other respondents--it is the interpretive equivalent of generalizability (Bitsch, 2005; Tobin & Begley, 2004). Bitsch (2005) states that the “researcher facilitates the transferability judgment by a potential user through ‘thick description’ and purposeful sampling.” In my case, the research data could be transferred to other contexts, such as alpha and beta software testing by Microsoft and other software companies. The researcher used a similar approach to do the qualitative analysis based on the pre and post questionnaire for my proposed IML, LOs and web repositories’ software. The users were explained, and thus thick description was provided through a power point presentation and question/answer session for the whole participants’ group. The sampling used for this research was convenience sampling in terms of researcher’s accessibility to a private high school, however, the principal played a very important role in selecting a purposeful sampling through his knowledge of participants’ background and computer knowledge.

Dependability

According to Bitsch (2005), dependability refers to “the stability of findings over time.” It involves participants evaluating the findings and the interpretation and recommendations of the study. The participants want to make sure that the recommendations are supported by the data received from the informants of the study (Cohen, Manion, & Morrison, 2011; Tobin & Begley, 2004). The author achieved dependability through member check (by sending the participants a copy of their transcripts) and peer examination from another pilot study that was done with fellow Ph.D. students at UNC.

Confirmability

Confirmability is defined as “concerned with establishing that data and interpretations of the findings are not figments of the inquirer’s imagination but are clearly derived from the data” (Tobin & Begley, 2004, p. 394). Bowen (2009) suggested that confirmability of qualitative inquiry is achieved through an audit trial, reflexive journal and triangulation. According to Bowen (2009), an “audit trail offers visible evidence--from process and product--that the researcher did not simply find what he or she set out to find.” Bowen (2009, p. 307) describes that an audit trail involves an examination of the inquiry process and product to validate the data. All of the decisions about the collection of data, recorded, and analyzed during an audit trail. The author was able to explain the collection of data through two interviews for pre and post-questionnaires, made transcripts through notes, which were written during the interviews, and analyzed in finding themes in the two questionnaires. Hence, the audit trail was kept through proper procedure. Triangulation is defined as a process that “involves the use of multiple and different methods, investigators, sources and theories to obtain corroborating evidence” (Onwuegbuzie & Leech, 2007). The author utilized triangulation method by incorporating multiple methods for analyzing the interview data. The author used surveys in a pilot study during Spring of 2018. However, during this research interviews and personal observations were used to understand the answers during the interviews.

Reflexivity

Krefting (1991) defined reflexivity as “an assessment of the influence of the investigator's own background, perceptions and interests on the qualitative research process.” It also includes the researcher’s personal history. Wallendorf and Belk (1989) described a reflexive journal as “reflexive documents kept by the researcher in order to reflect on, tentatively interpret, and plan data collection.” The author tried to keep his own influence out of the research findings. The data collection process, taking the notes, translating the notes into transcripts, and recognizing the themes in the transcripts guided the direction of its findings. The place where the researcher's background was important was to interpret and understand the themes to get the encouragement for the proposed software. However, there was no biased injected in any phase of this research process.

Conclusion

Thematic analysis was used to build meaning in this qualitative study. Pre and post-questionnaires and interviews allowed the researcher to understand the constraints of participants in relation to curriculum development and their ideas about how the prototype Instructional Modeling Language and repository support their process or aid their curriculum tasks. These methods are consistent with an interprets model of qualitative research. They are supported by means enacted to promote trustworthiness.

CHAPTER IV

FINDINGS

Background

The research method implemented was an interpretivist qualitative study in order to establish a proof of concept about the instructional modeling language, it was important to introduce it to and hear the perspectives of professionals in the field. Central points about the barriers surrounding teachers' existing course material building process and the advantages from IML prototype were identified and framed the investigation. Major themes and subthemes from the data were established through qualitative analysis regarding the process of creating course material (LOs). An interpretivist qualitative study is developed to promote an understanding of specific issues regarding the use of IML and web repositories by teachers. There are many names used when it comes to descriptive–interpretive qualitative research, in which various common elements are mixed and matched according to researchers' predilections; hermeneutic-interpretive research (Packer & Addison, 1989), interpretative phenomenological analysis (Smith, Jarman, & Osborn, 1999), and Consensual Qualitative Research (Hill et al., 1997). Interpretive-hermeneutic category of research falls under the more general umbrella of qualitative methods, *hermeneutics* being "the art and science of interpretation" (Yeaman, Hlynka, Anderson, Damarin, & Muffoletto, 2001).

Findings

This chapter presents the results and findings for the study. It presents research results, and the researcher has answered each question in order. The data in this research were collected through interviews and the notes were compiled and interpreted into themes. The author let the data drive itself into the interpretation. Barker, Pistrang, and Elliott (2016) suggest that questions for a qualitative research in an interview should be exploratory. These questions, the foundation for a qualitative inquiry, are typically used when :(a) we have little knowledge in a particular research area ;(b) existing research is confusing, contradictory, or not moving forward; or (c) the topic is highly complex. In our case, IML was non-existent until this research. It made a perfect sense to go about doing this research in a qualitative fashion. A similar concept is given by the philosopher Georg Henrick von Wright (1971) who further elaborated upon the difference between explanation and understanding, that the personal role of a researcher has an understanding and a humanist emphasis. Throughout this research, from the invention of IML and the use of LOs and web repositories, the author tried to understand the difficulties that educators face in designing instruction and what could help the teachers to overcome those difficulties in their profession? That was the motivation behind designing IML and applying it in an educator's profession.

A review of research (Banta, 2002; Lopez, 1999; Peterson, Augustine, Einarson, & Vaughan, 1999; Wenger, Snyder, & McDermott, 2002) shows that faculty and administration professionals in educational contexts rely on various interactions in professional groups to support their knowledge and curriculum development, such as through communities of practice or professional learning networks, but they often struggle for support in educational change movements. The results obtained from pre and post-questionnaire process of this research indicate similar themes and interactions. Table 1 identifies the issues and theoretical framework of the study.

Table 1

Pre-Questionnaire Themes

Themes	Contributing Factors
Time Consuming	Curriculum Design, LOs, Time Management
Lack of Technology Skills	Lack of Resources, Not Technical Background, Lack of Instructions, Lack of Training
Limited Sharing	Complex Topics, Lack of Interaction with the Subject Matter Experts, No Universal platform
Learning through Experience or Understanding	Previous Computer Knowledge or Internet, Just Get it first time

Measurement issues in terms of level and their quantification also came up during the data collection process. For example, themes are relative and pre-questionnaire or post-questionnaire themes like “time consuming,” “difficult,” and “easy” are subjective to quantify. When we ask from the scale of 1 through 10, people will answer subjectively based on their prior experience in the area and level of understanding in a topic of interest. The measurement and their quantification were ignored because of their fuzziness in terms of their actual weightage. Therefore, the author focused on the themes and analyzed accordingly.

The purpose of this study was to explore the challenges that educators have in designing and sharing course materials including syllabi, exercises, exams and homework. This research provided a solution as to how IML and shared web repositories could support curriculum development by teachers. Results were obtained by analyzing educators' interviews, researcher's observations and informal chats after the post-questionnaire interview. The teachers' responses and excitement through the IML and LOs' web repositories were part of the observations as well. Chronological and thematic analyses of the data were used for this study, which helped the researcher to answer the following research questions:

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language?

The findings of the research questions, the interpretive aspects within this study through interviews, personal and participant's observations, and informal chats after the interviews, describe the participants in which educators and administrators design their course materials and interact with each other. To supplement the research findings, topical findings provided educational and teaching background information about the participants, helped in understanding the interplay of research issues. The researcher decided to analyze the research questions by focusing on the themes, and then investigated specific interview questions for answers to topical (if any) questions arising within the study. After that, the researcher examined the intent of each interview question more carefully. While the focus of the study was to get answers for the research questions, the researchers did not stop the participants to bring any other related (topical) discussion into the conversation. This way the collection of the data, and its analysis for recognizing themes led the research to take its own course without the researcher's bias. Some of the topical findings included issues such as educators and administrator goals for developing educational materials for better students' interaction, sharing, and how an institution could more effectively use the proposed software to generate more revenue.

The five sections described below comprise the contents of this chapter.

1. A Brief Timeline for the Development of the Instructional Modeling Language

It summarizes the sequence of events leading up to the design of IML and approval of the Institutional Review Board (IRB). The purpose of presenting this timeline is to help the reader put the IML development process into a larger context. The IML context is very broad and can be applied by educators from all K-20 backgrounds.

2. Participants

It briefly describes teachers and administrators (identified by pseudonyms) who shared their experiences in personal interviews with this researcher and showed a greater interest toward the IML prototype.

3. Themes

This section describes a precise analysis of the keywords and phrases, commonly used among the 8 teachers and 2 administrators (staff) to sort out the existing teaching environment at the private school (pre-questionnaire phase) versus the proposed software solution in this research (post-questionnaire phase).

4. Details on Findings about the Research Questions

It contains an abridgment of findings, both about research questions and topical. It provides detailed findings on the main issues in the study. These findings were based on the data from thematic analyses of interviews and quotations from educators and staff members.

5. Summary

This is a point-by-point summary of the research questions and themes identified through this study.

A Brief Timeline for the Development of the Instructional Modeling Language

The researcher has a master's in computer science and had been training in the area of Information Technology (IT) for more than 10 years. The researcher taught many object-oriented languages in the field of Computer Science. Once researcher started his Ph.D. coursework in Educational Technology at the University of Northern Colorado during the Fall of 2012, he came across the concept of Learning Objects (LOs). As Objects and Classes are of everyday use in the field of Information Technology or Computer Science, the LOs are also gaining popularity in Educational Technology and Instructional Design. That is the reason, the researcher started exploring LOs. The researcher realized that while this concept is borrowed from the area of Information Technology, it is not consistent with the field. Moreover, there is a modeling language called as Unified Modeling Language (UML), which is used to design software. UML deals with graphical notations to depict objects and classes. No such modeling language exists for LOs. The researcher started working on the concept of Instructional Modeling Language (IML), which could be used to design LOs. The researcher connected this concept with web repositories, which could be used to store LOs and shared as well. The researcher presented this concept in the AECT 2015 conference in Indianapolis. The idea was well received, and the researcher presented this in his Ph.D. proposal in 2017. The researcher introduced this idea to the teachers of a private high school during his interviews with them in Fall 2018. The researcher got a very good feedback of his prototype and proposed software on the use of IML and web repositories.

Participants

Eight full-time teachers, two administrators (staff), and a part-time teacher at a private high school were interviewed for this study. Some demographic information, which could help identify the educational background of a participant was collected to help in this research. During the pre-questionnaire phase, the participants were asked to provide their perspectives about curriculum development and the aspects that influenced them the most. In general, the teachers had many comments and shared their frustration with the non-availability of tools, which delays their curriculum design. The administrators approached it from a different angle and were interested in saving their teachers' time, which they thought would allow more time for the student-teacher interaction and professional development. This would save money and increase students' retention (more revenue). For this research, it seemed a win-win situation and IML and web repositories had a big role to play. The interview with the teachers and administrators had three parts, pre-questionnaire, introduction to IML and web repositories, and post-questionnaire. Pseudonyms are used in this research for the participants and the researcher asked them to pick a name of their choice. The list of the participants with some of their demographic data that was relevant to the research was collected, and it is given in Table 2 below:

Table 2

Participants with Their Educational Background

Name	Educational Background	Teaching Experience (Grades)
Maya	BA	3rd to 5th
John Richard	BA in history	6th through 9th
AR	MA in Education	1st
Hawwa	BA & MA in Education	Kindergarten through 5th
Nena	BS in Biology	5th through 9th
AZ	BA and Certificate in English	ELA Instructor
Shannon	BA in ECE	Early Childhood Education (ECE)
MB	Certificate in ECE	Early Childhood Education (ECE)
MQ	Ph.D. in Instructional Design	Part-Time Arabic Teacher
AQ	Master's in international management	Director of Business and Development
Yousef	BS in Home Economics, BA in English, Minor in Teacher Education	Director of Students' Success

Pre-Questionnaire Findings

In the pre-questionnaire phase, the researcher asked the questions from the eight full-time, one part-time teacher and two administrators about their existing experience as it applies to the instructional design. The researcher was confronted with the list of problems that the teachers face in their everyday challenges to acquire the best tools and methodologies for their instruction. The teachers' complaint about the time it takes to create the course materials (LOs) and the lack of technological tools. That was consistent with the researcher's perception from his own 10 years of teaching experience, a reason to pick this topic for the research.

Maya pointed out that the challenges she faces is about creativity and having little time to build assignments that are relevant and make sense to kids. She said, "Few barriers in designing instructional materials are, to have resources to design homework, provide examples – it takes too much time." She currently uses her own tests and home works. She spends a lot of time in researching and putting things together from various sources. Normally she shares instructional materials with other teachers that she utilizes through email, Google docs, and making copies.

John Richard has a BA in history and teaches grade 6^{th} through $9^{th\ at}$ the high school. He listed his challenges in finding high quality assignments, activities, projects that are aligned with the curriculum. When asked about listing some of the barriers in designing instructional materials (LOs), he said, "A number of ideas are available, but many are low quality. The researcher spent many hours to design instructional materials. At some point the researcher have no choice but to pick something that is quickly available". Currently the methods that he uses to design curriculum are limited to whatever is provided by the publisher of the textbook, teachers pay teachers website, and other recommendations given by his co-workers. He shares his instructional materials through a common network drive.

AR has a master's in education, and she teaches 1^{st} grade. Her challenges were the time, scope, and sequence in designing curriculum. She has to make sure that once the curriculum is designed, it reaches to all learners with diverse backgrounds. When asked to list few barriers in designing instructional materials, she said, “I am trying to make sure it is fun and age appropriate, so it takes time. I want to make sure it ties with the curriculum which again requires a lot of thinking and time”. She currently uses Internet, textbooks, and research to design curriculum.

Hawwa has a BA and masters in education degrees, and she teaches kindergarten through 5^{th} grade. Her challenges in designing curriculum were how to design and add to the published curriculum, which was given to them by the administration. She felt the lack of resources to design curriculum. On the barriers’ question, she said, “she lacks the attractiveness of the instructional materials and money to have access to those resources”. She currently uses Microsoft Office to design curriculum and teachers pay teachers website. She also uses this website to share instructional materials.

Nena has a BS degree in Biology, and she teaches grade 5^{th} through 9^{th}. Her challenge in designing curriculum was how to make it suitable for most of the students. When asked about the barriers in designing instructional materials, she said, “Students do not understand instructions and the instructional materials are not of the appropriate length and duration”. She currently uses Microsoft Office and Chrome books to design the instructional materials with other teachers. She uses email and printed copies of the instructional materials to share with other teachers.

AZ has a BA degree and a certificate in English. She teaches grades 6^{th} through 9^{th}. Her challenges in designing curriculum include time restraints, lack of organizational help, and learning new ideas. When asked about the barriers in instructional materials, she said, “It is a challenge to know what topic/idea to reinforce with homework. It is difficult to keep up with the current technologies”. She currently uses Internet, textbook materials, and relies on ideas from her colleagues to design instructional materials. She uses email and printed copies to share instructional materials with other teachers.

Shannon has a BA degree and an Early Child Education (ECE). She teaches kindergarten. When asked about her challenges in designing curriculum, she said, “It takes time to integrate technology. It is very time consuming”. Her barriers that she faces in designing instructional materials included, training and understanding of technology inside the classroom, and sharing capabilities with other teachers. She currently uses online resources, Power Point, MS Excel, and MS word to design instructional materials. She uses Gradelink and email software systems to share with other teachers.

MB has a certificate in kindergarten and pre-kindergarten directorship. She is teaching Kindergarten. When asked about the challenges in designing curriculum, she said, “If I am able to reach every child’s needs that would be great. I don’t know how to balance lower and higher academics”. Her barriers in designing instructional materials included, understanding of what and why certain materials are necessary? She uses various methods in designing curriculum and instructional materials including, text, web, and ideas from other teachers. To share her instructional materials, she uses web and teachers’ meetings.

Yousef has a BS in Home Economics, BA in English and minor in Teachers’ Education. She is the Director of Student Success at the high school. She listed time constraints, lack of confidence, and teacher exemplars as the current challenges in the design of curriculum. When asked about the barriers they face in the designing of instructional materials, she said, “Finding work that is interesting and beneficial; making sure that it is at the students’ level”. She uses Google to find instructional materials related to lessons, online curriculum, and brainstorming. To share the instructional materials she uses email, chatgroups, and Google drive.

Introduction to Instructional Modeling Language (IML) and Web Repositories Findings

In this part, the researcher explained the acronyms that he has designed for various instructional materials (LOs) in IML and web repositories. The researcher demonstrated my prototype which could be extended to write the proposed software. This software (once built) could be used to design LOs and will be written by subject matter experts. Once designed the LOs could be posted online in the web repositories for sharing with other educators. There needs to be a standard defined to keep the quality of LOs. The sharing of LOs can be done at the school's district level, state level, national or even at an international level. The LOs could be posted as training exercises to the students as well where they could practice and become comfortable with difficult topics. Posting many levels of LOs (Introductory to Advanced) would give every student to learn regardless of their academic capability.

When asked from the teachers as to how they learn new computer software, most of them said because of their prior experience in Microsoft products, which was exactly how constructivists learn. The constructivist classroom provides opportunities to observe, work, interact, raise question enquiry and share their expectation to all (Kumar & Gupta, 2009). It can be argued that since every learner has a different experience, they learn at their own terms and style.

Some of them were of the opinion that they get it by listening and observing the instruction which the author thought was cognitivism. The theory behind cognitivism is that the learner's role is as an active and creative activity rather than a passive one (Reid, 2005). In cognitivism, the theory relates to the role of information processing by the brain. The author's observation of some of the participants following the instruction during the proof of concept demonstration at their own was another reason to believe that they were processing the information as they were explained.

Post-Questionnaire Interviews
Findings

The post-questionnaire refers to the interview that was conducted by the researcher after the IML prototype was introduced to the teachers and administrators and were asked to answer similar questions that were asked in the pre-questionnaire. This process gave the researcher the ability to analyze the benefits of the proposed software. MB was eager to put the software in her classroom if it is affordable or better if it is free. AR who had a Master's in Education and was a 1^{st} grade teacher, liked the idea to choose an LO from a set of options posted by other teachers through shared web repositories. Both liked the acronyms of the IML and were convinced that it will save time. They talked about motivating students through their availability of more time to engage them in doing exercises which otherwise might not be possible due to lack of time. MB thought it would be great opportunity to teach in a new way, something that would help in her professional development. MB said, "It would be great having a certain grade at your fingertips". AR thought IML concept with shared web repositories would be very successful. AR also said, "It would be nice to use other ideas for me to be more creative in instruction". They also liked the idea of sharing LOs through web repositories. MB suggested incorporating some sort of search engine in the proposed research software to look for the type of LOs she is looking for. AR recommended that for the LOs, there should be a standard defined and they should be categorized for easy access. AR suggested consistency among the stakeholders are necessary for a LO to be standardized. Both mentioned that this tool (IML and web repositories) would increase educators' and students' confidence alike. They suggested including tutorials and acronyms definitions in the proposed software in the future (Interview with MB and AR). By interviewing them, the researcher thought that there are so many avenues that this research could possibly take and be a root for many further researches. They both like others had volunteered to be interviewed for this research and were happy to sign the consent form.

Shannon had a BA and ECE degrees. She thought web repository was a very useful area for the teachers. She thought that the use of IML and web repositories will cut time and it will allow vast variety of materials to be shared. Shannon said this research provides "easy sharing for collaboration". She believed that this research will give more time for instruction, since currently a lot of time is wasted in searching for instructional material. She suggested making this proposed software tool more accessible and easier-to-use. Youssef had two degrees. One, BA in Home Economics, and the second BA in English with minor in Teacher's Education. She is the Director of Student Success. She thought the product of this research would be feasible to the instructors. She commented that, "It looks like very simple to use". She also thought that this tool would allow her to do many aspects of her job. Youssef thought once a full product of IML and web repositories is implemented, it can be shown to educators for their efficient use and it has an exciting prospect. "This way a teacher will be more available to the students," she thought. She suggested having aesthetic properties and ensuring each concept is easy to sift through in the IML and the web repositories.

AZ said that the research was done nicely and had a good logical prototype. She agreed that IML would save time, which could allow the teachers to do other work. She also said that web repositories could be very successful if used with the right LOs. She said, “It could open a new avenue for the teaching industry by offering new options”. She suggested a colored theme for the interface or other sophisticated model for the proposed software. Hawaa liked the logical aspect of IML and web repositories. She said, “it is easy to understand but probably not easy to use if used in menus. A search engine might be needed to look for the LOs”. She agreed that it would save time.

Nena thought that IML and web repositories and their use is a new idea and it can be used in many ways for teaching. She said, “It is easy and clear”. Time saving and reduced effort were her obvious observations about the prototype. On the design of LOs, she said that there is a lot of opportunity between students, teachers, and businesses on collaboration. For students, she thought it is like tutoring. John Richard thought that the final product might be easier to use. Web repository concept was more beneficial for him. He thought if this concept is integrated with quality materials (LOs) and linked properly, it would lead to success. The endless possibilities depend on the end product (Interview with John Richard). He thought a nice graphical user interface would also provide more power to the product. My final interviews with MQ and AQ were very promising. MQ has Ph.D. in Instructional Design and works as a part-time teacher. He provided a true picture of IML and web repository in the future. He thought if the prototype is designed in a systematic fashion, it has a lot of potential as the research implies. AQ has a Master’s in International Management and works as an administrator (staff). AQ is the director of business and development. He thought this concept if implemented is a win-win for students and teachers. It will provide ample time to the teachers to focus on other important things in their career. The students will also have opportunities to learn complex topics through LOs.

Maya teaches grade 3 through 5. She thought the research is done in a logical manner and it filters out what you need for teaching. In other words, it focuses on the needs of teachers. Maya thought the prototype to demonstrate IML and web repositories was easy and a promise for a faster approach towards instructional design. She said, “I think it will make my life easier as it will speed the process of making curriculum”. She expected a high-quality end product. She agreed that students would find better ways to do their assignments through this proposed software, which would be good for their learning. By using the proposed software, teachers will have more time to do other work important to their careers. She suggested that the tests and other course materials (LOs) need to be designed in an aesthetically pleasing manner and there should be options for different layouts in the final software product.

Themes

The interview questions were developed from foreshadowed themes in the literature and refined by the findings of the pre-questionnaire. These issues and topics determined not only the questions asked, but also the items of interest that were recorded during field observations and selected from documents in this interpretive study. The themes for pre-questionnaire and post-questionnaire are shown in Tables 3 and 4, respectively. The responses from teacher participants on the pre and post-questionnaire helped the researcher identify these themes. These themes are further explained in the following paragraphs:

During the pre-questionnaire interview, the teachers were asked to list their challenges and possible contributing factors in doing their job. The three themes stood out; everyone complaint about lack of time, lack of technology skills, and limited sharing. The curriculum design could take up to months in some cases. LOs creation in terms of examinations, quizzes, and homework was another time-consuming factor. Many teachers did not have proper computer training. They mentioned lack of resources and sharing about the teachers. At times, they did not know a subject matter expert to share with and used personal connections to get help. After the pre-questionnaire interview phase, the teachers were introduced with the prototype designed in this research with (LOs, IML and web repository) proof of concept. Afterwards, the teachers were asked from the post-questionnaire interview. The following themes were identified in the post -questionnaire interview phase.

Table 3

Post-Questionnaire Themes

Themes	Contributing Factors
Less Time Consuming	Development of LOs, curriculum design, is easy and faster
More Technology Skills	New proposed software, Keeping up-to-date with the technology
Global Sharing	Web repositories, LOs' design and use
Learning through Experience or Understanding	Previous Computer Knowledge or Internet, Just Get it first time
Easy-to-Understand User Interface and Cost	Suggestion for the future of the proposed software and free to the teachers

The software proposed in this research was demonstrated to the teachers through a proof-of-concept prototype. The teachers showed a lot of interest in the future software product. They all agreed that it would save them time to design instruction and LOs. They were excited to learn new technology and to keep them current with the latest developments. The concept of global sharing of LOs through web repositories was another aspect of this research that the teachers thought would alleviate their day-to-day problems. More importantly, the new proposed software can be made available round the clock at their convenient time.

Again, on the question of learning newer software concepts – the researcher concluded that the teachers and the administrators (staff) had a mixture of constructivism and cognitivism. Different activities like concept mapping, T-chart etc. can be used to design constructivist classroom learning (Dogra, 2010). Dogra (2010) also described that group discussion and brain storming play a significant role in constructivist classes. During the researcher's presentation on IML, LOs and web repositories, there were group discussions and question/answer session that helped in building the understanding of the participants. The teachers mentioned their previous experience with Microsoft software and Internet as a contributing factor in understanding this research. These explanations pointed the researcher to observe constructivism learning theory.

Few participants understood through cognitivism. Cognitivists' agree that knowledge is given and absolute, but the cognitivists focus, and emphasis is on the internal mental processes of the learner (Nagowah & Nagowah, 2009). The researcher agrees that some of the participants claimed that they "get it" once they are presented a topic especially computer software. The researcher also observed some of the participants going at their own and clicking the right place on their laptop during the proof-of-concept demonstration. Brain processing is a complex thing especially when it comes to an individual's understanding and learning. Some of those learning phenomena can be only asked or observed.

Details on Findings about the Research Questions

By doing a thematic analysis of interview data, it was evident that the three research questions were clearly answered in the interpretive study of this research. The researcher designed the interview questions to get the feedback of the teachers, and talk about their orientation to LOs, IML and the web repositories. The first research question is answered about the learning principles below.

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

The teachers were able to expand on the learning principles embedded in IML, the influence that IML and web repositories would have on instructional design, and the impact of IML in the design of LOs. The teachers were to judge the influence of IML and web repositories in the area of instructional design. The first research question was addressed through the explanation of IML, which each participant understood based on their own experience of computer software. The learning principle depicted the principle of constructivism. The theory of constructivism focuses on each learner's individual needs, experience, and is a very effective component of e-learning courses (Alzaghoul, 2012). Constructivism was studied by Jean Piaget and Lev Vygotsky who were psychologists by profession and were studying cognitive development (Rummel, 2008). Their study provided the basis of constructivism. Constructivists' view of learning about children was the development of knowledge through participation. In this research, the teachers demonstrated constructivism through their prior experience and participation as well.

However, there were more than one dominant learning principle in this research which was observed. There were elements of cognitivism as well. Piaget believed that that cognitive development was through observation and experimentation. Vygotsky viewed learning as a social process through interaction with the members of the culture (Rummel, 2008). The existing culture of information technology has dominated every discipline including education. The proposed software in this research was a part of the learning culture that can be related to Vygotsky's view. One of the observations was that cognition is related to the learning of a language and this existed in terms of concepts and processes in the brain (Chomsky, 1957). Cognitivism deals with the states of brain, activities, and processes to make sense of something. The author felt that the participants were making sense of the proposed software through cognitivism as well, which is another learning principle. There is an element of discovery and problem-solving skills as many constructivists believe, which enables learners to have the ability to build upon information in their own minds (Ertmer & Newby, 2013). The third learning principle in this research was of discovery learning on the part of the researcher. When results of an investigation depends on the work of others, it is in coherence with McAleese's (1990) research. In the case of IML, LOs and web repositories - it depended on the concept of object-oriented languages and design which is a mature area in the field of computer science (Rumbaugh et al., 1999). If the researcher did not have a background in Computer Science, this research idea might not have been looked at. This research became more powerful when the lack of a modeling language was noticeable by the researcher after a vast literature review. The second research question about the influence of LOs and web repositories is addressed below.

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Since IML idea was coupled with web repositories, it was a perfect marriage between the two areas. The IML prototype was introduced in a step-by-step fashion thus constructing the knowledge on top of each other's prior computer software experience. The use of technology has been a tool of communication for teachers to be in an active role to construct and present their knowledge (Means & Olson, 1997). This knowledge once constructed can be shared across the globe. That was the idea behind the second part of this research to share LOs through web repositories.

After the interviews were done, the researcher could easily analyze and see the direction the research was going. The 8 full-time and one part-time teacher had different educational and teaching background, experience, subject of expertise, and qualifications. The 2 administrators (staff) brought experience in teaching, coaching and counseling. The teachers had experience in creating syllabi and other teaching materials. The administrators referred to most of the answers in the past-tense showing what they learnt from their experience in designing instruction. What have worked and not worked in the past as it applies to instructional design? The challenges that were brought up in the interviews by the educators and administrators were; the needed funding for technology tools, lack of computer knowledge, difficulty in using the existing tools, and that it had been time consuming. These challenges were quite similar by both groups (teachers and administrators) of the participants showing that they worked closely with each other.

While the educators showed great interest in using the proposed IML software and web repositories because of its ease of use and LO's support for their courses, the administrators seemed interested in the overall cost savings and more student success. Both groups (educators and administrators) agreed for a need of such software, which can help them design their curriculum and course materials (LOs) faster so they can spend their extra time on professional development and students' interactions.

The researcher found themes that explained between teachers and administrators included; similar structures during pre-questionnaire and post-questionnaire interviews. Some of the themes that were identified during pre-questionnaire of the IML prototype included barriers in the creation of course materials (LOs) which involved the consumption of time and difficulty in their creation due to lack of expertise in every aspect of teaching. The other themes that were extracted after the post-questionnaire of the IML prototype included the opposite of what was identified in the pre-questionnaire phase. These themes included the ease-of-use, time saving aspect, technology learning, knowledge sharing and a wide area of innovation and possibilities. The concept of web repositories provided opportunities to utilize a "community of practice" (Wenger et al., 2002). Hence, the researcher found that IML, along with LOs and the sharing of the web repository presented in this research, will provide opportunities to build such community of practice.

The researcher also found that the existing collaboration among teachers is limited to a small group within a school or personal acquaintance. However, web repositories through the proposed IML software will enable a global sharing phenomenon. The contents shared can be applied to the existing course curriculums and teaching without a major effort. The only effort needed is a review and approval of LOs from the administrators or senior teachers. Some of the topical issues that were found during the pre-questionnaire included the technical difficulty in learning computer software. The answers in the post-questionnaire were the opposite of the pre-questionnaire. This difference in pre and post-questionnaire in terms of responses was a testimony to the fact that IML and the prototype was the reason in the positive difference between the two findings. This contrast in the author's findings was another encouragement that this research can have a significant effect on the teachers and administrator's performances in the future. The teachers' perspectives about the research question 3 is described below.

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language?

In the pre-questionnaire phase, the teachers and the administrators were asked to list the barriers they face in designing the curriculum and instructional design materials. Once introduced with IML and web repositories with a prototype for the proposed software, the teachers could take a sigh of relief when they saw that the proposed software would remove most of their barriers that they currently experience. The proposed software seemed a promise for teachers and administrators alike. Both of these groups thought that this proposed software would solve their issues in the design of instruction, which would ultimately benefit the students and the education system.

Summary

The summary of the major findings of this research, issues in the instructional design, the solutions of these issues through IML and web repositories, and any topical information that often interact with research issues are presented here. The author categorized the different phases of this research to understand its various aspects. While the learning principles of constructivism and cognitivism were noticed among the participants of this research, the researcher himself experienced the learning principle of discovery learning. Because of the researcher's background, he already had some idea about the pre-questionnaire phase. In the pre-questionnaire phase, the interview questions focused on the existing problems that the teachers face in the design of instruction. During the introduction of LOs, IML and web repositories phase, teachers and administrators of a private high school were introduced to the proposed software through a prototype and the proof of concept. In the post-questionnaire phase, the teachers and administrators were asked the same questions (similar to the pre-questionnaire) and their feedback on the proposed software. The results obtained were coded into themes finding the common phrases and keywords. The results were a breath of fresh air for the researcher giving the author a sigh of relief for the hard work put through the inception of this research idea, presenting in the AECT conference, and finally writing of this dissertation.

Elliott and Timulak (2005) called these phases as domains. Both of these authors reported that it is possible to find various kinds of relationship in interpretive qualitative study between domains, including temporal sequence which are things happened before these domains, causes are what influenced a domain, significations are what these domains are described now (Elliott & Timulak, 2005). This research is an exact reflection of temporal sequence (pre-questionnaire phase), causes (introduction of IML and web repositories), and significations (post-questionnaire phase). Hence, there were three domains in this study.

CHAPTER V

DISCUSSION AND CONCLUSION

This chapter discusses conclusions that may be drawn from the findings described in Chapter IV. The researcher presents an overall review of the concept of this research, discusses how the findings connect with existing literature and establishes a proof of concept. The implications of the instructional modeling language (and LOs with web repositories) to the existing educational system and what limitations that were noticeable during the study are addressed. The researcher also presents future research that can be continued after this study.

Discussion

These findings from pre/post questionnaire and interview data were used to explore the following three research questions.

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language?

A pre-questionnaire interview questionnaire was prepared by the researcher to ask the teachers before introducing them to the main research idea of LOs, IML, and web repositories. The premise of this questionnaire was to find out the existing barriers in designing course materials and curriculum. Some of the themes in the existing educational system that emerged during the pre-questionnaire were time consuming, lack of resources, lack of sharing, and less one-on-one interaction with the students, which affects the quality of education. All of these concerns were familiar to the researcher since he experienced similar issues during his teaching career as well.

During the introduction (middle) phase to the concepts of LOs, IML and web repositories, the participants were taught these concepts. The teachers explored the prototype for the proposed software in this research. This introduction was a new concept to the teachers; however, they understood the concepts with clarity. While LOs are already used in businesses and some educational institutions, many teachers and administrators have not been exposed to them yet. The researcher tried to avoid the computer jargon and used the visual representation and proof of concept of the proposed software to explain the ideas.

The teachers and administrators reacted in support of the proposed research. Some of them wanted the proposed software right away. Through the researcher's personal observation, interviews, and chats after the interview, the researcher was convinced that the time saving aspect of his research was the dominant factor. In the fast-paced life today, all of us need time and this research is a promising tool for the educators to save time. The researcher heard many voices saying, "Will it be free?". AZ said that the research was done nicely and had a good logical prototype. She agreed that IML would save time, which could allow the teachers to do other work. She also said that web repositories could be very successful if applied to the right LOs. She said, "It could open a new avenue for the teaching industry by offering new options." MB said, "It would be great having certain LO at your fingertips". She explained that it takes a lot of time to design a LO but through web repositories, it would become something as easy as grabbing something from a bookshelf.

From the interviews and personal observations, the researcher concluded that our educational system needs quality. The quality for a better syllabus and LOs can only be achieved if the teachers have access to quality materials and have time. This research had both of these aspects covered in the proposed software. Typically, no single school has all the intellectual and financial resources. This research was giving them a promise of unlimited LOs' web repositories, which could be shared, and allowing time for the teachers and administrators (staff), to incorporate the proposed software into their curriculum.

The post-questionnaire phase was the important part of this research. The themes that resulted from the teachers' post-interviews were opposite from the pre-questionnaire. This was a sign that the research was a game changer. It made the participants feel that their existing barriers in teaching could be resolved through the proposed software. The themes which were recorded for the proposed software were, time saving, cost effective, easy to understand, knowledge sharing through interaction with other teachers, and more time for students. This phase was very encouraging for the researcher to evaluate the research as a promise for the future of educational technology.

Since this proposed software will be ultimately used (after it is designed and developed) by educators, the encouragement given by them was a very good sign. The researcher felt that the main idea behind designing IML, LO's and web repositories did not focus on the theory itself but had practical uses. The encouragement also answered one of the research questions that was being studied about teachers' perception of the proposed software, which was very positive. The researcher felt that by watching the excitement by the educators, they needed a tool as proposed in this research to help them improve the quality of education.

Research Question 1

Q1 What kinds of learning principles exist in the Instructional Modeling Language?

The first research question was addressed through the explanation of IML, which each participant understood based on their own experience and needs of computer software. The knowledge building is independent of the source in constructivism, as the learners are acquiring the knowledge through their own set of beliefs and experiences in the subject area. Since IML was coupled with web repositories, it was a perfect combination between the two areas. The IML prototype was introduced in an easy-to-hard fashion thus constructing the knowledge on top of each other's prior computer software experience. The use of technology to communicate with others enables teachers to be in an active role to construct and present their knowledge like a state machine where the brain moves from one state to another based on the input and its processing (Means & Olson, 1997). This is the main idea behind cognitivism mode of learning. When scientists could not explain why and how individuals make sense of something and process, they were able to define cognitivism (Yilmaz, 2011). Cognitivism happens when some people process better than others in similar situations. It is this author's opinion that some individuals built their knowledge through constructivism which could ultimately help understand complex topics relatively easier than others depicting cognitivism. This knowledge once constructed can be shared across the globe. That was the idea behind the second part of this research to share LOs through web repositories.

There was another learning principle observed in this research as well, which is discovery learning by the researcher. Discovery learning in both individual and collaborative work leading to the establishment of a community of learners in which the results of an investigation depends on the work of others is in coherence with McAleese's (1990) research. McAleese's observation that learning by exploration is generally caused by known concepts that trigger new ideas. This was true in this case as well. The researcher was well versed in the area of object-oriented programming because of his background in computer science. The idea of objects, unified modeling language, and re-usability triggered the new concept of IML, LOs and web repositories.

The are many learning principles that exist in this research. The researcher came from a Computer Science background and had used objects and classes for over 10 years. The researcher found learning objects in the field of Educational Technology but could not find a modeling language, which existed in the field of Computer Science. This observation of not having a modeling language for LOs motivated the researcher and thus decided to invent one, which is IML. Once presented to the teachers, their understanding of the research presented a mixture of cognitivism and constructivism. Some of the teachers picked up the concepts very quickly demonstrating cognitivism. These teachers were familiar with typical computer software and used the same learning principles to understand the proposed software for LOs, IML and web repositories presented in this research. The author designed the proof of concept through a commonly used hyperlinks and hypertext manner where an average user would go on the Internet and click hyperlinks to move around various information. This is very similar to how Moonen (1999) described that designers need "to concentrate on how to structure the material, how to divide the material in appropriate learning objects, how to navigate through those learning objects in a hyperlinked pattern”. It is very important that a user must be able to navigate to different LOs in an easy way to appreciate the power of the proposed software. This is important for the success of a software. One of the reasons about the success of MS Windows software is, because it is user-friendly and easy to navigate. The proposed software in this research was designed by keeping educators in mind who might not have a computer background. After all, the educators will be the end-users of the proposed software.

Some teachers learnt through mixture of constructivism and cognitivism. In the case of cognitivism, the researcher had to demonstrate in a systematic fashion by building knowledge on top of each other. Whereas, the teachers also learnt through constructivism through their own prior experience and participation. Constructivism should provide authentic problem situations. Typically, constructivist-learning environment needs to provide many contexts to the learner for flexible problem solutions to understand. These various perspectives will help the learner to discuss problem situations from different viewpoints. Once learners understand their problems, as the participants pointed out in their pre-questionnaire phase – they were able to appreciate the learning and the use of the new proposed software. Similarly, social contexts provide opportunities cooperative learning and problem solution in learning groups (Gerstenmeier & Mandl, 1994). The researcher (through his more than 10 years’ experience of teaching) was ready to provide many examples and scenarios when a question was asked to clarify a concept in a social setting. These explanations helped the teachers to grasp the material through the learning phenomenon of constructivism and cognitivism.

The learning principles that exist in Instructional Modeling Language (IML) are constructivism and cognitivism from the educators' angle. Whereas, it was discovery learning from the researcher point-of-view. The proposed software appealed to the participants because of the reason that it would reduce the barriers, which exist in the current instructional design. The teachers had at least an undergraduate degree, few Masters, and a Ph.D. degree with various levels of computer background. The researcher concept about IML and web repositories was brand new to them. However, because of his easy-to-understand prototype, their experience and participation, they were able to construct their knowledge, and used their imagination to understand the proposed software. While the participants had identified the barriers that exist in their experience of instructional design, they were able to process and decipher the IML and the proposed software through cognitivism. The author himself had more than 10 years of teaching experience at the undergraduate and graduate level. Therefore, the pre-questionnaire interview answers that were received was no surprise for the researcher. Hence, once the teachers understood the prototype and the motivation behind IML and web repositories they were eager to learn through constructing their knowledge based on their experience and participation (constructivism), processing the new information (cognitivism) and the aspect of collaboration, which they were already familiar with.

Research Question 2

Q2 How does the concept of learning objects and web-based repositories influence instructional design?

Learning Object (LO) was introduced in the field of Educational Technology through its roots in Computer Science. While objects in Computer Science have attributes and methods combined, its counterpart LO has similarity when it comes to reusability.

LOs are defined by the IEEE Learning Technology Standards Committee (LTSC) as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (IEEE LTSC, 2002, page 141). Learning Objects and web repositories are also making its way into the world of Instructional Design (About Learning Objects, 2018). These two concepts (LOs and web repositories) when combined are going to change the way teachers design and share their instruction. The two concepts along with the introduction of IML was the focus of this research.

When it comes to reusability (thus LOs), it existed before technology was introduced in academia. Teachers would normally reuse each other's materials through personal connections by copying hard copies. However, through the advancement in technology and Internet, it increased considerably. Now, after the introduction of LOs and web repositories its use could go beyond imagination. A school teacher who lives in Africa can share his or her expertise (LO) with a teacher in Colorado by clicking few buttons on the computer. The phenomenon of sharing will be available instantaneously, ultimately saving time and money.

The concept of learning objects (LOs) and web- based repositories will influence instructional design in a multi-dimensional fashion. While the concept of LOs and web repositories is not new, it is not yet used by all educational institutions. Teachers at all levels are still engaged with old fashion methodologies, which is, not only time consuming but also adds to their work and thus frustration. The author through this research was able to explain the teachers about the concept of LOs and web repositories. The prototype demonstration was another tool that the researcher used as a proof of concept to convince that the proposed software will save them time, improve their performance and quality of education which will benefit them and the students alike. The myth about designing instruction as a complex thing can be clarified through a smart and innovative tool which involves the design, use, and sharing of LOs with web repositories. By saving time, teachers could focus on their other professional development and students can master the complex topics which otherwise would not be possible with the existing way of teaching and designing instruction.

Some of the bigger companies like, for example Cisco Systems, Inc. or the National Education Training Group, Inc. (NETg) are already using the concept of learning objects in their web-based training strategies and provide an instructional design model to support the development of these objects (Barritt, 2001). Since industries are all about profit and competition in leading new ideas, they utilize such concepts faster than academia. The academia can benefit from consortium of their partner schools to limit their sharing to the teachers who are willing to exchange the contents. However, an open source web repository might be something that is coming to the horizon anytime. Open source systems provide a very vast and sharing experience to everyone around the world. That means an efficient lab written in Africa (LO) can be shared in Colorado as soon as it is available through a web repository.

One of the major benefits that LOs and web repositories have is time saving. The way instructional design had been written in the past involved countless hours and re-iteration. This would frustrate educators and often time it is too late when some part or whole of the curriculum is ready for the existing class. This could be changed dramatically by the introduction of LOs and web repositories introduced in this research. Educators will be able to incorporate LOs of their choice at their convenience when it is needed. A faster availability of LOs will enable an efficient design of instruction at all levels (kindergarten through graduate studies). Most importantly, LOs and web repositories will give ample time to the educators to interact with their students providing individual attention and elevating the education standards.

On the second research question about the influence of IML and web repositories, the post-questionnaire interview (i, ii, iii, v and vi) and their answers were strongly supportive of this research. The teachers could foresee by using the prototype of the proposed IML software coupled with web repositories that the work of instructional design which takes weeks and months could be solved in hours. The time (thus cost) saving has multi-facet advantages. It will relieve the educators from a laborious repetitive work. It will also provide students with an opportunity to interact with their teachers on one-on-one basis providing a wealth of knowledge and understanding. The administrators were thrilled to save time and provide high quality education to their students thus increasing the enrollment (and the revenue).

Research Question 3

Q3 What are teachers' perspectives about the concepts of learning objects (LOs) and instructional modeling language?

The teachers, who were interviewed in this research showed a very positive attitude towards the concepts of LOs and IML. The response was phenomenal in terms of their appreciation of the proposed software which they thought would eliminate their existing instructional design issues, such as, time consuming, repetition, lack of sharing, etc. The administrators (staff) saw this research as a means to make their teachers available to the students thus improving the quality of education and increasing student's enrollment and revenue. By doing a thematic analysis of their responses to the interview questions, it was clear that they were impatient to see the actual software. They agreed that their time would be saved from months to days and from days to hours. As described above (in Table 3), in the post-questionnaire phase, every participant had one theme, “will save time” which was common in the proposed software. They were all inclined about time, that it would give them more time for everything, curriculum preparation, LOs preparation, home works, quizzes, and professional development. They also agreed that it would give them more time to interact with the students for topics that the students were interested in. Many students do not get the time they need to interact with their teachers to ask them questions. Once students do not understand a topic, they would start avoiding their teachers thus leading to not enough understanding about a subject and bad grade. Douglas (2001) asserts that learning objects should be used in the instructional system development process both when instructional interventions are designed or upgraded, and when new instructional materials are created. Douglas (2001) wrote that,

> [T]his involves a paradigm shift from what is currently a predominantly craft-based approach to educational product development. Design thinking needs to move from an approach that is oriented towards creating large integrated packages (e.g. textbooks, CBT) to one that is built around collections of specialized, reusable and granular components. (p. 3)

The author’s research complements many authors like Douglas. This had been the themes in our pre-questionnaire phase where the teachers complaint about the large and boring curriculum. LOs could reduce a lot of pain from educators’ lives when it comes to instructional design.

Tennyson and Foshay (2000) described five key areas that require special attention during learning environment maintenance. First area is the question concerning whether the use of instructional materials is still worth in the existing learning environment and it must be checked through a cost-benefit analysis. This researcher completely agrees that the cost of building the current instruction is way beyond the benefit. The second area they talk is about the revision of the learning environment to keep them up-to-date. Through 10 years of teaching experience, the researcher has observed that the update of the instructional design is time consuming at the least and impossible in certain situations due to economic and administrative reasons. The proposed software would provide a remedy to this update of instructional design through quick and reusable LOs by utilizing IML and web repositories.

Tennyson and Foshay (2000) argued the third area is about the learner attitudes toward the instruction and the materials. They suggest assessing together with performance measures, because both may be fluctuating. The fourth area is about the changes in the characteristics of the learner, the learning goals, prerequisites for learning, and societal policies, etc. They recommend that all of these measures need to be evaluated to make the appropriate adjustments. Things like learning environment used in an international setting, internationalization and localization have to be addressed. For example, many disciplines such as rare surgeries do not have enough experts in the world, and shared web repositories presented in this research could provide an answer to such LOs. One recent example was a surgery done by an expert surgeon in Dubai where two infants had joint heads. These cases could be stored as LOs internationally for the benefit of the medical professional groups for knowledge sharing and further advancements in the field.

The researcher thinks that the adjustments as mentioned by Tennyson and Foshay (2000) need time and with the existing instructional design systems, time is not available for anyone whether they are educators or student learners. The proposed research is an answer to provide that time. The last area is mentioned by Tennyson and Foshay is about the special media types which is used in the learning environment needs evaluation and maintenance. This research (about IML, LOs and web repositories) has been evaluated through a prototype. Its maintenance can be done on as needed basis in the future. The researcher agrees with Tennyson and Foshay because every media whether special or the existing ones need evaluation and maintenance.

In an attempt of proof of concept, the participants of this study which included teachers and administrators (staff) from a high school were asked to list the barriers and asked their challenges in their existing way of instructional design. They all (11 out of 11) expressed “time consuming” as the top leading theme in their interviews. Once the researcher was convinced that time consuming is the major flaw in the existing educational system, he introduced the participants with the prototype of the proposed software. An actual software demonstration of a fictitious course was shown. In this demonstration, some of the reusable components (LOs) such as home works, and quizzes were added to a fictitious course. Once the fictitious course was partially built, it was obvious that if there was a web repository available with many options of LOs to choose from, it will be a matter of hours if not minutes to build any course an educator wants.

The participants were convinced, thus assuring the proof of concept that the prototype will work if implemented fully as a software.

The third research question was about teachers' perspective on learning objects and IML, which was very positive. There was a sense of urgency in their request for the availability of the proposed software. The teachers (10 out of 11), thought that IML seems to be easy to use and putting LOs on web repositories will open all avenues for the teachers and students alike. It will save them time, which could be used for other important teaching activities. They (9 out of 11) thought it would save cost, which also could be used for other resources. All teachers were willing to be in contact if and when this software is available to them. The aspect of innovation was the key in this research which was based on the researcher's teaching background. The researcher had seen the barriers in the current instructional design first hand before interviewing the teachers. There is no doubt that teachers are the most important stakeholders to bring change and innovation into the classroom (Miller, 2008). The researcher agrees with Miller because of the observation and by asking the post-questionnaire interview (iv, v, and viii) and listening to their answers that had similar themes.

Theoretical ideas are hard to challenge because they lack the practical aspect. However, any software tool that is predicted to provide a certain advantage must be able to demonstrate its benefits through a prototype and thus proof of concept. The proposed software in this research (which had a hands-on demonstration) about IML, LOs and web repositories was not only had a theoretical base; it provides a solid prototype to visualize. The proposed software is a promise for educators to save time and promote a universal learning at the local, national, and international level.

Limitations

The prototype as it exists cannot provide the user interface that could be presented in the proposed software. The user interface will play an important role in the ultimate software, which could be built to support the idea of LOs and IML. While the benefits of this research attracted the teachers, the user interface is important to new users if the actual software is developed in the future. A user interface is the combination of the mental model of a user with the person who designs the model and the programmer's model (Mandel, 1997; Roberts, Berry, Isensee, & Mullaly, 1998). The final software product needs to be designed in such a way that it fits in with the way a user views it. The information should be designed and programmed by keeping the user in mind. The individual user or a group of users should be part of the design and programming team, which will serve as the basis of the user interface and detailed description of the user's characteristics and computer background etc. should be taken into account (Treu, 1994). Since most of our users are teachers, they should be involved when designing the proposed software.

The IML designer's model will provide the overall layout of the system that it describes, the objects the user will need, the visual representation, and the interaction that would take place with the proposed software. The programmer can then take the design and write the code to accomplish the user interface, functionality, connection with the web repository and download and upload capabilities. This part does not exist now because it will need many programmers and funding to write this software, however, it is a start. Some of the existing features from other software could also be incorporated with the proposed software, such as, a learning management system.

The teachers' lack of computer knowledge was a limitation in this study. This limitation was not related in any way to the research, but an observation by the researcher showing that the newer topics (such as LOs) are still not implemented in every school. The concept of LOs was new to some teachers. The teachers did not have a Computer Science background and the author was aware of this limitation, hence, a proof of concept was provided to alleviate this limitation and the design details were ignored which were something that the teachers did not have to deal with anyway.

Another limitation of the research and ultimately the proposed software, is that the background of the teachers cannot be assumed to be perfect even when an easy-to-use software is designed. The term easy is relative. Some teachers who struggle now with the existing MS software will still have difficulty in understanding a new software no matter how easy the software is. Therefore, the researcher suggests complementing the software with a manual or online training tutorial to overcome this limitation. An instructor led training can also be an option along with a textbook covering the sample examples of the proposed software.

Implications

While LOs are introduced in the field of educational technology, no modeling language exists as compared to their counterparts in the field of computer science. LOs have many benefits because of their reusability. However, they have not been utilized in the educational system to their full extent. The author was able to contribute to the field of educational technology in the following ways:

- Recognized the issues that the current educators face in their everyday work of designing curriculum and course materials.

- Designed a proof of concept through a prototype for the proposed software (IML and LOs' web repositories) which would help resolve the issues that are faced by current educators.
- If implemented and shared through web repositories, the proposed software in this research could revolutionize the way instruction is designed today.

Future Research

This is the beginning of the research about IML. There are many areas of instructional design where the discussion of LOs, IML, and web repositories could be continued. Students were not involved in this research. The perceptions of LOs and web repositories, if available to students as part of their learning as they need could be another research. LOs and web repositories could be made available to students and their perspectives could be another dissertation by itself. Performance of teachers and students is another area that could be studied after the use of the proposed software. The author is confident about the advantages of this research and the possibilities are many. The future research is not limited in the area of instructional design. It can be extended in the area of Computer Science where big data libraries of LOs, design patterns, artificial intelligence and other innovative areas could be studied with high-speed networks as they are retrieved by the users, teachers, and students alike through Internet.

Conclusion

The idea of LOs and web repository are becoming very popular in the field of Educational Technology. While the idea of LOs was borrowed from Object-Oriented Design in Computer Science, there was no counterpart available in modeling the instruction as we have UML. UML is a modeling language used to design objects in Computer Science. The researcher came up with a new modeling language that he calls Instructional Modeling Language (IML). IML, LOs and web repositories research and proof-of-concept was very well received by educators and administrators alike. The researcher was able to interview 8 full-time, one part-time teacher, and 2 administrators of a private high school. They (11 out of 11) all agreed that the proposed software will save time in designing instruction and would help them increase their knowledge through web repositories.

The idea of IML and web repository combined could become a revolutionary phenomenon in the field of Educational Technology. Since the researcher has more than 10 years of teaching experience in the field of Computer Science, IML was designed to resolve most of the barriers, which were faced, by him and thus the teachers in the pre-questionnaire phase. Therefore, when the prototype of LOs, IML and web repositories was presented to the teachers, the response was very positive. The teachers (11 out of 11) agreed that the proposed software will help them reduce time (and thus cost), will provide sharing among other teachers, and be able to give individual attention to their students. This will improve the standard of education in their schools and help the teachers spend time for their professional development as well.

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APPENDIX A

ACRONYMS FOR LEARNING OBJECTS (LOs)

Acronyms for LOs

The following acronyms are used in our IML.

LO	-	Learning object
LJ	-	Learning objective
LJn	-	Learning objective number (e.g. LJ1)
SLJ	-	Super learning objective
LJm	-	Learning objective through mobile devices
LO_n1	-	LO for course number
LO_n2	-	LO for course name
LO_si	-	LO for school information
LO_nn	-	Any LO that starts with the letter n for the future
LO_cd	-	LO for course description
LO_cg	-	LO for course goals
LO_ce	-	LO for course expectations
LO_e	-	LO for examination
LO_en	-	LO for examination number such as 1, 2, 3, etc.
LO_ef	-	LO for final examination
LO_em	-	LO for midterm examination
LO_h	-	LO for home works
LO_hn	-	LO for home works's number such as 1, 2, 3, etc.
LO_q	-	LO for quizzes
LO_qn	-	LO for quiz number such as 1, 2, 3, etc.
LO_oq	-	LO for online quiz

LO_oqn - LO for online quiz number such as 1, 2, 3, etc.

LO_cp - LO for class participation

LO_gp - LO for grading policy

LO_gs - LO for grading scale

LO_sp - LO for school's policies

LO_cm - LO for course materials

LO_o - LO for course outline

LO_tb - LO for textbook

LO_rl - LO for reading list (books)

LO_ra - LO for reading list (articles)

LO_oc - LO for reading list (online content)

LO_rb - LO for reference books

LO_l - LO for labs

LO_ln - LO for labs number such as 1, 2, 3, etc.

LO_li - LO for lab instructions

LO_io - LO for instructor office information (location)

LO_ip - LO for instructor's picture

LO_d - LO for discussions

LO_de - LO for fescriptions

LO_j - LO for journals

LO_s - LO for schedule

LO_ip - LO for individual projects

LO_gp - LO for group projects

LO_os	-	LO for online submission instructions
LO_lj_de	-	LO for description about LJ
LO_slj_de	-	LO for description about SLJ

APPENDIX B

FINDINGS OF THE PILOT STUDY

Findings of the Pilot Study

This study was about discovering and proposing an Instructional Modeling Language and LOs' repositories to alleviate the challenges that educators face in their everyday teaching life. People who participated in this study were the exact kind of population that I was looking for. They were all teachers and teaching at a middle school in Denver, Colorado. I tried to make my IML prototype as simple as possible so they can use it without any confusion. Since the participants varied in the courses they teach, it increased our trustworthiness and our triangulation. I found several challenges that the teachers face in preparing class material. These challenges were constructed from pre-questionnaire phase of the participant's interviews that I did during my research. I will to address the challenges and provide the solution through my IML prototype in depth.

The most common challenge among all the teachers was the time-consuming factor in creating the course material. The continuous editing and modification of course syllabus, exams, quizzes, home works, etc., which I defined as LOs, was taking time. "The real challenge is the time that we spent on creating the course material (Anwar)." Once created it was a challenge of its own to explain and go over the whole curriculum to the students and other teachers alike. This time could have been used in productive manner and this made them frustrated.

Jade was concerned about how he could share his course material without going through explaining each part of it.

> Sharing course material is a challenge for me. I have created my own artifacts, which I understand. I have not followed any standard. Now that I am moving to management side, I would like to give the course materials to someone else, but it

> seems like it is not going to work. My style of creating notes is not understandable to other teachers. Looks like I will have to just give them the list of topics and they would have to create everything from scratch." (Jade)

The second most common barrier for these teachers was lack of an automated tool that would help them design a curriculum. Mrs. White told me that the existing computer software were not as helpful as they should. "Basically, we have to design and write our own course material. I wished if we had some kind of pre-built software for each grade (Mrs. White)." They had to either modify an existing curriculum or re-create from scratch. This not only took more time, they had to request time from other teachers who had taught the course before. Either it became an issue of time and understanding of the subject from other teachers' perspective before they could offer it to the students.

The third barrier to the teachers was sharing of the course material. It was not just emailing a copy of the course materials. It had to be explained and edited to meet it to the needs of the students. There was limited help to standardize the material thus making every course a new project. Miss Kate was un-happy because of her lack of computer skills. "I know basic computer software like office, etc. However, in order to create course material, I need to learn some of advanced computer skills which I am not very good at. I try to get help from other teachers, but everyone is busy in their own teaching. I end up doing a not very professional job for my classes. I wished I could do better (Miss Kate)." Miss Tie fall into the same category as well, she had very little exposure to the advanced computer skills. "I never imagined I had to do so much work on a computer to just create lessons for my classes. I am good in the subject that I teach but I am not a computer guru. I wished there was a software for each grade and all the subjects. Life would be so easy" (Miss Tie). The teachers had to be aware of new concepts and standards to incorporate into their curriculum and be able to use software to incorporate the changes. Not all teachers were computer wizards making it difficult and they had to depend on other teachers to walk them through the software processes.

After I recognized the three main barriers, time consuming, lack of an automated tool, and lack of sharing--I read their post-questionnaire interviews, which was based on the use of IML. Jade was of the opinion that "This might be a game changer." "I wish this tool comes into the market soon as a software so we can save time" (Mrs. White). Miss Kate thought that, "IML and LOs' repository would be an answer to her prayers." "Wow! It will definitely save time for me since I am not a computer expert and I can get the best lesson for my class from the repository. Collaboration in action" (Miss Tie).

The participants agreed that IML prototype saved their time. If implemented in software the IML will eliminate most of their barriers including time, automation of preparing the course material, and sharing of course material (LOs). Some of the teachers had concerns about the final IML software product (if and once implemented) for the understanding of the software. However, they all agreed that the prototype was easy to understand. "This was not hard as I thought. Every new concept had been a challenge to learn but not this one. I think this could be the future of instructional design (Jade)". In conclusion, the teachers were in consensus that the IML prototype and sharing of LOs' were good innovative tools that could save countless hours of teachers' valuable time which would be used for teaching.

APPENDIX C

PROOF OF CONCEPT

Proof of Concept)

First Screen:

LO's Design Tool (Proposed Software Demo)

LO_si

LO_cd

………………………………………………..

LO's Design Document Demo:

LO_si
LO_cd
LO_io
LO_co
LO_ce
LO__gs
LO_q1
LO_q2

Click Fill Template 1

More Templates Options "Fill Template 2," "Fill Template 3," etc.

Screen 2:

Academy Park High School

Course Syllabus--Senior Transitional Math

Course Description	**Instructor Information**
Credit Hour: Math requirement	Name: Mrs. Green
Marking Period: Second Semester	Phone: 613-522-4330 ext. 6107
Class Location: Room 107	Office Location: Room D205
E-Mail: mrsgreen@sedelco.org	Office Hours: 2:35-3:10 Thursdays by appointment

Course Description:

This course is designed to prepare students for mathematics courses in the college transfer curriculum and/or for Technical Mathematics I. It involves the study of elementary algebra through quadratic equations.

Course Outline

Students who successfully complete Senior Transitional Mathematics will be competent in the following areas:

- *Add, subtract, multiply, and divide real numbers.*
- *Solve linear equations and inequalities in one variable.*
- *Solve literal equations for the indicated variable.*
- *Graph linear equations in two variables.*
- *Add, subtract, multiply, and divide polynomials.*
- *Factor polynomials.*
- *Simplify, multiply, and divide rational expressions.*
- *Solve a system of linear equations in two variables.*
- *Perform operations on square roots.*
- *Solve quadratic equations.*

Grading Scale

The grading system for the Mathematics Department at Academy Park High School is as follows:

Tests, Projects, & Major Papers	-	*30%*
Quizzes, Classwork, & Minor Assignments	-	*25%*
Warm up, Notes, & Journal Assignments	-	*15%*
Attendance & Class Participation	-	20% (school wide)
Homework	-	10% (school wide)

Course Expectations

1. Arrive to class on time
2. Be prepared
3. Respect your classmates and teacher
4. Give your all, all the time
5. Be responsible for your actions
6. No eating, drinking, cell phones, or ipods permitted in the classroom

Quizzes

Homework will be given approximately four days a week. It will be collected in the beginning of class the day it is due. It is YOUR responsibility to complete homework assignments. You will be given the opportunity to make up THREE homework assignments at the end of the marking period if they were not completed.

Unit/ Topic	Course Activities	Assessments/Assignments	Month/ Timeframe
Real Numbers/Algebraic Expressions	*Large Group Review*	*Quiz1/Test, Homework*	*Sept./1st MP*
Solving Equations/Inequalities	*Small Group Review*	*Quiz2/Test, Homework*	*Oct./1st MP*

Download Quiz1 from Web Repository

Download Quiz2 from Web Repository

Screen 3:

Quiz 1

Name

Grade

Question 1: How many cups are in 10 quarts?

- 25
- 30
- 36
- 40

Question 2: What is the range of the following set of data: 12, -2, 9, 3, 2.4, 7.1, 11?

- 12
- 14
- 12.4
- 14.4

Question 3: John starts a saving account with $100. Every week he adds $6 to his account.
Which equation can be used to determine the number of weeks w, after which John's accounts reaches $220?

- 6w + 100 = 220
- 6w - 100 = 220
- 6w + 220 = 100
- 6 + w = 220

Question 4: If a, b and c are odd integers, which of the following expressions must be an even integer?

- a + b + c
- a(b + c)
- ab + bc + ca

APPENDIX D

INSTITUTIONAL REVIEW BOARD

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE:	October 8, 2018
TO:	Altaf Siddiqui, Ph.D.
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[1224027-2] Design of Instructional Modeling Language and Learning Object Repositories
SUBMISSION TYPE:	Amendment/Modification
ACTION:	APPROVAL/VERIFICATION OF EXEMPT STATUS
APPROVAL DATE:	October 8, 2018
EXPIRATION DATE:	October 7, 2022

Thank you for your submission of Amendment/Modification materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Nicole Morse at 970-351-1910 or nicole.morse@unco.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.

UNIVERSITY OF
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