

EFFECTIVENESS OF EMPLOYING MULTIMEDIA PRINCIPLES IN THE DESIGN OF
COMPUTER-BASED MATH TUTORIALS FOR STUDENTS WITH LEARNING
DISABILITIES

BY

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Abstract

This study was designed as an extension of a formative pilot study to enhance the Blending Assessment with Instruction Program (BAIP) developed by the Center for Educational Testing and Evaluation (CETE) and the eLearning Design Lab (eDL). The animated tutorial prototype, which was studied as part of this project, was for young children. The study evaluated a prototype of online instructional tutorial in mathematics designed for students with disabilities. The tutorial prototype was instructional, interactive, and aligned with the state assessment standards and indicator at the fourth grade level. The goal of the study was to obtain formative data from subject matter experts (SMEs), special education teachers and multimedia/technology experts regarding the usability and accessibility of the tutorial design for students with disabilities. The tutorial was designed based on the principles of designing multimedia instruction given by Mayer (2005).

A purposeful sampling process was used. Three groups of individuals were invited to participate in the study; they were subject matter experts in mathematics (SME), special education teachers, and multi-media/technology experts. Participants within each group were selected as based on their expertise and experience. Out of the 17 invitations, 10 individuals agreed to participate. They included - three SMEs, four special education teachers, and three multi-media and technology experts.

Frequency results from the survey instruments and formative data gathered through online comments and suggestions provided valuable information regarding the design and accessibility of the tutorial prototype. These data, in turn, will be used to enhance the tutorial prototype to be tested in the second study researching the effectiveness of the revised prototype in teaching students with learning disabilities in authentic instructional settings.

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Table of Contents

ABSTRACT -----	ii
ACKNOWLEDGEMENTS -----	iii
LIST OF TABLES -----	vii
LIST OF FIGURES -----	viii
LIST OF APPENDICES -----	ix
CHAPTER ONE-----	- 1
Introduction-----	1
Statement of the Problem-----	5
Research Questions-----	7
CHAPTER TWO-----	8
Literature Review-----	8
Mathematic Learning Difficulties (MLD)-----	8
Memory Systems and MLD-----	9
Cognitive Architecture Theories-----	12
Paivio’s Dual Coding Theory (DTC)-----	12
Baddeley’s Working Memory Model-----	16
Instructional Theories-----	18
Sweller’s Cognitive Load Theory (CLT)-----	18
Mayer’s Cognitive Theory of Multimedia Learning (CTML)-----	22
Principles of Multimedia Learning and Their Application in Online Tutorials-----	25
CHAPTER THREE-----	30
Methods-----	30
Problem-----	30
Research Questions-----	31
Participants-----	32
Tutorial Prototype Design-----	32
Instrument Design-----	36
Instrument Format-----	36
Data Collection-----	37
Data Analysis Procedures-----	38
Formative Report-----	41
CHAPTER FOUR-----	42
Results-----	42
Participants-----	42
Research Questions-----	43
Research Question 1-----	43
Research Question 2-----	44
Research Question 3-----	58
Research Question 4-----	61
Research Question 5-----	64
Participants’ Comments and Feedback-----	68
CHAPTER FIVE-----	71
Discussion-----	71

Introduction	71
Discussion	72
Tutorial Alignment	73
Multimedia Features	74
Multimedia Features for Students with Learning Disabilities	74
Functional Reliability	75
Multimedia Principles.....	75
Animation and Interactivity Principle.....	76
Split-attention principle and redundancy principle.....	76
Personalization principle	77
Worked-out examples principle	77
Guided discovery-immediate feedback principle	77
Segmenting Principle	78
Pre-training Principle	78
Limitations	79
Future Research	80
References	82

List of Tables

Table 1 Number of Participants Within Each Subgroup-----	43
Table 2 Frequency Counts for Questions Regarding Multimedia Feature Given by SMEs, Special Education Teachers, and Multimedia/Technology Experts -----	46
Table 3 Comments on Multimedia Features Given by SME-----	48
Table 4 Comments on Multimedia Features Given by Special Education Teachers -----	52
Table 5 Comments on Multimedia Features Given by Multimedia/Technology Experts -----	56
Table 6 Frequency Counts for Questions Regarding Multimedia Features for Students with Learning Disabilities Given by Special Education Teachers -----	58
Table 7 Comments on Multimedia Features for Students with Learning Disabilities Given by Special Education Teachers-----	59
Table 8 Strengths and Weaknesses of the Tutorial Model given by Multimedia/Technology Experts -----	61
Table 9 Frequency Counts on Questions regarding Functional Reliability for Students with Learning Disabilities Given by Special Education Teachers and Multimedia/Technology Experts -----	62
Table 10 Comments on Functional Reliability for Students with Learning Disabilities Given by Special Education Teachers and Multimedia/Technology Experts -----	63
Table 11 Frequency Counts for Questions Relating to Mayer’s Multimedia Principles Given by SMEs, Special Education Teachers, and Multimedia/Technology Experts-----	68

List of Figures

<i>Figure 1(a)</i> . Independent processing of incoming information within verbal subsystem -----	13
<i>Figure 1(b)</i> . Independent processing of incoming information within non-verbal subsystem ---	13
<i>Figure 2</i> . Parallel processing of incoming information in verbal and non-verbal subsystems----	14
<i>Figure 3</i> . Dual coding. Information travelling in parallel fashion through verbal and non-verbal subsystems, making connections within the two subsystems and between the two subsystems -----	15
<i>Figure 4</i> . A schematic presentation of multiple-component model of working memory-----	17
<i>Figure 5</i> . Revised model of working memory by Baddeley with the ‘Episodic Buffer’ -----	18
<i>Figure 6</i> . Screen shot from the tutorial prototype, introducing the concept of Pint -----	33
<i>Figure 7</i> . Screen shot from the tutorial prototype, teaching the concept of Pint -----	34
<i>Figure 8</i> . Screen shot from the tutorial prototype providing practice for the concept 2 Cups = 1 Pint -----	34
<i>Figure 9</i> . Screen shot from the tutorial prototype providing practice questions based on the taught concept of pint -----	35
<i>Figure 10</i> . Screen shot from the tutorial prototype showing the word problem based on the concepts thought through the tutorial -----	35
<i>Figure 11</i> . Screen shot of the website page with tutorial prototype and the survey instrument --	37
<i>Figure 12</i> . Nine criteria developed by the eDL development team to guide the decision making process for determining the priority for making modifications in the tutorial design based on the comments given by all the participants -----	40

List of Appendices

Appendix A Online Informed Consent agreement -----	89
Appendix B Demographic Questions -----	93
Appendix C Screen Shots of Tutorial sent to Subject Matter Experts -----	96
Appendix D Screen Shots of Tutorial sent to Special Education Teachers -----	120
Appendix E Screen Shots of Tutorial sent to Technology/Multimedia Experts -----	144
Appendix F Subject Matter Experts (SMEs): Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria -----	168
Appendix G Special Education Teachers: Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria -----	178
Appendix H Multimedia/Technology Experts: Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria -----	192
Appendix I Questions Relating to Eight of 10 Principles of Multimedia Instructional Design Given by Mayer-----	207

Chapter One

Introduction

Legislations such as No Child Left Behind Child Left Behind (NCLB, 2001) and the Individuals with Disabilities Education Act (IDEA, 2004) have led to changes in the way students with disabilities are educated in schools today. Now more than ever, students with disabilities are faced with meeting the same general education curriculum standards as their non-disabled peers. In measuring Adequate Yearly Progress (AYP) districts must demonstrate continuous growth by all students including students with disabilities. Applying the same curriculum standards to all students is based on the premise that equity can be achieved and current academic achievement gaps can be reduced through access to the general education curriculum by students with learning disabilities. The underlying assumption is that teachers will be successful in aligning instruction with curriculum standards. If this is not achieved, then students with disabilities will be disadvantaged on state assessments as such assessments are based on curriculum standards. However, instructional alignment is not easily achieved due to the general nature of how standards are stated. While states typically break curriculum standards down to more specific statements, it still requires considerable content knowledge on the part of teachers to translate standards into aligned instruction. This is a particular challenge in the education of students with disabilities. (Thurlow & Wiley, 2004).

Apart from being an important subject area in a student's education, understanding mathematics is important throughout one's life. Increased access to standards based curriculum and high expectations are supported by the Race to the Top (RTTT) authorized under sections 14005 and 14006 of American Recovery and Reinvestment Act (ARRA, 2009), which addresses

four reforms including enhancing standards and assessments. Central to this reform is the creation of a Common Core of standards. During early January of 2010, a draft copy of the Common Core K-12 Mathematics Standards was released making reference to students with disabilities (“The Common Core Standards”, 2009). In discussing students with disabilities, the following statement appeared in the draft of the Mathematics Common Core Standards Initiative:

The Common Core Standards articulate rigorous expectations in the areas of mathematics, reading, writing, and speaking and listening in order to prepare students to be college-and career-ready. These standards identify the knowledge and skills students must acquire in order to be successful. Research shows that students with disabilities are capable of high levels of learning and should not be limited by low expectations and watered down curriculum. It is imperative that these highly capable students-regardless of their disability-are held to the same expectations articulated in the Core Standards as other students (p.3).

Despite instructional, educational, and accountability changes brought about by public policies such as NCLB, IDEA, and RTTT, research findings continue to indicate that there is an achievement gap in mathematics between students in the United States and other countries as well as gaps between subgroups within the United States (Institute of Education Sciences, 2006; National Center for Educational Statistics [NCES], 2009). According to the National Assessment of Educational Progress the overall average scores of fourth graders in mathematics has not changed since 2007 (NCES, 2009). Although the 2007 Trends in International Mathematics and Science Study show that the average mathematics achievement of fourth-grade students in the

United States was 11 points higher than the average score in 1995, seven countries continued to out-perform students from the United States at the fourth grade level.

Achievement gaps are also apparent between subgroups within the United States. According to the Nation's report cards given by National Assessment of Education Progress (NAEP) there are significant average scale score differences between students with disabilities and students without disabilities in mathematics (Braswell, Dion, Daane, & Jin, 2005; Perie, Grigg, & Dion, 2005). Between 2003 and 2007, the average scale score differences between students with disabilities and without disabilities in mathematics has fluctuated between 22 to 30 points at the 4th grade level, and between 38 to 46 points at the 8th grade level (Lee, Grigg, & Dion, 2007).

When examining achievement gaps between students with disabilities and their non-disabled peers, Parmar and Cawley (1997) found that students with learning disabilities typically function two to four grade levels below expectancy across the mathematics curriculum. Additionally, the National Center for Educational Outcomes reported in 2004 that not only were students with disabilities performing below all students across the country, but also that the gap actually grew significantly larger as students got older (as cited in Thurlow & Wiley, 2004). Results on the 2009 NAEP supports this fact showing that the achievement gap between students with and without disabilities is significant both at the 4th and 8th grade level and in fact increases as students progress through school – 21 point difference at the 4th grade level and 38 point difference at the 8th grade level.

The underlying assumption in requiring the application of curriculum standards to all students is that the instruction they receive is aligned with the curriculum standards that state assessments are designed to assess. Translating curriculum standards into instruction is difficult

due the general manner in which standards are stated (Montague & Garderen, 2008). The alignment of instruction with standards for students with learning disabilities is further complicated by the lack of content knowledge on the part of special education teachers. Maccini and Gagnon (2002) report that 45% of special education teachers were not familiar with the National Council of Teachers of Mathematics (NCTM, 2000) standards in mathematics upon which most state assessments are based. With lack of content knowledge by teachers combined with the learning attributes of students with learning disabilities the probabilities on increasing achievement in mathematics for these learners is greatly reduced. According to Wiley, Thurlow, and Klein (2005) without curriculum alignment “students – especially those with learning disabilities – would face an unfair and almost impossible challenge to prove what they have learned” (p. 3).

One way to ensure that students with learning disabilities meet curriculum standards is to provide them with curriculum and instruction that is aligned with the standards they are expected to meet. If this does not occur then students with learning disabilities are at risk of being assessed over skills and concepts on which they have not been given an opportunity to learn. Technology offers solutions for individualizing instruction that have not previously been available in the instruction of students with disabilities. It is now feasible to develop instructional strategies for teachers and tutorials for students that can be made accessible online 24 hours, seven days a week. Feedback can be immediately provided to the learner and the teacher. Even with these resources teachers must possess the necessary content knowledge and understanding of the learner to make decisions that are necessary to align their instruction with curriculum standards and the specific needs of their students. The focus of this study is on evaluating the design of online tutorials in mathematics for young children with learning disabilities.

Statement of problem.

Within the context of aligning instruction in mathematics with curriculum standards and utilizing technology to enhance instruction for students with learning disabilities there are associated problems. When technology is employed to create self-paced online tutorials that allow students with learning disabilities to work independently, it is important to control the reading level. If a student is unable to read the information provided in the mathematic presentation of skills and concepts, the learner is prevented from benefiting from the math instruction. Moreover, if instructional tutorials involve assessments, it is imperative that students be able to comprehend the assessment despite deficiencies in their reading skills.

It is important to remember that state assessments are not only designed to measure the students understanding of skills or concepts related to specific curriculum standards, but are structured by grade level. This may further limit the ability of the student with a learning disability to demonstrate what they have learned (Robinson, Robinson, & Maceli, 2000). They may be making progress in understanding the skill or concept but not at the level of their grade placement. These circumstances may result in excessive cognitive load for students with learning disabilities studying mathematics and/or in responding to state assessments.

The use of multimedia can facilitate a reduction in cognitive load as can interactivity and immediate feedback on student responses (Mayer & Moreno, 2003). By reducing the reading requirements, providing needed scaffolding, and employing multimedia features there is a potential for increasing the power of instructional features of online tutorials to enhance achievement for students with learning disabilities. Appropriately designed computer based tutorials aligned with standards in mathematics provide an opportunity to extend overall instruction as well as instructional time for students with disabilities. This can occur by allowing

students to work independently on tutorials 24/7 and thus allowing teachers more time in class to focus on instruction.

This study was designed in response to research findings gathered during two years of field testing the Blending Assessment with Instruction Program (BAIP) in mathematics developed by the Center for Educational Testing and Evaluation (CETE) and the eLearning Design Lab (eDL) at the University of Kansas (Meyen & Greer, 2009). The eLearning Design Lab (eDL) has been developing and researching lessons and online tutorials that are aligned with NCTM standards in mathematics. Over two hundred districts in Kansas tested the BAIP mathematics lessons and tutorials in grades three through high school. During the past two years of field-testing, 5700 students with Individualized Education Programs (IEPs) have been included among the students completing tutorials in grades 3 through high school. Each tutorial includes four embedded assessments. During field testing students with IEPs earned a mean score of 2.23 on the tutorials and students without IEPs earned a mean score of 2.61. While the performance of students with IEPs was considered as good performance it was learned that the reading difficulty of content on the tutorials may be hampering the performance of students with disabilities. As a result of these findings the eDL designed a tutorial model with reduced cognitive load and increased mediation.

This study evaluated an online instructional tutorial prototype in mathematics designed for students with learning disabilities. The prototype addressed a 4th grade geometry standard in mathematics through reduced reading requirements, animations, interactivities, and immediate feedback. The primary purpose of this study was to engage subject matter experts (SMEs), special education teachers, and multimedia/technology experts in reviewing the alignment of

tutorial content with the specified standard, appropriateness of instruction, and effectiveness of the animations and graphics.

Research questions.

The research questions focused on the first stage of evaluating the design, structure, and textual features of a prototype online instructional tutorial for students with learning disabilities. The tutorial was designed to reduce cognitive load through a reduction in the reading requirements while incorporating multimedia principles and keeping the mathematics instruction aligned with a standard at the fourth grade level. The prototype was anchored with an emphasis on graphics, animation, and interactivity.

1. Are the skills and concepts in mathematics aligned with the intent of the standard and indicator on which the tutorial is aligned?
2. Do the multimedia features, including graphics, animations, and interactivity employed in the presentation of content enhance learning?
3. Do the multimedia features, including graphics, animations, and interactivity accommodate the learning attributes of students with learning disabilities?
4. Is the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
5. Is the tutorial model consistent with the multimedia principles outlined by Mayer?

Chapter Two

Literature Review

Mathematic learning difficulties (MLD).

Failure to achieve math literacy can seriously impede both daily living and vocational prospects for students with disabilities. While children with disabilities in mathematics are specifically included under the IDEA 2004 definition of Learning Disabilities, seldom do math learning difficulties cause children to be referred for evaluation (Garnet, 1998). Even after being identified as having a learning disability, few children are provided sufficient assessment and remediation for their mathematic difficulties (Geary, 2004). This is due, in part, to the very diverse nature of mathematic disabilities.

Approximately 6% of school-age children have significant deficits in mathematics (National Center for Learning Disabilities [NCLD], 2009). This has caused many researchers to investigate cognitive factors that affect or impact mathematic learning difficulties (MLD). As a result, there is a growing body of literature that describes specific cognitive deficits in students with MLD. Students with MLD have been found to show deficits in working memory and in the storage and retrieval of information from long-term memory, thus resulting in a number of processing deficits and weaknesses in problem solving skills (Geary, 1993, 2004; Geary, Hansen, & Hoard, 2000; Jordan & Hanich, 2000).

According to Geary (2004), competencies in any given area of mathematics generally are found to be dependent on a child's conceptual understanding and procedural knowledge. Conceptual understanding refers to knowledge about different mathematical concepts (Geary, 2004). For example, a student who is learning to calculate the area of a polygon must understand

and be able to define the concepts of 'area' and 'polygon'. On the other hand, procedural knowledge refers to comprehension of the mathematical procedure. Taking the same example of calculating the area, procedural knowledge will require the student to know a formula and be able to follow the steps that are needed to derive an answer. These competencies, in turn are dependent on various cognitive systems such as working memory, long-term memory, and executive functioning (Geary, 2004; Geary, Hoard, Byrd-Craven, Nugent, & Numtee, 2007).

Memory systems and MLD.

According to the Mathmedia (2004), "Mathematics is the study of the relationships among numbers, shapes, and quantities. It uses signs, symbols, and proofs and includes arithmetic, algebra, calculus, geometry, and trigonometry". On the other hand "Arithmetic is the branch of mathematics that deals with addition, subtraction, multiplication, and division with the use of numbers in calculations." The most obvious difference is that arithmetic is all about numbers and mathematics is all about theory. The processes involved in both, mathematics as well as arithmetic, are dependent on capacities and functions of various memory systems such as working memory, long-term memory, and central executive functioning (Geary, 2004; Geary, et.al., 2007).

"Working memory is an ability to hold a mental representation of information in the mind while simultaneously engaging in other mental processes" (Geary, et.al., 2007, p. 1345).

Although the relation between working memory and difficulties in executing mathematical procedures is not yet fully understood, it is clear that children with MLD have some form of deficit in working memory (Siegel & Ryan, 1989; Hitch & McAuley, 1991; Geary, et. al., 2007).

Long term memory (LTM) is a system within the brain that allows for the permanent storing, managing, and retrieving of information (“Definition of Long Term Memory”, 2004). Research findings by Geary, Hitch and McAuley (1991, 2004, & 2007) suggest that children with MLD have difficulty storing arithmetic facts in or accessing them from LTM (Hitch and McAuley, 1991; Geary, 2004; & Geary, et. al., 2007).

The term ‘executive function’ describes a set of cognitive abilities that control and regulate the ability to initiate and stop actions, to monitor and change behavior as needed, and to plan future behavior when faced with novel tasks and situations (“Executive Function”, 2010). Many developmental delays and deficiencies in mathematics appear to be related to disruptions in the function of the central executive (Geary 1993, 2004; & Geary, et. al. 2007).

Delays and/or deficiencies in executive functioning, working memory, and long-term memory impact a child’s ability to attain, process, and retrieve mathematical information (Geary, 2004). These delays and/or deficiencies often manifest themselves differently in different students. Some students may have difficulties due to weakness in visual-spatial skills, where they may understand the needed math facts, but have difficulty putting them down on paper in an organized way. Visual-spatial difficulties can also make it very difficult for students to comprehend what is written on a board or in a textbook (NCLD, 2009). Other children may have language-processing deficits, which cause them to have difficulty solving basic math problems using addition, subtraction, multiplication, and division.

Some students may have missing or faulty connections between working memory and long-term memory (Conway & Engle, 1994; Geary 2004; & Geary et al., 2007). Any disruption in the ability to represent or retrieve information from long-term memory results in difficulties in forming problem-answer associations during arithmetical procedures. As a consequence students

have difficulty learning new math facts and retrieving those facts that are represented in long-term memory. They may struggle to remember and retain basic math facts and/or have trouble figuring out how to apply their knowledge and skills to solve math problems. Most of the children with MLD show persistent deficits in some areas of arithmetic and counting knowledge. Along with frequent procedural errors, many of these children have an immature understanding of certain counting principles, and with respect to arithmetic, they use problem solving procedures that are more commonly used by younger, typically achieving children (Geary et al., 2000; Jordan & Hanich, 2000). These developmental delays and deficits appear to be related to a combination of disrupted functions of the central executive, including attentional control and poor inhibition of irrelevant associations, and difficulties with information representation and manipulation in the language system (Geary, 2004; & Geary, et. al., 2007).

In light of what is known about MLD, it is important to take into consideration the general theories of human cognition when creating or providing instructional support for students with MLD. To do so, one needs to examine general theories of cognitive architecture, to learn how the brain takes in, processes, and retrieves mathematical information. Theories which have addressed cognitive architecture include: Paivio's Dual Coding Theory, also known as DCT (Paivio, 1969, 1975) and Baddeley's Working Memory Model (Baddeley, & Hitch, 1974; Baddeley & Logie, 1999; Baddeley, 2000). Paivio's theory is based on the perceptual aspects of cognition, whereas Baddeley's theory takes a sensory modality view of cognition. Moreover, one needs to examine how cognitive architecture impacts instructional design. Instructional theories that take into account cognitive architecture include: Sweller's Cognitive Load Theory, also known as CLT (Sweller, 1994, 2003; Sweller, Merrienboer, & Pass, 1998) and Mayer's

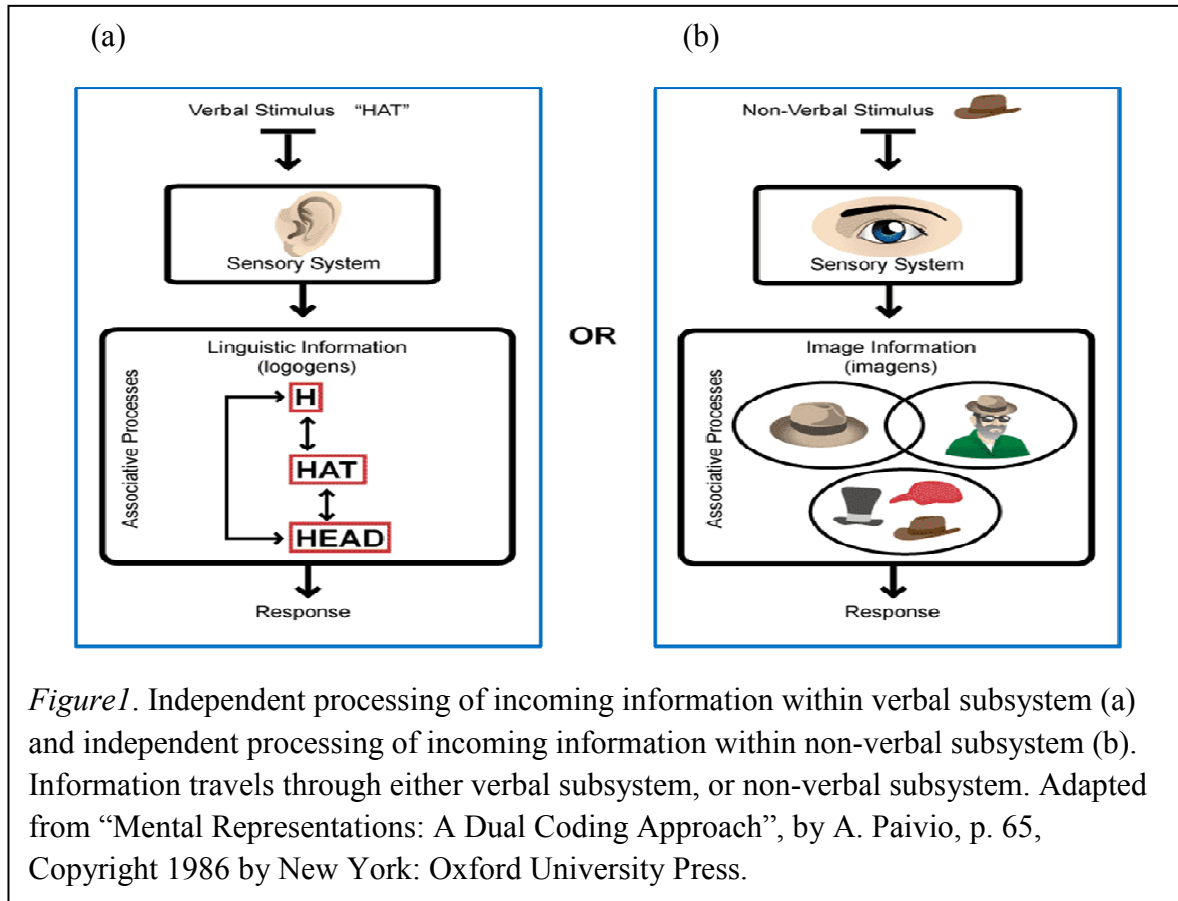
Cognitive Theory of Multimedia Learning, also known as CTML (Mayer, 2005; Mayer & Moreno, 2007).

Cognitive architecture theories.

Paivio's dual coding theory (DCT).

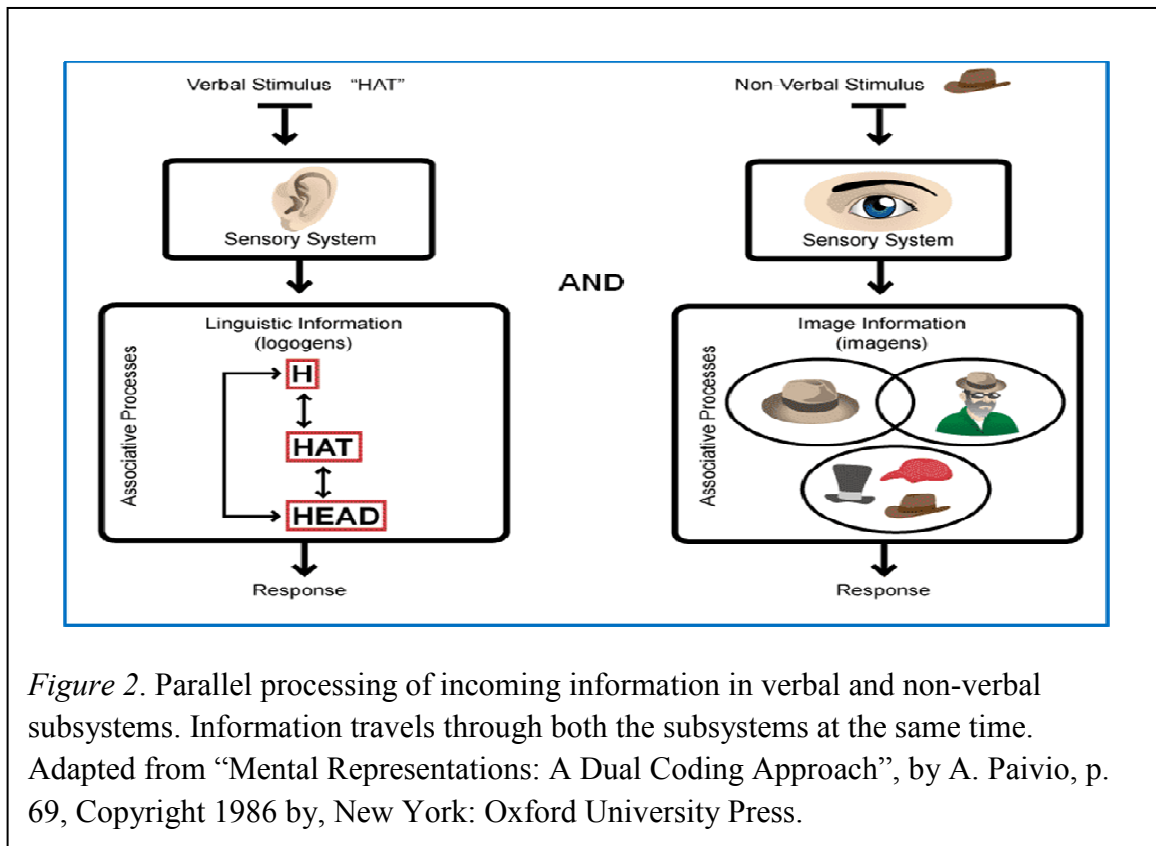
Paivio's Dual Coding Theory (DCT) is one of the most influential and empirically sound theories ever developed (Sadoski & Paivio, 2001; Reed, 2006). The theory is concerned with how information from the external world is perceived and processed within memory. It postulates that humans process environmental stimuli through two subsystems that can process information simultaneously, one subsystem processing verbal information and one subsystem dealing with visual and spatial objects/information. Humans rely on these two subsystems as they process, store, and retrieve information from long-term memory. The two subsystems have different functions; the verbal subsystem processes and stores linguistic information (logogens) whereas the visual subsystem processes and stores images and nonverbal information (imagens) (Paivio, 1971).

The two subsystems can be activated independently, in parallel, or in a connected way. For example, if someone said the word 'hat', it could be processed independently by entering the brain through the sensory system and traveling through either the visual or verbal subsystem. When processing environmental stimuli through one subsystem, the stimuli can only be associated with terms or images that are stored within that subsystem – thus resulting in connections or associations with the other content that is already stored within the subsystem's long term memory (see Figure 1a and 1b).



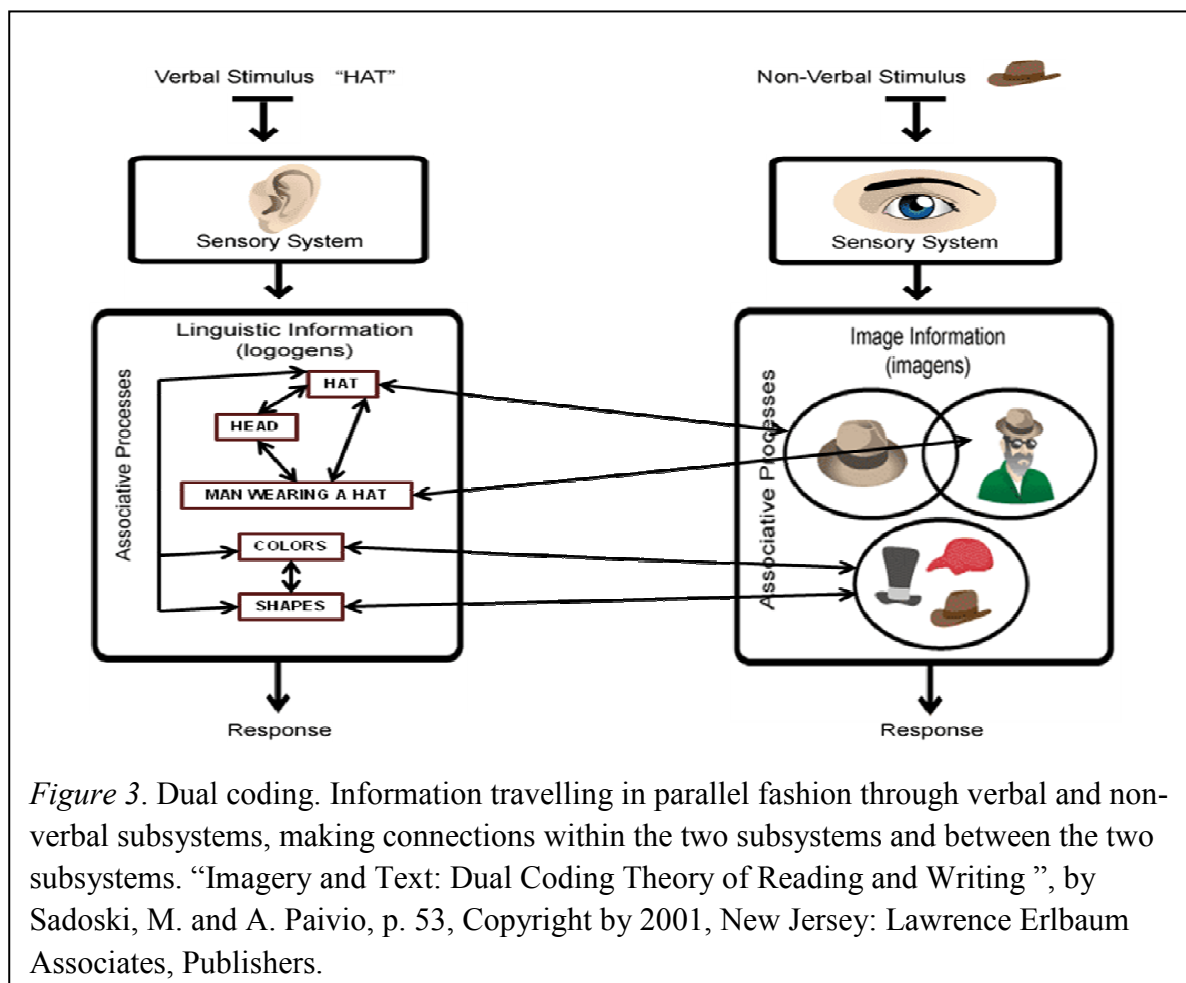
For example, the word 'hat' enters into the verbal subsystem and triggers and makes connections between other words that have already been stored within the verbal subsystem. Thus, processing and storing the new word ('hat') based on previous connections or schemas that are stored within long-term memory (see Figure 1a). Or the word 'hat' enters into the non-verbal subsystem and triggers and makes connections between other words that have already been stored within the non-verbal subsystem (see Figure 1b).

Another way in which the brain can process information is referred to as parallel processing. Here the brain processes information through both the verbal and nonverbal subsystems in parallel fashion. In this way, the word 'hat', would enter the sensory system and travel through both the verbal and visual subsystems in a parallel fashion (see Figure 2).



By traveling through both the visual and verbal subsystems, the brain processes the information in a parallel fashion, which allows for parallel dual processing and storage. As a result, connections and associations are made within both the verbal subsystem and the nonverbal subsystem.

The other way in which our brains could process the word ‘*hat*’, involves both parallel processing and the creation of connections between the two subsystems. That is the word ‘*hat*’, could enter the sensory system and travel through both the verbal and visual subsystems in a parallel fashion while at the same time spark connections and/or associations between the two subsystems (see Figure 3). This path would strengthen memory, as it would result in dual coding with interrelations and connections between the two subsystems (Paivio, 1971, 1975, 1986; Sadoski & Paivio, 2001).



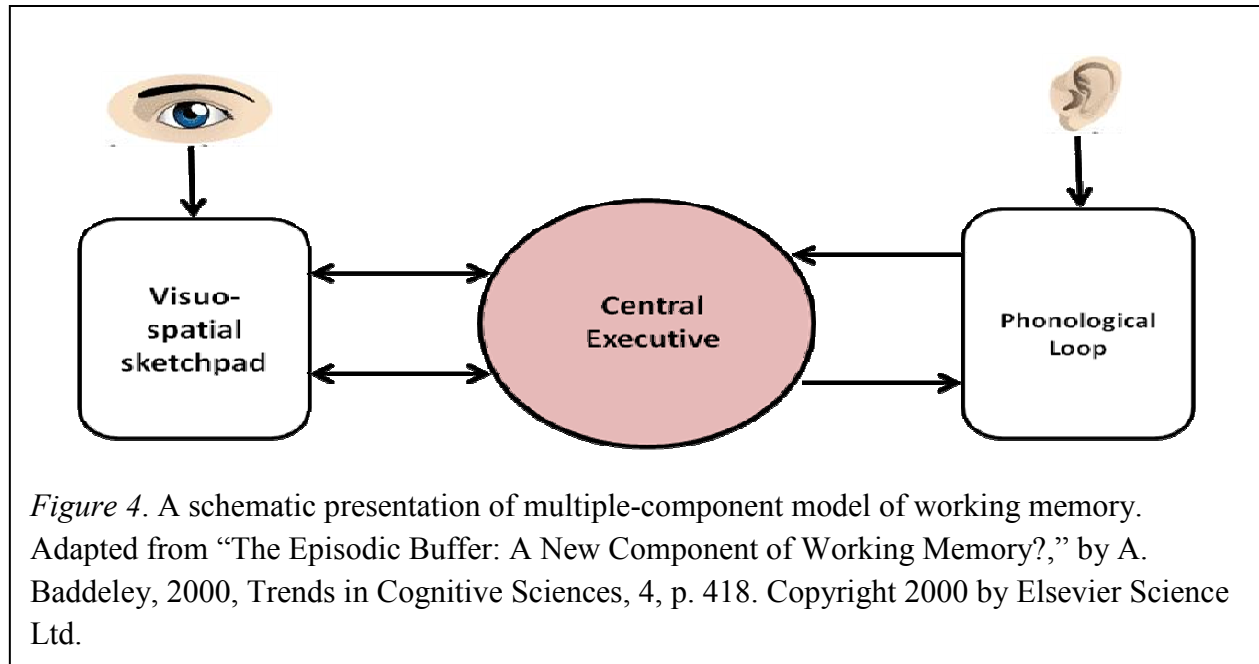
It is easy to see why Paivio’s theory is referred to as the dual coding theory as it proposes two independent memory codes (one for visual information and one for verbal information), either of which can result in recall. Having two memory codes to represent an item provides a better chance of remembering that item than having only a single code (Paivio, 1969, 1975).

Research has conducted to determine which subsystem, if both are being used at the same time, results in greater learning (Paivio, 1971, 1975; Reed, 2006). It has been found that imagery potential or image memory of words is more of a reliable predictor of learning than is the association potential or verbal memory of the words. Thus, pictures typically result in better memory than do concrete words. The reason images are effective is that an image provides a second kind of memory code that is independent of the verbal code.

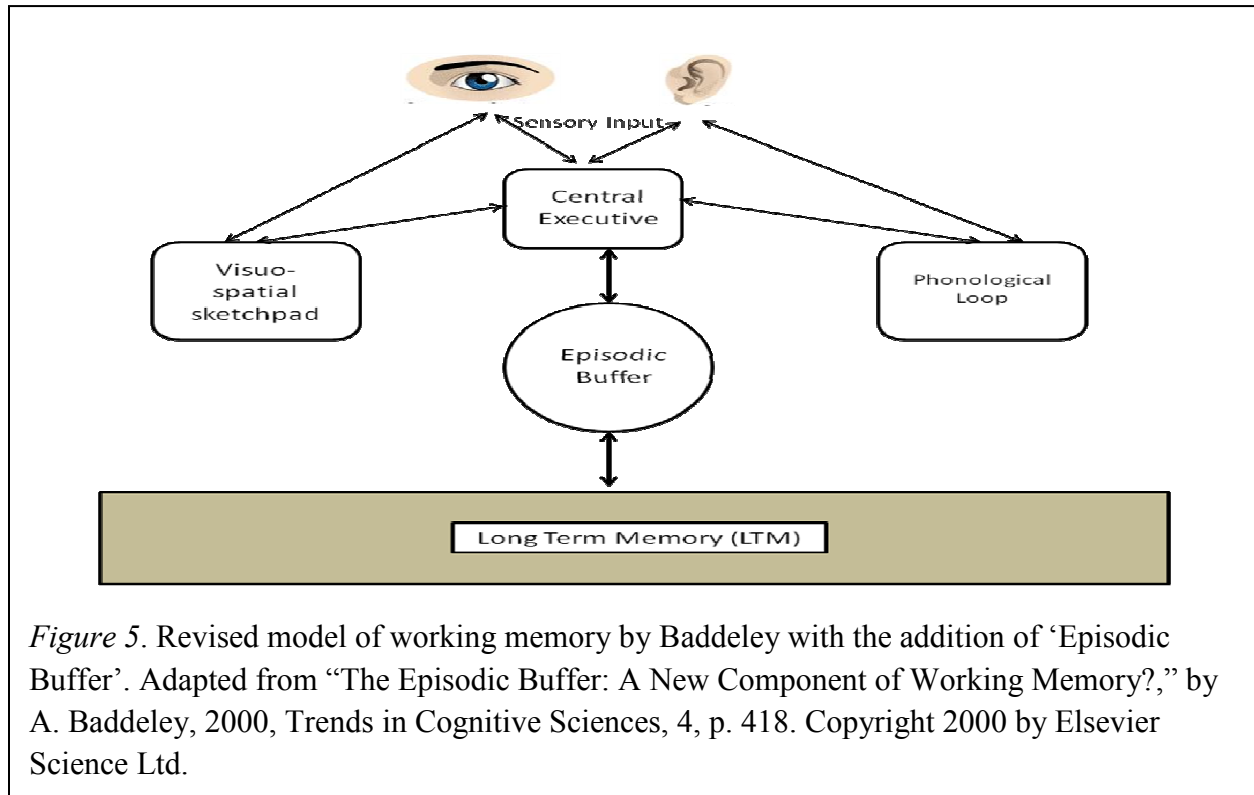
Baddeley's working memory model.

Although the working memory model proposed by Baddeley and Hitch (1974) is similar to Paivio's in that it distinguishes between verbal and visual processing, Baddeley and Hitch's theory concentrates on the processes taking place in working memory (Reed, 2006). "Working memory plays an important role in everyday cognitive tasks, where multiple steps with intermediate results need to be kept in mind temporarily to accomplish task at hand successfully" (Shah & Miyake, 1999, p. 2). For example, when doing grocery shopping, one usually has a list of things he/she needs to buy. Once at the store, the individual has to find the items on the list, compare prices of different brands, compare the quality of different brands, remember what brands the family prefers, and consider the monthly budget. All of these tasks rely heavily on working memory as they need to be kept in the head temporarily as the individual shops.

The model proposed by Baddeley and Hitch (1974, 1999, & 2007) consists of four components: (a) a phonological loop that maintains and manipulates auditory information, (b) a visuospatial sketchpad that maintains and manipulates visual and spatial information, (c) a central executive responsible for selecting strategies and integrating information between the phonological loop and the visuospatial sketchpad, and (d) an episodic buffer (Baddeley & Hitch, 1974; Baddeley, 2000, 2007). The Phonological loop holds speech-based information or acoustic information that fades within seconds unless refreshed by rehearsal. The visuospatial sketchpad holds visual and spatial information, which also fades within seconds unless refreshed by rehearsal (see Figure 4).



Thus, working memory has a limited capacity to store and process information, as information fades within seconds unless refreshed or rehearsed. The central executive controls different processes within working memory, including encoding and retrieving strategies from long term memory, the switching of attention between subsystem, and mental manipulation of material held within the phonological loop and visuospatial sketchpad. The episodic buffer serves as a limited capacity storage that can integrate information from the visuospatial sketchpad, phonological loop, and central executive (see Figure 5). The buffer provides the interface between the three memory subsystems (phonological loop, the visuospatial sketchpad, and the central executive) and long-term memory that allows perceptual information, information from the subsystems and from long-term memory to be integrated (Baddeley, 2000, 2007; Reed, 2006).



A key component of Baddeley’s theory is that working memory has a very limited capacity to attend to, manipulate, and make meaning out of external stimuli. Thus, it is imperative that those developing instructional resources take into account the capacity of working memory, how the brain processes and organizes information, and how the brain relies on long-term memory to process external stimuli. Sweller’s Cognitive Load Theory and Meyer’s Cognitive Theory of Multimedia Learning are two theories, which focus on the instructional implications of Paivio’s and Baddeley’s cognitive architecture theories.

Instructional theories.

Sweller’s cognitive load theory (CLT).

According to Paivio and Baddeley (1975, 2000), due to the limitation of working memory, the brain relies heavily on information that is stored within long-term memory to help

organize and make meaning out of incoming environmental stimuli. Thus, people learn better when they can build on what they already understand or know. When novel information is introduced, often individuals do not have stored information available within long-term memory that can be utilized to organize and make meaning out of the novel information (Sweller, 2004). Consequently, following instruction on novel information, the brain must randomly propose organizational combinations and test them for effectiveness. According to Baddeley (1974, 2000), organization and testing of novel information can be difficult as information within working memory fades quickly. Moreover, recent research by Cowen (2010) has shown that the working memory in adults can only attain to and process approximately 3 to 5 meaningful chunks. Thus, due to the limited capacity of working memory, the procedure of randomly organizing novel information in order to make meaning out of it is only possible with a very limited number of elements. As a consequence, working memory is severely limited when dealing with large amounts of novel information.

The impact or influence that working and long-term memory has on learning is central to Sweller's cognitive load theory. Based on what is known about the limitation of working memory and the impact of long-term memory on learning, instructional resources should be developed so that they can act like a substitute for missing schemas within long-term memory or trigger schemas in long-term memory (Sweller, et. al. 1998, Sweller, 2004).

Taking into consideration the dual coding process and limitations in working memory, instruction should include both verbal and nonverbal representations so that information can be processed in both the verbal and nonverbal subsystems thus, enhancing the probability of making connections between working memory and long-term memory. A potential problem in

coordinating multiple representations that can be processed in both the verbal and nonverbal subsystems is that the multiple representations can overwhelm working memory capacity.

There are two ways of overcoming the limited capacity of working memory through learning – automatic processing and/or schema acquisition (Sweller, et. al. 1998). Automaticity occurs as a result of extensive practice. For example, in mathematics time is spent teaching and practicing basic multiplication facts. Through continued practice many students are able to automatically provide the product when given a multiplication problem. This automaticity aids students when solving mathematic word problems involving multiplication. By being able to automatically recall multiplication facts, effort does not need to be taken to solve a multiplication problem and thus a student's working memory is freed up to focus on the other steps that are necessary to solve the word problem. You can see the effects of automaticity to reading as well. For example, the procedures involved in reading letters become automated in childhood and thus most adults can read without consciously processing the individual letters that make up the sentences and paragraphs. So with sufficient practice, a procedure can be carried out with minimal conscious effort resulting in minimal working memory load. Thus automatic processing requires less space in working memory which frees up space for use elsewhere.

The second way to overcome limitations in working memory is through schema acquisition. Familiar, organized information previously stored in long-term memory, often referred to as “schemas”, can eliminate the limited capacity of working memory by functioning as an organizing agent (Sweller, et al., 1998; Sweller, 2003). Schemas are based on our prior and social expectations, and they play a major role in organizing our experiences. Schemas help us process information quickly and economically and facilitate memory recall. Instead of relying on working memory to attain to, manipulate, and organize all incoming environmental stimuli

before the stimuli fades, working memory can take in environmental stimuli and communicate and make meaning out of it through the existing schemes in long-term memory. As a result, schemas are organized knowledge structures that increase the amount of information that can be held in working memory by chunking elements.

Going back to the ‘hat’ example, a schema can be anything that has been learned and is treated as a single entity. If the learning process has occurred over a long period of time, the schema may incorporate a huge amount of information. (Sweller, 1994, 2004; Sweller, et. al. 1998). For example, an adult’s schema of ‘a school’ may include an extensive knowledge about curriculum subjects and the overall functioning of the education system. Thus, the schema would hold a huge array of information ranging from things needed for school, timetables, concept of school buses, basic architecture of school buildings, different topics taught at different grade levels, assessments, etc. Because all of this information is organized into one schema ‘school’ it is not intellectually demanding. It can be held and processed in working memory effortlessly because school schema acts as a single element. The sub-elements or lower-level schemas that are incorporated in the higher-level schemas no longer require working memory capacity. Although there are limits on the number of elements that can be processed by working memory, there are no apparent limits on the amount of information that can be processed within schemas. Thus, making connections between incoming information from already organized and stored information within long-term memory (schemas) helps to eliminate the quick fading of information that often occurs within working memory.

Sweller’s Cognitive Load Theory (Sweller, et al., 1998; Sweller, 1988, 1994, 2005; Paas, Renkl, & Sweller, 2004) explains three categories that impact working memory that are present when tackling novel information – extraneous, intrinsic, and germane cognitive load.

- *Extraneous cognitive load* (Sweller, 2005) “is caused by inappropriate instructional designs that ignore working memory limits and fail to focus working memory resources on schema construction and automaticity” (p. 26). These instructional designs do not contribute to learning or understanding but occupy the limited capacity of the working memory.
- *Intrinsic cognitive load* (Sweller, 2005) “is the cognitive load due to the natural complexity of the information that must be processed” (p. 27). More the steps or levels involved in the problem to be solved, more will be the demand on the working memory, thus causing increase in the intrinsic cognitive load.
- *Germane cognitive load* is cognitive load that is designed to enhance schemas or lead to automaticity (Sweller, 2005). It is often referred to as an ‘effective’ cognitive load.

The three types of cognitive load are additive. So if one is reduced, another one can be increased. The overall aim of instruction should be to reduce extraneous cognitive load caused by inappropriate instructional procedures. By reducing extraneous cognitive load, working memory is freed up, allowing for an increase in germane cognitive load. On the other hand, if the complexity of the information presented is low (intrinsic cognitive load), increases in germane cognitive load may be possible even with high levels of extraneous cognitive load as working memory is freed up due to low levels of intrinsic cognitive load. (Sweller, 1988, 1994; 2004).

Cognitive theory of multimedia learning (CTML).

The Cognitive Theory of Multimedia Learning (Mayer, 2005) also addresses both dual coding and limitations in working memory. The theory is based on three principle assumptions of cognitive science – dual channel, limited capacity, and active processing.

- *Dual Channel Assumption*: This assumption states that humans have separate information processing channels; one for visually and spatially represented material and second one for auditorily represented material (Paivio, 1975; Baddeley & Logie, 1999). This assumption is incorporated in CTML by proposing that the human information-processing system contains an auditory/verbal channel and a visual/pictorial channel (Mayer & Anderson, 1991, 1992).
- *Limited Capacity Assumption*: This assumption states that each channel, visual as well as auditory, can process only limited amount of information at one time (Mayer, 2005). Central executive component in Baddeley's working memory model (Baddeley & Logie, 1999) helps us to make decisions regarding what incoming information to pay attention to. The central executive also helps decide which connections should be build among and/or between the selected pieces of information, and our existing knowledge (Mayer, 2005).
- *Active Processing Assumption*: The third assumption focuses on the cognitive process in which we actively engage in order to construct a coherent mental representation of our experiences (Mayer, 2005). These active processes can be broadly divided into three categories; selecting relevant material, organizing selected material, and integrating selected material with existing knowledge. "Active learning occurs when a learner applies cognitive processes to incoming material- processes that are intended to help the learner make sense of the material" (p. 36).

Knowledge can be structured in three ways- Process Structures are represented as cause and effect chains and consists of how some system works, Comparison structures are represented as matrices and consist of comparisons among two or more elements along several dimensions, and generalization structures are represented as a branching tree and consist of a main idea with

subordinate supporting details. Understanding a multimedia message often involves constructing one of these kinds of knowledge structures (Mayer, 1996, 2005).

Cognitive model of multimedia learning which is intended to represent the human information-processing system is made up of three memory stores- Sensory Memory, Working Memory and Long-term Memory (Mayer, 1996, 2005; Mayer & Moreno, 2007). For meaningful learning to occur in a multimedia environment, the learner must involve in five cognitive processes as follows,

- Selecting relevant words is a cognitive process mediating a change in knowledge representation from the external presentation of spoken words to a sensory representation of sounds to an internal working memory representation of word sounds (Mayer, Heiser, & Lonn., 2001; Mayer, 2005; Mayer & Moreno, 2007).
- By Selecting relevant images a knowledge representation from external presentation of pictures is changed into a sensory representation of unanalyzed visual images in the working memory (Mayer, et al., 2001; Mayer, 2005; Mayer & Moreno, 2007).
- The third process involves organizing selected words (Mayer, et al., 2001; Mayer, 2005; Mayer & Moreno, 2007). The input for this step is the word sounds selected from the incoming verbal message. The output for this step is a verbal model- a coherent or structured representation in learner's working memory of the selected words or phrases. The cognitive process involved in this change is organizing selected words in which the learner builds connections among pieces of verbal knowledge. This process is most likely to take place in an auditory channel.
- The visual image base selected from the incoming pictorial message is used as an input for the next step of organizing selected images (Mayer, et al., 2001; Mayer, 2005; Mayer &

Moreno, 2007). The output for this step is a pictorial model- a coherent or structured representation in learner's working memory of the selected images. The cognitive process involved in this change is organizing selected images in which the learner builds connections among pieces of pictorial knowledge. This process is most likely to take place in the visual channel. Both organizing processes are subject to same capacity limitations that affect the selection process and are not arbitrary but reflect an effort to build a simple structure that makes sense to the learner (Mayer, 2005).

- As a last process, integrating word-based and image-based representations (Mayer, et al., 2001; Mayer, 2005; Mayer & Moreno, 2007) involves building connections between corresponding portions of pictorial and verbal models as well as knowledge from long-term memory. This process occurs in visual and verbal working memory and involves the coordination between them. This is an extremely demanding process that requires the efficient use of cognitive capacity. The process reflects sense making because the learner must focus on underlying structure of the visual and verbal representations. The learner can use prior knowledge to help coordinate the integration process (Mayer, 2005).

Principles of multimedia learning and their application in online tutorials.

Knowing how students learn and solve problems helps us to understand the ways in which learning environment should be organized, as without such knowledge, the effectiveness of instructional designs is likely to be random (Mayer, 2005). The theories that have been discussed can be summarized into 10 principles that should be addressed when developing instructional resources designed to aide dual processing and decreasing limitations in working memory.

1. Multimedia Principle: People learn better from words and pictures than from words alone (Fletcher & Tobias, 2005). In the tutorial prototype developed for this study, teaching sections as well as practice sections have pictorial presentations including graphics and animations along with the written text.
2. Split-attention Principle: When designing instruction, including multimedia instruction, materials should be formatted so that the sources of information are physically and temporally integrated and thus eliminate the need for learners to engage in mental integration. By eliminating the need to mentally integrate multiple sources of information, extraneous working memory load is reduced, freeing resources for learning (Sweller, et al., 1998; Sweller, 2004). On some of the screens, especially in the teaching sections of the tutorial, graphics and animations convey the information instead of text, thus integrating multiple sources of information and reducing cognitive load.
3. The Modality Principle: Under certain, well-defined conditions, presenting some information in visual mode and other information in auditory mode can expand effective working memory capacity and so reduce the effects of an excessive cognitive load (Sweller, et al., 1998; Sweller, 2004; Low & Sweller, 2005). In the tutorial, in the teaching sections, after the initial teaching steps, same steps are repeated, where there is no auditory input, but the animation of all the steps can be seen. This prototype study uses only visual mode throughout the tutorial.
4. The Redundancy Principle: Redundant material interferes with rather than facilitates learning. Redundancy occurs when the same information is presented in multiple forms or is unnecessarily elaborate (Sweller, 1988, 1994; Sweller, 2004). On some screens same information is presented in textual as well as in graphical form. During the testing of this

prototype, questions were asked to see if this created redundancy and increase in cognitive load.

5. **Segmenting Principle:** People learn more deeply when a multimedia message is presented in learner-paced segments rather than as a continuous unit (Mayer & Anderson, 1992; Mayer, et al., 2001; Mayer, 2005). Throughout the tutorials, the control of the pace is in the hands of the student. The tutorial does not go forward or backwards unless student clicks the respective arrows or finishes the task set for him/her on that screen.
6. **Pre-training Principle:** People learn more deeply from a multimedia message when they know the names and characteristics of the main concepts (Mayer, 2005). Throughout the tutorial, new terms were introduced, taught and then opportunity for mastering the concept was provided, thus increasing the chances of deeper mathematical understanding.
7. **Personalization Principle:** People learn more deeply when the words in multimedia presentation are in conversational style rather than formal style (Mayer, 2005). Being a tutorial in mathematics, the terms used to teach a concept in the tutorial were formal. However they were taught using real life examples, using words and language from day-to-day usage. This helped to make the connection as to how the concept being taught was related in everyday life.
8. **Guided Discovery: Immediate Feedback Principle:** The learner's knowledge acquisition process progresses by stating rules or hypothesis on the basis of concrete situations and by subsequently testing these hypotheses in new situations (Mayer, 2005). The student first learns the steps of how to solve a particular type of problem in the tutorial and then applies that knowledge while solving similar problems without any scaffolds. At every stage the tutorial prototype incorporates feedback given through a multimedia agent in the form of

‘happy’ or ‘sad’ boy. The sad faced boy also gives hints which a student can use to get a correct answer.

9. The Worked-Out Examples Principle: People gain a deeper understanding when they receive worked-out examples in initial cognitive skill acquisition (Sweller, 2004, 2005). Worked examples can be expected to reduce extraneous cognitive load by acting as an instructional central executive and so reducing the load on working memory; leaving more working memory capacity to acquire knowledge to store in long-term memory. Series of examples with successively faded worked-out examples should be employed in order to structure the transition from example study to problem solving in later phases of skill acquisition (Renkl, Atkinson, & Grosse, 2004). Throughout the tutorial, one can see the use of worked out examples. Tutorial first teaches the concepts in a broader topic, then introduces the types of problems related to the topic and then teaches how to solve those problems using step by step instructions for the first example and then gradually removing the scaffolds.
10. Animation and Interactivity Principle: Animated models are in line with the current focus on lifelong learning and flexibility in task performance that increasingly emphasize the modeling of cognitive skills, such as problem solving and reasoning in a variety of domains. This enables learners not only to observe how a problem is solved, but also why a particular method is chosen. Computer-based animations with verbal explanations are increasingly used to explicate the covert processes in cognitive modeling and seem to be in particular successful in learning abstract concepts and processes. Computer-based characters support learners with verbal feedback and guidance in order to engage them in more active learning (Wouters, Paas, & van Merriënboer, 2009). Apart from the use of the most basic form of animated characters; a happy faced boy gives positive feedback for the correct answer and a

sad faced boy gives a message that the answer is wrong; this prototype uses animations and interactivity opportunities throughout the tutorial.

Chapter Three

Methods

Problem.

Public policy governing the education of children and youth in the United States continues to evolve. Public Law 94.142 the *Education for All Handicapped Children Act* passed in 1975 set forth the principle of a Free and Appropriate Public Education (FAPE). The mandates of this law were supported by due process procedures. More recently public policy has shifted toward placing greater accountability on schools to increase access to the general education curriculum. No Child Left Behind (NCLB, 2001) and the Individuals with Disabilities Education Act (IDEA, 2004) have been central to changing public policy in how the educational needs of students with disabilities are met. A significant aspect of this legislation relates to the movement in general education towards a standards based curriculum with progress measured by state assessments. In measuring Adequate Yearly Progress (AYP) districts must demonstrate continuous growth by all students. Increased access to standards based curriculum and high expectations are supported by the RTTT authorized under sections 14005 and 14006 of ARRA (2009), which addresses four reforms including enhancing standards and assessments. Central to this reform is the creation of a Common Core of standards.

Despite changes in public policies such as NCLB, IDEA and RTTT the achievement gap between the mathematics performance of students with disabilities and their non-disabled peers continues (Wiley, Thurlow, & Klein, 2005).

The eLearning Design Lab (eDL) has been developing and researching lessons and online tutorials that are aligned with NCTM standards in mathematics. During the last two years of

field-testing 5700 students with IEPs have been included among the students completing tutorials in grades 3 through high school. Each tutorial includes four embedded assessments. Students with IEPs earned a mean score of 2.23 and students without IEPs earned a mean score of 2.61. While the performance of students IEPs was considered as good performance it was learned that the reading difficulty of content on the tutorials may be hampering the performance of students with disabilities. As a result of these findings the eDL has designed a tutorial model with reduced cognitive load and increased mediation. The intent was to meet the requirements of the multimedia instructional principles outlined by Mayer in *'Principles of Multimedia Learning'* (2005) as being essential to learning by students with learning disabilities. The model prototype had been through internal alpha testing prior to this research.

This study was designed to engage subject matter experts, special education teachers, and technology/multimedia experts in reviewing the alignment of tutorial content with the specified standard, appropriateness of instruction and effectiveness of the animations and graphics. The online tutorial prototype was aligned with a fourth grade math standard.

Research questions.

The research questions focus on the first stage of evaluating the design, structure, and textual features of a prototype online tutorial designed for students with learning disabilities. Specifically, the study investigated the following research questions:

1. Are the skills and concepts in mathematics aligned with the intent of the standard and indicator on which the tutorial is aligned?
2. Do the multimedia features, including graphics and animations employed in the presentation of content enhance learning?

3. Do the multimedia features, including graphics, animations, and interactivity accommodate the learning attributes of students with learning disabilities?
4. Is the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
5. Is the tutorial model consistent with the multimedia principles outlined by Meyer?

Participants.

The objective of this study was to obtain feedback as part of the formative evaluation process in the design of an online tutorial designed for students with learning disabilities. A purposeful sampling process was used. Three groups of individuals were invited to participate in the study; they were subject matter experts in mathematics (SMEs), special education teachers, and multimedia/technology experts. Participants within each group were selected based on their expertise and experience. A total of seventeen individuals were invited to participate in the study - three SMEs, 10 special education teachers, and four multimedia/technology experts. Out of the 17 invitations, 10 individuals agreed to participate. They included - three SMEs, four special education teachers, and three multimedia/technology experts.

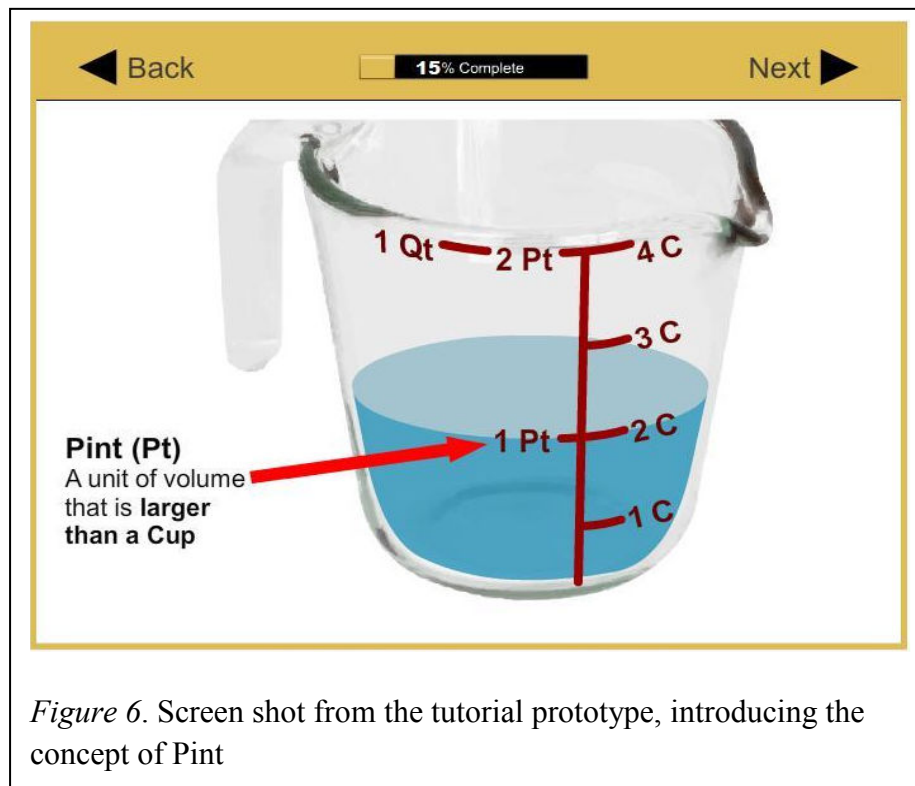
Tutorial prototype design.

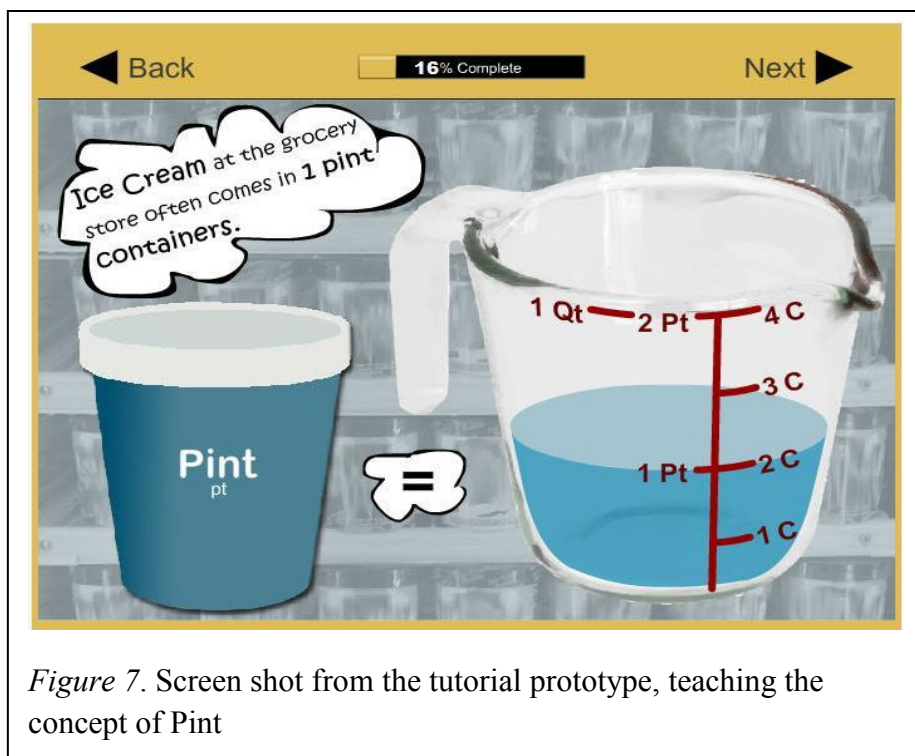
Curriculum standards are typically broken down into instructional sub sets such as indicators. The tutorial was aligned with the following 4th grade geometry indicator:

The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure volume to the nearest cup, pint, quart, or gallon.

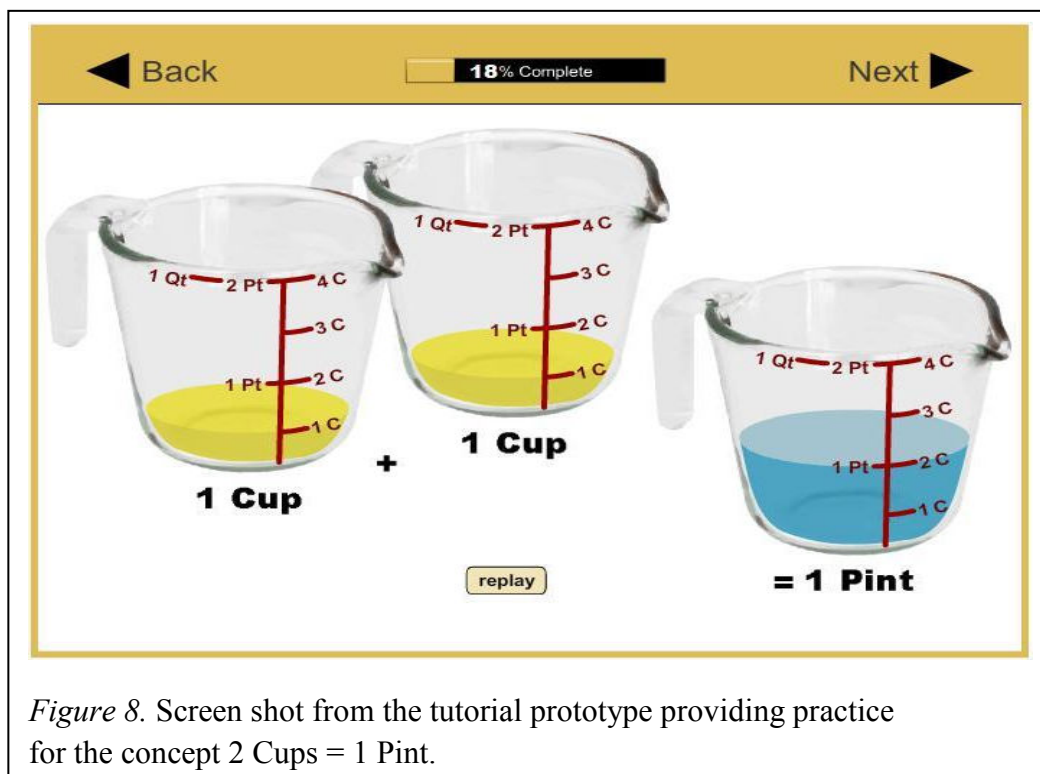
The indicator for the tutorial was selected on the basis of the mathematic concept being taught through the employment of animated multimedia features within an online tutorial format. The concept allowed for meeting the eight out of 10 multi-media instructional principles outlined by Mayer in *'Principles of Multimedia Learning'* (2005).

The tutorial was designed to reduce cognitive load through a reduction in the reading requirements while keeping the mathematics instruction aligned with the indicator. The prototype was multimedia anchored with an emphasis on graphics, animation, and interactivity. The tutorial followed a pattern, where one mathematic concept was introduced and taught through the use of virtual online manipulative objects, graphics, and animations (see Figures 6 and 7).





This was followed by practice questions for the concept, with the help of graphics, animations and online virtual manipulation. (see Figures 8 and 9).



← Back 20% Complete

A pint of ice cream equals ____ cup(s). check answer

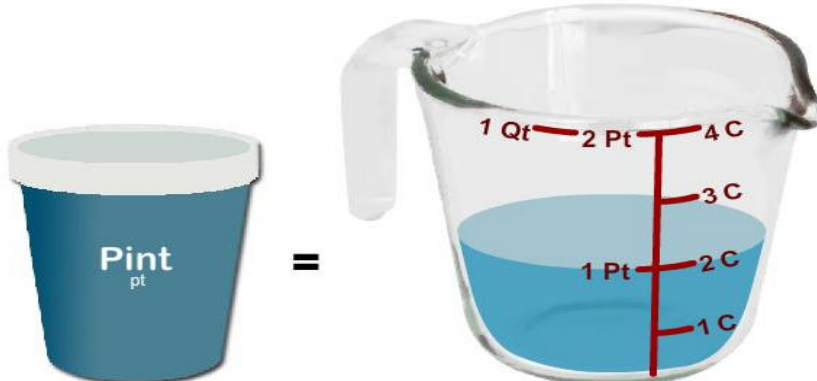



Figure 9. Screen shot from the tutorial prototype providing practice questions based on the taught concept of pint

This format continued throughout the online tutorial. The tutorial ended with word problems that students would be required to solve by applying what they have learned through the tutorial (see Figure 10).

← Back 96% Complete

Planning a Party

Aaron is planning to have a party for 14 of his friends. He thinks that each friend will drink one cup of juice. He has 1 gallon of juice. Does he have enough juice for each of his friends?



Lets convert Aaron's gallon to cups to see if he has enough juice for his friends:

1 gallon = _____ quarts check answer

Figure 10. Screen shot from the tutorial prototype showing the word problem based on the concepts thought through the tutorial.

Instrument design.

Three different instruments were used in the study (See Appendix C, D, and E for each instrument). The instrument for special education teachers consisted of 20 questions. The instrument for SMEs and multimedia/technology experts consisted of 15 questions. Sixty percent of the questions were common across the three instruments. The remaining questions were unique to the expertise respective participant groups. The instrument for special education teachers focused on questions designed to determine if the content, reading level, and navigation of the tutorial were suitable for students with learning disabilities. The instrument for SMEs focused on questions that targeted the relationship of the math content to the grade level standard. The instrument for the technology/multi-media experts targeted the quality and functionality technical features of the tutorial, such as speed of animations, color compatibility, navigation, and interactivity.

Instrument format.

Each screen of the tutorial was designed in a format that allowed the participant to view and interact with the tutorial on the left half of the monitor screen and the instrument questions on the right half of the screen. This allowed participants to interact with the tutorial directly while reviewing the questions. Instrument questions were synchronized to the active portion of the tutorial that the participant was viewing (see Figure. 11).

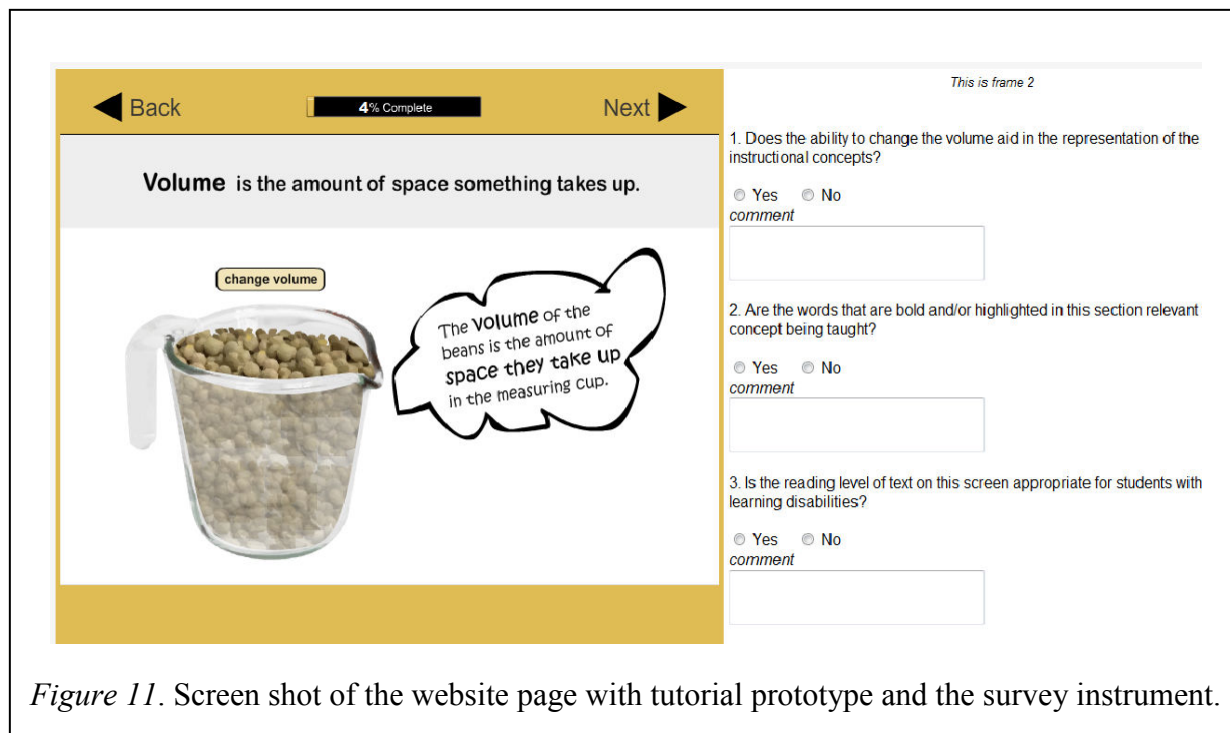


Figure 11. Screen shot of the website page with tutorial prototype and the survey instrument.

Participants were able to move forward and backward within the tutorial using the ‘Back’ and ‘Next’ buttons, this was the same navigation that the students would use if they were completing the tutorial. Participants recorded their responses online.

All questions were in a ‘yes’ or ‘no’ format with a provision for entering a comment for elaboration. Participants were able to complete their responses at their own pace. They were also able to review the tutorial and complete their responses over multiple sessions, with their responses saved between sessions.

Data collection.

Emails were sent to the 17 participants explaining the study and asking each individual if he/she would be willing to participate in the study. Once confirmation was received an email was sent to the participants directing them to a website. Each participant was sent a different URL to insure that each participant would receive the correct instrument. Participants were asked to read

an Informed Consent Agreement online and enter their name and the date on the consent agreement (see Appendix A for the copy of the online consent). Once this was completed they were provided directions for completing a short series of demographic questions (see Appendix B for the list of demographic questions for each group of participants). Participants were then prompted to read the standard, benchmark, and indicator that the tutorial was designed to teach. By clicking a “continue” button at the end of the page the tutorial appeared on the monitor screen.

Data analysis procedures.

As the participants progressed through the tutorial, their responses were collected through the software designed for the study. Once all of the participants completed their responses, three separate data sets, one for subject matter experts, one for special education teachers, and one for multi-media and technology experts, were exported into an excel file. The excel file was then formatted and uploaded to an SPSS program and frequency analyses were completed on the quantitative data. Frequency tables were generated using the descriptive statistics function in SPSS. Each instrument was analyzed separately for the three groups (SMEs, special education teachers and multimedia/technology experts). Questions common across each group were analyzed separately to determine how each question was interpreted for different screens by the respective participant groups.

Questions on each instrument were then grouped based on 8 of the 10 multi-media principles reported by Mayer (2005) in *Principles of Multimedia Learning*. The 8 principles included animation and interactivity, split-attention, redundancy, personalization, worked-out

examples, guided discovery – immediate feedback, pre-training, and segmenting). Frequency tables were generated for each principle.

The instruments were designed to elicit constructive input from SMEs, special education teachers, and multimedia/technology experts through comment fields incorporated within the instrument. The qualitative data provided by the participants' through comments was analyzed to identify similar responses given by all three group of participants.

Nine criteria were developed by the eDL development team to guide the decision making process for determining the priority for making modifications in the tutorial design based on the comments (see Figure 12 for all nine criteria). The intent was to develop a formative map based on the elements of the prototype design that potentially could be the focus of feedback. The map took the form of specific criteria in a hierarchy with the number one criteria requiring the most development effort and/or resources to modify or create.

Formative Mapping Feedback Criteria

1. Add new features: (e.g. audio/calculator/navigation)
2. Graphic changes/suggestions: (e.g., design, color, number, match with content etc)
3. Delete or modify content: (add, delete, or content that needs to be in audio but not readable on screen)
4. Additional practice: (additional practice by learner in manipulations or carrying out a task)
5. Relevance to disabilities: (addition of best practices known to be effective with the task being taught by a specific screen.)
6. Technical changes: (problems with sound quality or control-problems Associated with programming or navigation options.)
7. Interactivity and animation changes: (add or delete interactivity and/or animations, issues with speed, and issues with display of content)
8. Feedback to learner: (add, delete, or modify in any manner)
9. Other: (Comments that do not fit any of the criteria or pertain to the overall prototype tutorial.)

Figure 12. Nine criteria developed by the eDL development team to guide the decision making process for determining the priority for making modifications in the tutorial design based on the comments given by all the participants.

Three jurors, with development and design experience, were selected to analyze the participants' comments based on the formative mapping criteria. Each juror was given a copy of the instrument, the participants' comments, and the coding criteria. The nine coding criteria were explained to the jurors. Jurors were then asked to individually code the comments using the nine criteria. Jurors independently applied the criteria. The results were then compiled by the researcher and provided to the three jurors. The jurors then met a second time to discuss the discrepancies in their ratings. After reaching consensus on the meaning of each criterion on which there was a discrepancy in the first application they repeated the process of applying the criteria to the comments on which they varied the first time.

Formative report.

A report was prepared for the use of the eDL staff in modifying the prototype tutorial for field testing with students identified with learning disabilities. The formative nature of the report involves the organization of results around three themes i.e., the research questions, the multimedia principles and the formative map. The goal is to identify and validate needed modifications and to facilitate the prioritization of needed changes. Prioritization combines importance and required resources to make the modification. Those items receiving the highest priority in the formative mapping process will be the first to be implemented in the development process.

Chapter Four

Results

This study was designed in response to research findings gathered during two years of field testing the Blending Assessment with Instruction Program (BAIP) tutorial model in mathematics. The BAIP tutorial model was developed by the eLearning Design Lab (eDL) in collaboration with the Center for Educational Testing and Evaluation (CETE) at the University of Kansas. This study evaluated a new multimedia instructional tutorial prototype in mathematics designed for students with learning disabilities. The prototype was aligned with a 4th grade geometry standard and designed to reduce the cognitive load for the learner. It addressed this standard through animations, interactive exercises, and reducing the reading requirements. In addition the tutorial was designed to provide students immediate feedback and instructional support. The purpose of the study was to conduct a formative assessment of the design, structure, compliance with multimedia principles, and appropriateness for students with learning disabilities. Through this study needed modifications in the tutorial were identified. A second study will be conducted to determine the effectiveness of the tutorial design in authentic settings with students.

Participants.

Three groups of participants were selected to participate. They included, subject matter experts (SMEs), special education teachers, and multimedia/technology experts. 10 of 17 invitees agreed to participate (see Table 1).

Table 1

Number of Participants Within Each Subgroup

Subgroups	No. of Participants
Subject Matter Experts (SMEs)	3
Special Education Teachers	4
Multimedia /Technology Experts	3
Total	10

Participants were asked to provide demographic information regarding their teaching experience. Each participant was asked their experience in teaching mathematics in a regular classroom as well as in teaching mathematics to students with disabilities. One of the three SMEs had over 21 years of teaching experience in the regular classroom for grades two through high-school. The other two SMEs had taught mathematics in a regular middle-school and high-school classroom for over 16 years. Two of the special education teachers have been teaching mathematics in an inclusive elementary classroom as well as in resource room for over 9 years. The other two special education teachers have an average of 11 years of experience in teaching mathematics in elementary and middle school. The three participants in the multimedia /technology expert group, have used technology as a tool for instructional purposes for over 6 years.

Research questions.

Research question 1. Are the skills and concepts in mathematics aligned with the intent of the standard and indicator on which the tutorial is aligned?

To determine if the skills and concepts in the tutorial aligned with the 4th grade geometry standard and indicator SMEs, special education teachers, and multimedia/technology experts were presented the following information defining the standard, benchmark, and indicator:

Standard: Geometry – The student uses geometric concepts and procedures in a variety of situations.

Benchmark: Measurement and Estimation – The student measures using standard units of measure including the use of concrete objects in a variety of situations.

Indicator: The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure - volume to the nearest cup, pint, quart, or gallon;

They were then asked if the instruction provided through the tutorial was aligned with this 4th grade geometry standard and indicator.

Three SMEs were presented the alignment question. This resulted in three responses by the SMEs including two ‘Yes’ responses, zero ‘No’ responses, and one non response. Four special education teachers were presented the alignment question resulting in 4 responses. Three of the responses to the alignment question were ‘Yes’ and one was ‘No’. None of the respondents provided comments regarding their ‘yes’ or ‘no’ choice for the alignment question.

Research question 2. Do the multimedia features, including graphics, animations, and interactivity employed in the presentation of content enhance learning?

To determine if the multimedia features, including graphics, animations, and interactivity employed in the presentation of content enhance instruction, SMEs and special education

teachers were asked four questions throughout the tutorial, multimedia/technology experts were asked five questions on each screen where the content presentation was appropriate. In Table 2 the first four questions listed were presented to SMEs, special education teachers, and multimedia/technology experts on each screen where the content presentation was appropriate. The responses of the three SMEs on the four items resulted in 78 responses including 55 'Yes' responses, 18 'No' responses, and five non responses. The responses of the four special education teachers on the four items resulted in 92 responses by special education teachers, including 73 'Yes' responses, 16 'No' responses, and three non responses. The responses of the three multimedia/technology experts on the four questions resulted in 36 responses including 26 'Yes' responses, eight 'No' responses and two non responses. Question 5 in Table 2 was presented only to multimedia/technology experts on each screen where the content presentation was appropriate. The responses of the multimedia/technology experts on the fifth question resulted in nine responses including five 'Yes' responses, one 'No' response, and two non responses (see Table 2 for responses by SMEs, special education teachers and multimedia/technology experts).

Table 2

Frequency Counts for Questions Regarding Multimedia Features Given by SMEs, Special Education Teachers, and Multimedia/Technology Experts

Question	SMEs					Special Education Teacher					Multimedia/ technology Experts				
	n	TQ	Y	N	NR	n	TQ	Y	N	NR	n	TQ	Y	N	NR
1. Does the ability to change the volume aid in the representation of the instructional concepts?	3	1	3	0	0	4	1	4	0	0	3	1	3	0	0
2. Does the ability to change the unit aid in the representation of the instructional concepts?	3	1	3	0	0	4	1	4	0	0	3	1	2	1	0
3. Does this screen provide enough opportunity for manipulation to enhance learning?	3	15	29	14	2	4	15	46	12	2	3	4	8	4	0
4. Do the graphics and animations on this screen facilitate learning?	3	9	20	4	3	4	6	19	4	1	3	6	13	3	2

5. Do the animations function at the correct speed?	3	3	5	1	2
---	---	---	---	---	---

Note. TQ= Total number of questions throughout the survey; Y= Yes; N= No; NR= No Response

In addition to the yes/no questions, each participant group was provided an opportunity to submit comments clarifying their responses to questions presented within each frame. Subject matter experts provided 32 comments/suggestions regarding the multimedia features within the tutorial. Several of the comments addressed the speed of the animations, some provided suggestions regarding changes to graphics, and a few provided suggestions towards the end of the tutorial regarding changes to the organization of the content to provide clarity for students with disabilities (see Table 3 for the comments given by SMEs).

Table 3

Comments on Multimedia Features Given by SMEs

Question	Comments
1. Does the ability to change the volume aid in the representation of the instructional concepts?	<p>Frame 2 Consider changing emphasis to show volume as main concept. Reduce level of importance on sizes. Match colors with cup, pint, quart, gallon images.</p>
2. Does the ability to change the unit aid in the representation of the instructional concepts?	<p>Frame 3 Change describe to measure</p>
3. Does this screen provide enough opportunity for manipulation to enhance learning?	<p>Frame 2 It doesn't provide any. It is an introduction to the lesson.</p> <p>Would help if students could both fill and empty.</p> <p>Frame 3 No manipulation provided</p> <p>The container looks too much like a cup measuring tool. Make the container less like an actual measuring tool, more like just a cylinder.</p> <p>Frame 21 Maybe also show gallon filling up the 4 quarts.</p> <p>Frame 28 Why have the number of quarts indicated on the gallon when you are asking the number of quarts in a gallon?</p> <p>Frame 30 Could you have students do the grouping and moving?</p> <p>Frame 37 A second practice example may be appropriate</p>

I like screen 37 allowing conversion both ways. I don't think I agree with the statement "conversion allows you to change units as long as what you take away equals what you add." You aren't really taking away or adding and I think this leads to misconceptions. It is an exchange, just like 2 nickels for a dime.

Frame 38

Consider stopping at each step.
Manipulation is possibly too fast for the student to connect.

Frame 40

Kids may get impatient waiting for the dragged object to show up below before they can drag another object. I did.

Frame 41

Animations were possibly too fast for some learners

Would be nice to be able to reverse the conversion also

Frame 47

Better than the last example. The previous was more abstract.

Same concern about kids getting impatient while waiting to drag the next object.

Frame 46

It might be helpful to allow student to convert between units and count each time.

Frame 47

Could possibly identify counting as essential before conversion and then counting again after the conversion.

Frame 48

Could have more examples or more possible answers at the end of the exercise to choose from.

4. Do the graphics and animations on this screen facilitate learning?

May be have the visual rep of each gallon, quart, etc

Frame 4

Consider making all lines yellow in color.

Nothing definite to say the dots are representing cups. Maybe group each measurement dots to represent the 2 cups in a pint and 2 pints make a quart and so on.

Frame 6

The carton looks bigger than the measuring cup.

Frame 8

The carton looks bigger than the measuring cup.

Frame 18

Maybe have the gallon can earlier to convey that the gallon container can have multiple shapes. Consider a more familiar larger measuring cup or a milk.

Frame 38

Too fast

Possibly slow speed or give student the opportunity to progress through each step.

Frame 44

The animations were not natural and led misunderstanding.

Minimally

The concept was confusing. Counting was demonstrated, but the organization or process was not natural.

They don't match what I did on frame 43 and that's a bit confusing. Why not count something I've worked with before?

Special education teachers provided 36 comments/suggestions regarding the multimedia features. Several of the comments, suggested additional practice opportunities within the tutorial. In addition, they suggested a number of changes to graphics and animations. Some individuals suggested to accent some of the features within the tutorial for students with disabilities (see Table 4 for comments by special education teachers)

Table 4

Comments on Multimedia Features Given by Special Education Teachers

Question	Comments
1. Does the ability to change the volume aid in the representation of the instructional concepts?	<p data-bbox="824 417 932 449">Frame 2</p> <p data-bbox="824 455 1312 527">It was nice to see that volume was not restricted to the full cup</p> <p data-bbox="824 558 1435 627">If possible, having a 3rd volume would be even better!</p> <p data-bbox="824 661 1435 772">Because it shows the student the cup filling up. So those students with a language delay could visually see the space being taken up.</p>
2. Does the ability to change the unit aid in the representation of the instructional concepts?	<p data-bbox="824 806 932 837">Frame 3</p> <p data-bbox="824 844 1300 915">Once again the opportunity to see the definition displayed is critical</p> <p data-bbox="824 947 1409 1058">It serves as a visual aid for students. It would be beneficial to all, especially those with a language delay.</p> <p data-bbox="824 1089 1435 1192">Why is the text in the text-bubble slanted? For children with visual issues it might be better to have it level</p>
3. Does this screen provide enough opportunity for manipulation to enhance learning?	<p data-bbox="824 1226 943 1257">Frame 21</p> <p data-bbox="824 1264 1398 1375">It would be more engaging for students to be able to drag and click the quarts to fill up the gallon- more interactive</p> <p data-bbox="824 1407 948 1438">Frame 28</p> <p data-bbox="824 1444 1386 1516">It just depends.... Some will need more than this.</p> <p data-bbox="824 1547 1409 1659">My first attempt at ordering the units only required one move to place them in sequence, multiple tries might be encouraged.</p> <p data-bbox="824 1690 948 1722">Frame 30</p> <p data-bbox="824 1728 1373 1839">Should include multiple volume options or attempts. When I replayed the screen it presented the exact same volume.</p> <p data-bbox="824 1871 948 1902">Frame 37</p>

I like that the user can convert back and forth.

Frame 39

Need additional practice and examples where the answer is not always 4

Frame 40

Does not allow the student to try and convert more than necessary - also the example does not involve converting to gallons nor are additional practice items presented

Frame 42

Restricted to one example

Although, more practice would be super too!

Frame 46

Great practice with multiple opportunities

Frame 47

First sequence cards were already in order

Frame 48

I think there is a possibility that some kids with LD would lose track of the conversions here...there are many steps (multiplication problems) that he/she would need to complete.

Might be nice to have a place where students can manipulate the individual cups, pints, etc in case they can't multiply in their head

Frame 49

IDK-I have the same concern here...that some kids with LD may lose track of what they are doing.

Need something to help with the multiplication

4. Do the graphics and animations on this screen facilitate learning?

Frame 4

It visually shows the difference to the students and allows them to easily see

The writing on the objects needs to be larger so it can be read

The equivalency of units is great and critical!

Frame 6

No real animations on this page. can the milk carton be poured into the cup measure?

Provides the students with a common reference

The milk carton is something that most students are familiar with, therefore, it gives them background knowledge.

With change of coloration

There is no animation on this screen, but the previous screen was good

Frame 8

but the inability to replay the animations limits it to a learning that occurred in the past or based on memory

Depends on the level of the student

As long as the students can move back and forth between screens

Frame 12

Wish the quart container would fill the measuring cup

Frame 18

Milk gallons are common knowledge too.

Would like the paint to pour into the gallon container

Frame 30

First time I have heard any noise. I think having things read to the students would help as well, or at least having the option.

Multimedia/technology experts provided 18 comments/suggestions specific to individual frames. Several of the comments addressed the need for changes in graphics, additional opportunities for manipulation of the content, and suggestions regarding the speed of the animations (see Table 5 for the comments by multimedia/technology experts).

Table 5

Comments on Multimedia Features Given by Multimedia/Technology Experts

Question	Comments
1. Does the ability to change the volume aid in the representation of the instructional concepts?	<p>Frame 2</p> <p>Although I wonder if some basic measurement markings on the cup would also assist with this visual</p>
2. Does the ability to change the unit aid in the representation of the instructional concepts?	<p>Frame 3</p> <p>It would be better to explicitly show XX cups, YY quarts, and ZZ pints.</p> <p>While this is helpful to be able to change units- I already have a mental model of this image as a measuring cup. In this example- using a gallon container would better represent this concept so the units match this visual model of volume.</p>
3. Does this screen provide enough opportunity for manipulation to enhance learning?	<p>Frame 30</p> <p>Should allow user to manipulate independently</p> <p>Once showing how to find total volume, students should be given an opportunity to try it out by themselves.</p> <p>Frame 37</p> <p>More manipulation with being able to convert is needed</p> <p>Frame 40</p> <p>Students will probably try to put cups into the Gallons converters, which is not supported by the current tutorial.</p> <p>Frame 43</p> <p>This was good practice, but I missed the question and couldn't move forward until I made all the conversions. I think the question needs to be spelled out more. Also, when moving the cups around too quickly, I ended up in a loop where the light bulb kept dinging.</p> <p>When students got stuck, they may not know</p>

4. Do the graphics and animations on this screen facilitate learning?

what to do. In that case, the tutorial should provide some guidance to the students.

Frame 4

Some students may not understand what the squares mean. More description about the square needed. Or more explicit examples, 2 cups of water need to fill up one pint, etc., might work better than using number of squares.

Although the animation is not totally necessary

Measuring devices need to be differentiated visually.

I think the animation and the questions may confuse some students about what the question is looking for. Asking "How many cups can we convert into pints?" The answer can be 4 and 6 since the graphics in pints has three of them. I think that the questions and the graphics do not match with each other.

I think somehow the directions on Cups is not convert from Pints to Cup but going back to the previous direction (cup to pint)

something wrong with the background sound.

5. Do the animations function at the correct speed?

Frame 44

A little too fast

Wrap-up Question 1

But, the user may want to have more control of the animation and sound, which is not allowed.

I think the animation speed for all of them run at a good speed. The chance for replay is provided, so students can review it at anytime

Note: All comments are reported as recorded by respondents.

Research question 3. Do the multimedia features, including graphics, animations, and interactivity accommodate the learning attributes of students with learning disabilities?

To determine if the multimedia features, including graphics, animation, and interactivity accommodate the learning attributes of students with learning disabilities, special education teachers were presented three questions when the frame content was relevant to students with learning disabilities. The responses of the four special education teachers resulted in 95 responses including 85 ‘Yes’ responses, seven ‘No’ responses, and three non responses (see Table 6 for responses by special education teachers).

Table 6

Frequency Counts for Questions Regarding Multimedia Features for Students with Learning Disabilities Given by Special Education Teachers

	Special education teachers				
	n	TQ	Y	N	NR
1. Do the animations and interactions accommodate the needs of students with learning disabilities?	4	10	32	6	1
2. Is the tutorial content appropriate for 4 th grade student with learning disability?	4	7	26	1	1
3. Is the reading level of the text appropriate for students with learning disability?	4	7	27	0	1

Note. TQ= Total number of questions throughout the survey; Y= Yes; N= No; NR= No Response

In addition to the yes/no questions, special education teachers provided 15 comments/suggestions regarding the relevance of multimedia features within the tutorial for students with learning disabilities. Several suggested that additional practice opportunities should be added throughout the tutorial. They also suggested changes to graphics to make concepts

clearer and suggested adding a calculator and e-reader for students with disabilities (see Table 7 for the comments given by special education teachers).

Table 7

Comments on Multimedia Features for Students with Learning Disabilities Given by Special Education Teachers

Question	Comments
1. Do the animations and interactions accommodate the needs of students with learning disabilities?	<p>Frame 4 For these animations, it is not clear what the intent of the page is (relationship between the different units or the fact each holds a different volume - which by the way is lost because the volume is represented linearly rather than within each container.</p> <p>Without knowing the nature of the learning disability, I would say yes.</p> <p>Frame 15 Need to stress the pint as the half way point to a quart or else it would be lost.</p> <p>Frame 28 However, I think having the t/f quiz at the end of the practice would be best, or even having it again at the end to review would be good. I had trouble the first time around!!!</p> <p>Frame 30 I like this!!</p> <p>They do, but may have to be repeated several times.</p> <p>Frame 37 You should be able know that you can reverse the conversion also</p> <p>Frame 39 No opportunity for additional practice here</p>

	Frame 42 It is confusing to show 3 pints when you want the answer to be 2
2. Is the tutorial content appropriate for 4 th grade student with learning disability?	Frame 28 But I think it may take more time for a 4th grader with a LD to master this. The visuals really help! Frame 42 At some points I think a calculator or a conversion chart would be helpful to those students with severe learning disabilities Frame 44 But once again the sounds might be highly annoying
3. Is the reading level of the text appropriate for students with learning disability?	Frame 2 The one concern I might have is that students might miss the critical thought that it is that volume is the space the BEANS take up in the cup. Frame 3 While the words are at the right reading level the concept is rather abstract - can voice over be added so students can hear the statement as well as read it? I even had to read it twice to be sure I knew exactly what was being talked about.

Note: All comments are reported as recorded by respondents.

At the end of the instrument, multimedia/technology experts were asked two questions regarding the strengths and weaknesses of the tutorial model in meeting the needs of students with learning disabilities. Most of the comments supported the simplicity and clarity of the graphics. However, changes in several graphics were suggested to add consistency throughout the tutorial. In addition multimedia/technology experts suggested adding an audio feature (see Table 8 for multimedia/technology experts' comments).

Table 8

Strengths and Weaknesses of the Tutorial Model given by Multimedia/Technology Experts

Question	Comments
1. What do you consider to be the strengths of this tutorial model for the students with learning disabilities?	Visual simplicity, use of common examples The simplicity and clarity of graphics. All graphics use only elements that is necessary. The simplicity of navigation. Linear and straightforward.
2. What do you consider to be the weaknesses of this tutorial model for the students with learning disabilities?	Miss use of measuring cup for multiple units of measurement. Need to establish consistent visuals at the beginning and stay consistent throughout the tutorial. All of the content is presented without sound at all. Thus, students need to read and understand from what is available to them. In certain activities such as questions and drag and drop interaction, there are a lot of information to be processes since the content focus on several concepts together. For example, on one of the conversion, students are seeing cups, pints, quarts, and gallon at the same time and they need to process all of the concepts together to answer the question. For normal students, I think it is ok, for students with learning disabilities, each question may be divided into smaller units.

Note: All comments are reported as recorded by respondents.

Research question 4. Is the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

To determine if the tutorial is functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended, special education teachers and multimedia/technology experts were asked to respond to one question. This question resulted in 44 responses by special education teachers including 39 ‘Yes’ responses,

four ‘No’ responses, and one non response. Three multimedia/technology experts were presented the same question resulting in 25 responses including 12 ‘Yes’ responses, five ‘No’ responses, and eight non responses (see Table 9 for responses by special education teachers and multimedia/technology experts).

Table 9

Frequency Counts on Questions regarding Functional Reliability for Students with Learning Disabilities Given by Special Education Teachers and Multimedia/Technology Experts

	Special education teachers					Multimedia/technology experts				
	n	TQ	Y	N	NR	n	TQ	Y	N	NR
Is the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?	4	11	39	4	1	3	8	12	5	8

Note. TQ= Total number of questions throughout the survey; Y= Yes; N= No; NR= No Response

Special education teachers provided five comments regarding functional reliability of the tutorial for students with learning disabilities. They suggested adding audio. They also commented that although visuals were helpful, there needed to be more practice opportunities within the tutorial for students with learning disabilities to master the concept.

The majority of the responses by the multimedia/technology experts suggested the need to have keyboard navigation in addition to the mouse (see Table 10 for comments by special education teachers and technology/multimedia experts).

Table 10

Comments on Functional Reliability for Students with Learning Disabilities Given by Special Education Teachers and Multimedia/Technology Experts

Question	Special education teachers' comments	Multimedia/technology experts' comments
1. Is the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?	<p>Frame 28 But I think it may take more time for a 4th grader with a LD to master this.</p> <p>The visuals really help!</p> <p>Frame 39 But I do think it may be hard for some students to keep that conversion information in their short term memory.</p> <p>Frame 40 This just allows them to practice it correctly no opportunity for error or thinking</p> <p>Frame 48 The question should be read to the student</p>	<p>Frame 10 Although need to be able to move forward and backwards using the keyboard without a mouse for greater accessibility</p> <p>If the students do not need any help using a mouse. If not, alternative navigation such as keyboard may be needed. (Adding shortcut key into the programming is one way to achieve this. Normal people do not need to see this but those who want to use the keyboard can use the navigation.)</p> <p>Frame 39 I think the animation and the questions may confuse some students about what the question is looking for. Asking "How many cups can we convert into pints?" The answer can be 4 and 6 since the graphics in pints has three of them. I think what I feel is that the questions and the graphics are somewhat not match with each other well enough.</p> <p>Frame 42 Too many questions on this page, when going from larger to smaller, asking "How many ____ is unnecessary</p>

Frame 47

Too many words on the page,
should also have graphical re-
enforcement

If the students do not have
difficulties when using a
mouse pointer.

Note: All comments are reported as recorded by respondents.

Research question 5. Is the tutorial model consistent with the multimedia principles outlined by Mayer?

To determine if the tutorial model is consistent with the multimedia principles outlined by Mayer, questions were asked regarding eight principles- Animation and Interactivity, Split Attention, Redundancy, Personalization, Worked-out Examples, Guided Discovery-Immediate Feedback, Pre-training, and Segmenting.

The responses of the three SMEs resulted in 84 responses to questions relating to the Animation and Interactivity principle including 60 'Yes' responses, 19 'No' responses and five non responses. The responses of the four special education teachers resulted in 92 responses to questions relating to the Animation and Interactivity principle including 73 'Yes' responses, 16 'No' responses and three non responses. The responses of the three multimedia/technology experts resulted in 45 responses to questions relating to the Animation and Interactivity principle including 32 'Yes' responses, nine 'No' responses and four non responses. The total number of responses for all three groups of participants were 221. Out of these responses, 165 were 'Yes' responses, 44 were 'No' responses and 12 were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in 48 responses to questions relating to the Split Attention principle including 44 'Yes' responses, one 'No' response and three non responses. The responses of the four special education teachers resulted in 24 responses to questions relating to the Split Attention principle including 20 'Yes' responses, three 'No' responses and one non response. The responses of the three multimedia/technology experts resulted in 26 responses to questions relating to the Split Attention principle including 20 'Yes' responses, three 'No' responses and three non responses. The total number of responses for all three groups of participants were 98. Out of these responses, 84 were 'Yes responses, seven were 'No' responses and seven were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in 48 responses to questions relating to the Redundancy principle including 44 'Yes' responses, one 'No' response and three non responses. The responses of the four special education teachers resulted in 24 responses to questions relating to the Redundancy principle including 20 'Yes' responses, three 'No' responses and one non response. The responses of the three multimedia/technology experts resulted in 26 responses to questions relating to the Redundancy principle including 20 'Yes' responses, three 'No' responses and three non responses. The total number of responses for all three groups of participants were 98. Out of these responses, 84 were 'Yes responses, seven were 'No' responses and seven were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in 18 responses to questions relating to the Personalization principle including 14 'Yes' responses, two 'No' response and two non responses. The responses of the four special education teachers resulted in 16 responses to

questions relating to the Personalization principle including 13 ‘Yes’ responses, three ‘No’ responses and zero non responses. The responses of the three multimedia/technology experts resulted in 12 responses to questions relating to the Personalization principle including 10 ‘Yes’ responses, two ‘No’ responses and zero non responses. The total number of responses for all three groups of participants were 46. Out of these responses, 37 were ‘Yes responses, seven were ‘No’ responses and two were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in nine responses to questions relating to the Worked-out Examples principle including eight ‘Yes’ responses, zero ‘No’ response and one non response. The responses of the four special education teachers resulted in 12 responses to questions relating to the Worked-out Examples principle including 11 ‘Yes’ responses, one ‘No’ responses and zero non responses. The responses of the three multimedia/technology experts resulted in nine responses to questions relating to the Worked-out Examples principle including nine ‘Yes’ responses, zero ‘No’ responses and zero non responses. The total number of responses for all three groups of participants were 30. Out of these responses, 28 were ‘Yes responses, one was ‘No’ response, and one was a non response (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in 39 responses to questions relating to the Guided Discovery-Immediate Feedback principle including 32 ‘Yes’ responses, five ‘No’ response and two non responses. The responses of the four special education teachers resulted in 48 responses to questions relating to the Guided Discovery-Immediate Feedback principle including 41 ‘Yes’ responses, four ‘No’ responses and three non responses. The responses of the three multimedia/technology experts resulted in 36 responses to questions relating to the Guided

Discovery-Immediate Feedback principle including 27 'Yes' responses, three 'No' responses and six non responses. The total number of responses for all three groups of participants were 143. Out of these responses 100 were 'Yes responses, 12 were 'No' responses and 11 were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

The responses of the three SMEs resulted in 33 responses to questions relating to the Segmenting principle including 28 'Yes' responses, three 'No' response and two non responses. The responses of the four special education teachers resulted in 36 responses to questions relating to the Segmenting principle including 33 'Yes' responses, two 'No' responses and one non response. The responses of the three multimedia/technology experts resulted in 15 responses to questions relating to the Segmenting principle including 10 'Yes' responses, three 'No' responses and two non responses. The total number of responses for all three groups of participants were 84. Out of these responses, 71 were 'Yes responses, eight were 'No' responses and five were non responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

Questions relating to the Pre-training principle were only asked to SMEs and special education teachers. The responses of the three SMEs resulted in 12 responses to questions relating to the Pre-training principle including 11 'Yes' responses, one 'No' response and zero non responses. The responses of the four special education teachers resulted in 36 responses to questions relating to the Pre-training principle including 33 'Yes' responses, one 'No' responses and two non responses. The total number of responses for the two groups of participants were 48. Out of these responses, 44 were 'Yes responses, two were 'No' responses and two were non

responses (see Table 11 for all the responses from SMEs, special education teachers and multimedia/technology experts).

Table 11

Frequency Counts for Questions Relating to Mayer's Multimedia Principles Given by SMEs, Special Education Teachers, and Multimedia/Technology Experts

Principles	SMEs				Special education teachers				Multimedia technology experts				Total			
	n	Y	N	N	n	Y	N	N	n	Y	N	N	n	Y	N	N
				R				R				R				R
1. Animation and Interactivity	3	60	19	5	4	73	16	3	3	32	9	4	10	165	44	12
2. Split Attention	3	44	1	3	4	20	3	1	3	20	3	3	10	84	7	7
3. Redundancy	3	44	1	3	4	20	3	1	3	20	3	3	10	84	7	7
4. Personalization	3	14	2	2	4	13	3	0	3	10	2	0	10	37	7	2
5. Worked-out examples	3	8	0	1	4	11	1	0	3	9	0	0	10	28	1	1
6. Guided discovery-Immediate feedback	3	32	5	2	4	41	4	3	3	27	3	6	10	100	12	11
7. Pre-training	3	11	1	0	4	33	1	2					7	44	2	2
8. Segmenting	3	28	3	2	4	33	2	1	3	10	3	2	10	71	8	5

Note. TQ= Total number of questions throughout the survey; Y= Yes; N= No; NR= No Response

For a complete listing of all of the questions within the tutorial related to the principles, see Appendix I.

Participants' comments/feedback.

To elicit constructive input from subject matter experts, special education teachers, and technology/multimedia experts, text fields were embedded within each frame of the online instrument to obtain participant comments (see Appendices C, D, and E for copies of the

instruments). A total of 222 comments were provided by the participants, 66 from SMEs, 85 from special education teachers, and 71 from multimedia/technology experts. (see Appendix F, G, and H for comments/feedback provided by each group of participants).

Three reviewers independently coded the comments from the three instruments using the following nine coding criteria.

1. Add new features
2. Graphic changes/suggestions
3. Delete or modify content
4. Additional practice
5. Relevance to disabilities
6. Technical changes:
7. Feedback to learner
8. Other

Out of 222 comments, 34 of the SME comments were coded the same by the three independent reviewers, 46 of the special education teacher comments were coded the same by the three independent reviewers, and 50 of the multimedia/technology expert comments were coded the same by the three independent reviewers (see Appendix F, G, and H for a summary of the independent coding of the three reviewers).

After coding the instruments independently, the reviewers met to discuss the coding criteria and individual differences on the coding of the comments. During this meeting the three reviewers agreed on the coding of 14 additional comments by SMEs, resulting in 73% agreement. After reviewing special education teacher comments, the three reviewers agreed on the coding of 35 additional comments, resulting in 95% agreement. After reviewing

multimedia/technology experts comments, the three reviewers agreed on the coding of 19 additional comments, resulting in 97% agreement (see Appendix F, G, and H for the summary of the coding agreement after the discussion).

Chapter Five

Discussion

Introduction.

Advancements in technology have resulted in new avenues for supporting teachers in enhancing learning for children with disabilities. Now individualized feedback can be instantaneous, teachers and/or publishers of instructional materials can create multimedia resources, and web-based instruction can be integrated with face-to-face instruction or as an independent study resource. The application of technology to the development of instructional resources facilitates the employment of formative measures to improve instructional resources based on what is learned through research and field testing. This study is based on lessons learned from a pilot test and two years of field-testing online tutorials in mathematics with over 5700 students with learning disabilities. The resource was 417 online tutorials in mathematics developed as part of a system that also included research based lessons and resources for parents that are aligned with standards developed by the National Council of Teachers of Mathematics (NCTM). The system was conceptualized as the Blending Assessment with Instruction Program (BAIP). BAIP was developed by the eLearning Design Lab (eDL). The target audience included students enrolled in inclusive classrooms including students with disabilities and students without disabilities. The original online tutorial model was based on an instructional design aligned with a specific indicators related to state standards. The tutorial was introduced to the student with an age appropriate example of the indicator to be learned. Four mathematic questions were embedded in the tutorial. The learner was provided feedback on each response in

the form of an explanation on why their response was correct or incorrect. They were also allowed to repeat an item if they wished.

A major finding through pilot testing and field testing indicated that the reading level of the tutorial content appeared to be interfering with the ability of students with learning disabilities in demonstrating their skills in mathematics. A review of the literature revealed that cognitive load could be a factor that was impeding learning due to the reading level and the amount of reading required to successfully complete a tutorial. This theory combined with the theory on the integration of multimedia into online instruction represented the underpinnings for the design and development of a prototype model. The model greatly reduced the reading requirements and added graphics and animations while holding the math concept being taught in alignment with the standard for the grade level.

Prior to this study, the prototype was subjected to a series of alpha tests by the eDL. The current study focused on the formative process designed to investigate the extent to which the prototype was (a) aligned with the standard/indicator, (b) met the principles of multimedia, and (c) allowed ease of navigation for students with learning disabilities. A second study will be conducted by the eDL following revision of the prototype based on findings from this study. The second study will research the effectiveness of the revised prototype in teaching students with learning disabilities in authentic instructional settings.

Discussion.

The intent of this study was to obtain insights from subject matter experts (SMEs), special education teachers, and multimedia/technology experts on specific features presented through selected frames of the tutorial. The focus of the frames studied was representative of

standards based content in mathematics, multimedia principles of instructional design, and instructional needs of students with learning disabilities. The instrument design was configured so that the respondent could view the tutorial frame and the questions on the monitor simultaneously (see Figure 11 in Chapter Three).

In the analysis of the formative comments from expert groups the focus was on identifying the input from the primary expert group and then determining the additional suggestions and/or features offered by the other two groups. In Chapter Four the detailed comments were presented for each question by the primary and the appropriate comparison group(s). For purposes of this discussion the focus is on sharing the additional suggestions and/or features added by the appropriate comparison group(s) to those generated by the primary group. For example, on the multimedia features the multimedia/technology expert group was the primary group and the comparison groups were the SMEs and the special education teachers. For the questions on multimedia and students with learning disabilities, the primary expert group was considered the special education teachers and for the functional reliability the multimedia/technology group served as the primary group.

Tutorial alignment.

No comparison is offered on the alignment question pertaining to the instructional content of the prototype module and the 4th grade math standard on which the tutorial was based. This was because the question was asked on the overall experiences in the tutorial and there was consensus among the groups that the tutorial content was aligned with the 4th grade standard/indicator in geometry. These observations by the SMEs and special education teachers will be validated during the second study.

Multimedia features.

The multimedia/technology experts were the primary source for the multimedia features (see Table 5 in Chapter Four for the detailed comments provided by the primary source). In the analysis of the comparison groups, 32 suggestions/comments were provided by SMEs and 36 comments/suggestions were provided by special education teachers. However there were only 10 comments/suggestions from SMEs and 13 comments/suggestions by special education teachers that differed from the primary source. These differences fell under the following categories:

- Adding additional practice throughout the tutorial
- Slowing the speed of animations down for the students with disabilities
- Speeding up the animation of the ‘funnel’ (see Appendix C for an example of the funnel in frame 40).
- Adding a calculator
- Adding audio

Multimedia features for students with learning disabilities.

The special education teachers were the primary source (see Table 7 in Chapter Four for the detailed comments provided by the primary source). In the analysis of the comparison group, four comments/suggestions were provided by multimedia/technology experts. Two of the four comments differed from the primary source. These differences fall under the following categories:

- Maintaining consistency in the visuals and graphics throughout the tutorial
- Breaking down the instruction into smaller units, for students with learning disabilities

Functional reliability.

The multimedia/technology experts were the primary source for functional reliability (see Table 10 in Chapter Four for the detailed comments provided by the primary source). In the analysis of the comparison group, five comments/suggestions were provided by special education teachers. All five comments/suggestions provided by special education teachers differed from the primary source. These differences fall under the following categories:

- Breaking down the instruction into smaller units for students with learning disabilities.
- Adding additional practice throughout the tutorial
- Allowing mistakes to be made on some frames to enhance learning through critical thinking (see frame 40 in Appendix D for the example of the content)
- Adding audio
- Adding calculator

Multimedia principles.

This study examined the tutorial design based on eight of the 10 multimedia principles outlined by Mayer (2005).

- animation and interactivity
- split-attention
- redundancy
- personalization,
- worked-out examples
- guided discovery – immediate feedback

- pre-training
- segmenting

In examining the comments/suggestion provided by the three groups of participants, commonalities regarding the principles were found.

Animation and interactivity principle.

The tutorial prototype was designed so that students with learning disabilities could interact and manipulate features within the tutorial. Despite this, both SMEs and special educations teachers suggested that additional animations and opportunities to interact within the tutorial should be added. Both the SMEs and special education teachers stated that the additional practice opportunities would reinforce the concepts being taught throughout the tutorial and benefit students with disabilities.

Split-attention principle and redundancy principle.

While designing the tutorial, effort was made to reduce redundancy of graphics and text to eliminate the need for students to mentally integrate multiple sources of information. In doing this, text and graphics were formatted so that sources of information were physically integrated (see Appendix C, frames 6, 8, and 12 where the text was physically placed alongside the graphics). SMEs suggested adding additional text on some screens to enhance the understanding of the concept. The suggestions given by special education teachers and multimedia/technology experts centered around changes in the graphic sizes and coloration so that they resemble more real-life objects, thus making them automatically recognizable. Special education teachers also

suggested to change slanting text in the bubble to be in one level for the benefit of students who have visual issues.

Personalization principle.

Several survey questions asked the participants whether the language used in the tutorial was conversational rather than formal. None of the multimedia/technology experts provided comment for this question. A majority of the special education teachers stated that they did not understand the difference between ‘conversational and formal’ and therefore did not provide comments. The SMEs were the only group to comment on these questions. They agreed that most of the content was written using conversational language. However, being a tutorial in mathematics, all of the content could not be conversational. All the mathematical phrases, such as ‘volume’, ‘pint’, ‘measurement’ etc. used in the tutorial were part of the formal content. SMEs concluded their remarks by stating that being a mathematical tutorial, one could not expect it to be a completely conversational but a mixture of conversational and formal.

Worked-out examples principle.

None of the SMEs and multimedia/technology experts provided comments for these questions. The comments/suggestions provided by the special education teacher were very specific to one frame (see Appendix D, frame 15 for the example of the frame). They suggested adding more worked-out examples, especially for ‘converting cups into quarts’.

Guided discovery-immediate feedback principle.

In this study, the tutorial used the most basic form of animated characters. A happy faced boy gave positive feedback for the correct answer and a sad faced boy gave a message that the

answer was wrong. All three groups of participants suggested having more elaborate feedback, especially for the wrong answers. They suggested that the feedback could be in form of a hint, or providing guidance/help students navigate to the previous page to see the concept again. On some screens the multimedia agent does not appear until you are through all of the steps. The three groups of participants suggested to have feedback on the frames where a student had to solve a multi-step problem (see Appendix D, frames 40 and 43 for the example of a multi-step problem). Some of the comments by special education teachers suggested having not only positive, negative, right, and/or wrong feedback, but also to add encouraging statements for keeping students engaged throughout the tutorial.

Segmenting principle.

Allowing students to progress through the tutorial at their own pace was one of the principles guiding the design of this tutorial prototype. Special education teachers did not provide any formative comments on these questions. The SME and multimedia/technology experts agreed that even though students can progress at their own speed throughout the tutorial, animation speed on some of the screens did not provide the opportunity to move ahead faster. They suggested providing students with more control over the speed of animations.

Pre-training principle.

Questions relating to the Pre-training principle were not included in the survey instrument for multimedia/technology experts. On the other hand SMEs and special education teachers answered questions related to this principle throughout the tutorial. The comments/suggestions by SMEs underlined the need to add new content to make some of the concepts clearer to a

typically achieving fourth grade student. They also suggested changes in the graphics to make them more accessible and closer to real-life objects. Special education teachers provided a number of suggestions pertaining to changes in the tutorial to make it more accessible for students with learning disabilities. Their suggestions included:

- Maintaining consistency in the visuals and graphics throughout the tutorial
- Breaking down the instruction into smaller units, for the students with learning disabilities
- Adding additional practice throughout the tutorial
- Slowing the speed of animations down for the students with disabilities
- Adding calculator
- Adding audio

Limitations.

Three SMEs, four special education teachers, and three multimedia/technology experts completed the formative review of the tutorial prototype. Each participant was selected on the appropriateness of their expertise and experience to providing the needed formative feedback. While the number of participants were considered sufficient for the formative feedback needed at this stage in the tutorial development, a larger sample might have identified additional needed modifications.

Responses by participants to the instrument were submitted independently and remotely through a web site. This format provided flexibility as it allowed participants to complete the instrument and review the tutorial prototype at their own pace. However, using the web

distribution and online review process, limited the researcher's ability to interact, clarify, or elaborate with the participants' during the review process.

The major limitation was the lack of a low cognitive model as an example when developing the prototype that had the potential of going to scale. A major concern was to be able to produce the final version of the tutorial at scale. The prototype is not highly scalable, but if found to be effective with struggling learners, it will be cost effective to produce.

Future research.

This research studied the design and development process of a multimedia tutorial tailored to the needs of students with learning disabilities. The goal of this study was to apply a formative process in refining the tutorial prototype and readying it for evaluation with students in an authentic setting. The participants were three groups of individuals with experience and expertise highly relevant to the design and development of a low cognitive load model for teaching math to students with learning disabilities. The data collected in this study were in the form of descriptive statements in response to questions tied to the instructional design for teaching a standard based math concept while reducing cognitive load. The analysis will be ongoing as the eDL team interprets each element of feedback from the expert groups and makes revisions in the model based on the result of this study. Once revised, an independent source will be asked to participate in a series of alpha tests prior to subjecting the revised tutorial to field testing in authentic settings. It is anticipated that there will be variability in the interpretation of the results of this study, when this observed discourse will occur among the interdisciplinary team responsible for the revisions. The individual responses in the form of comments/statement

will provide a rich resource for discourse and decision making. Validation of those decisions will be pursued through subsequent field testing.

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Appendix A

Online Informed Consent agreement

Approved by the Human Subjects Committee Lawrence Campus, University of Kansas. Approval expires one year from 12/4/2009. HSCL #18394
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INFORMED CONSENT STATEMENT

*Effectiveness of employing multimedia principles in the design of computer-based math tutorials
for students with learning disabilities*

INTRODUCTION

The Department of Special Education in the School of Education at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

PURPOSE OF THE STUDY

The purpose of this study is to evaluate the effectiveness of design, structure, and textual features of an online instructional tutorial for students with learning disabilities.

PROCEDURES

An access to a website will be provided to all the participants. The participants will have to go through a tutorial available on the website and fill out online survey questionnaires giving

the feedback about the tutorial. The tutorial will require 20 to 25 minutes to go through and the questionnaires will need approximately 15 to 20 minutes to go through and be filled out. The survey questionnaires will be accessible from the same website. Once all the surveys are in, and if any further explanation is needed on the comments made by the participant a short follow-up interviews will be conducted on a telephone according to the convenience of those participants. Duration of the interview will vary based on your reply, but I anticipate that the interview will not take more than 20 minutes.

RISKS

No risks are anticipated.

BENEFITS

The results of the survey questionnaires and follow-up interviews will help improve the prototype of online math tutorials. It will help in understanding the effectiveness of using animations and reduced readability in a tutorial that is aligned with the state Mathematics standards as well as state assessment standards. These findings will be beneficial for making interactive online tutorials for all the possible mathematics standards in the future as well as extended research in the same area.

PAYMENT TO PARTICIPANTS

Participants will NOT be paid.

PARTICIPANT CONFIDENTIALITY

Your participation is solicited, although strictly voluntary. Your name will not be associated in any way with the information collected about you or with the research findings from this study. The researcher will not share information about you unless required by law or unless you give written permission. It is possible, however, with internet communications, that

through intent or accident someone other than the intended recipient may see your response. If you would like additional information concerning this study before or after it is completed, please feel free to contact us by phone or mail. Completion of the survey indicates your willingness to participate in this project and that you are over the age of eighteen. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429 or (785) 864-7385 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email mdenning@ku.edu.

QUESTIONS ABOUT PARTICIPATION should be directed to:

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KEEP THIS SECTION FOR YOUR RECORDS.

(Project/Study Title)

Effectiveness of employing multimedia principles in the design of computer-based math tutorials for students with learning disabilities

(Provided by HSCL office)

HSCL #18394

PARTICIPANT CERTIFICATION: If you agree to participate in this study please Type your name and date where indicated. Print and keep the consent information for your records.

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study and the use and disclosure of information about me for the study.

I agree to take part in this study as a research participant. By typing my name below, I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

Type Participant's Name

Type today's date

Appendix B

Demographic Questions

Demographic questions for subject matter experts (SMEs).

- Name (optional): _____
- Age: _____
- Institutional or School Affiliation: _____
- Areas of interest in Mathematics: _____
- Years of Experience in teaching Mathematics in a regular classroom: _____
- Experience in teaching Mathematics in a regular classroom: (As a pull down menu:
Possibility of choosing more than one option)
Postsecondary instruction
Pre School
Elementary
Middle School
High School
- Years of Experience in teaching Mathematics to students with disability: _____
- Experience in teaching Mathematics to students with disability: (As a pull down menu:
Possibility of choosing more than one option)
Inclusion
Resource Teacher
Tutor
Special Class
Parent
- Grade Placement: (As a pull down menu)
Pre School
1
2
3
4
5
6
7
8
9
HS

Demographic questions for special education teachers.

- Name (optional): _____
- Age: _____
- Institutional or School Affiliation: _____
- Areas of interest in Mathematics: _____
- Years of Experience in teaching Mathematics in a regular classroom: _____
- Experience in teaching Mathematics in a regular classroom: (As a pull down menu:
Possibility of choosing more than one option)
Postsecondary instruction
Pre School
Elementary
Middle School
High School
- Years of Experience in teaching Mathematics to students with disability: _____
- Experience in teaching Mathematics to students with disability: (As a pull down menu:
Possibility of choosing more than one option)
Inclusion
Resource Teacher
Tutor
Special Class
Parent
- Grade Placement: (As a pull down menu)
Pre School
1
2
3
4
5
6
7
8
9
HS

Demographic questions for multimedia/technology experts.

- Name (optional): _____
- Age: _____
- Institutional or School Affiliation: _____
- Years of Experience in using Technology as a Tool: _____
- Experience in using technology as a tool: (Drop down menu:)
 - Communications*
 - Development of instructional resources*
 - Teaching*
 - Research*
 - Data Management*
 - Instructional Design*
 - Content management*
- Years of Experience in using Technology for Instructional Purposes: _____
- Experience in using technology for instructional purposes: (Drop down menu: Check all those that apply)
 - Postsecondary instruction*
 - K-12*
 - Special education*
 - Professional Development*
 - Instructional*

Appendix C

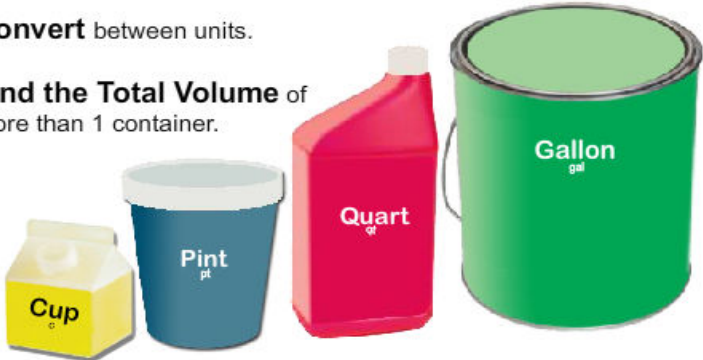
Screen Shots of Tutorial

Sent to subject matter experts (SMEs).

0% Complete
Next ▶

In this lesson you will learn how to...

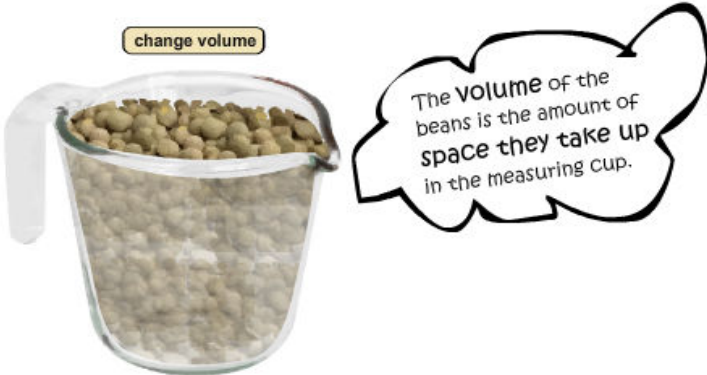
1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.



The illustration shows four containers representing different volume units. From left to right: a yellow carton labeled 'Cup' with a small 'c' below it; a blue bucket labeled 'Pint' with a small 'pt' below it; a red jug labeled 'Quart' with a small 'qt' below it; and a large green can labeled 'Gallon' with a small 'gal' below it.

◀ Back
4% Complete
Next ▶

Volume is the amount of space something takes up.



The image shows a clear measuring cup filled with brown beans. A yellow button above the cup says 'change volume'. To the right, a speech bubble contains the text: 'The **volume** of the beans is the amount of **space they take up** in the measuring cup.'

◀ Back
4% Complete
Next ▶

This is frame 1

When we want feedback, questions will appear in this section of your screen. This will begin with the next frame. Use the 'Next' button in the tutorial to proceed.

This is frame 2

1. Does the ability to change the volume aid in the representation of the instructional concepts?

Yes No

comment

2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

Yes No

comment

3. Does this screen provide enough opportunity for manipulation to enhance learning?

Yes No


comment

This is frame 3

Back Next 6% Complete

Units help us describe how much of something there is.

change units



We can use **different size units** to describe the **same volume** of beans.

1. Does the ability to change the units aid in the representation of the instructional concepts?
 Yes No
comment

2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
 Yes No
comment



3. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

This is frame 4



Back Next 8% Complete

Cup, Pint, Quart, and Gallon **are units that hold different amounts of volume.**



Cup



Pint

Quart

Gallon

replay

1. Do the graphics on this screen facilitate learning?
 Yes No
comment

2. Do the animations on this screen facilitate learning?
 Yes No
comment

3. Do the animated graphics and text convey the same information?
 Yes No
comment

← Back 10% Complete Next →

1 Qt — 2 Pt — 4 C
3 C
1 Pt — 2 C
1 C

Cup (C)
A small unit of volume

This is frame 5

Questions continue with the next frame.

← Back 12% Complete Next →

Milk cartons at school often have 1 cup of milk in them.

Cup

1 Qt — 2 Pt — 4 C
3 C
1 Pt — 2 C
1 C

This is frame 6

Regarding frames 5 and 6

1. Do the graphics and text on each screen convey the same information?

 Yes No
comment

2. Do the graphics and animation on these screens facilitate learning?

 Yes No
comment

3. Is the presentation of the content conversational rather than formal?

 Yes No
comment

◀ Back 15% Complete Next ▶

Pint (Pt)
A unit of volume that is larger than a Cup

This is frame 7

Questions continue with the next frame.

◀ Back 16% Complete Next ▶

Ice Cream at the grocery store often comes in 1 pint containers.

Pint
pt

This is frame 8

Regarding frames 7 and 8

1. Do the graphics and text on each screen convey the same information?

Yes No

comment

2. Do the graphics and animation on these screens facilitate learning?

Yes No

comment

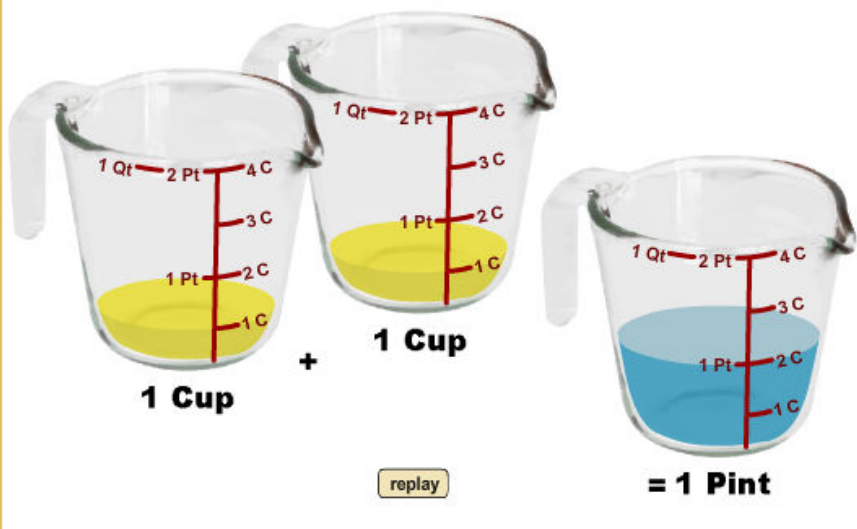
3. Is the presentation of the content conversational rather than formal?

Yes No

comment

This is frame 9

Back Next 18% Complete



1 Cup + 1 Cup = 1 Pint

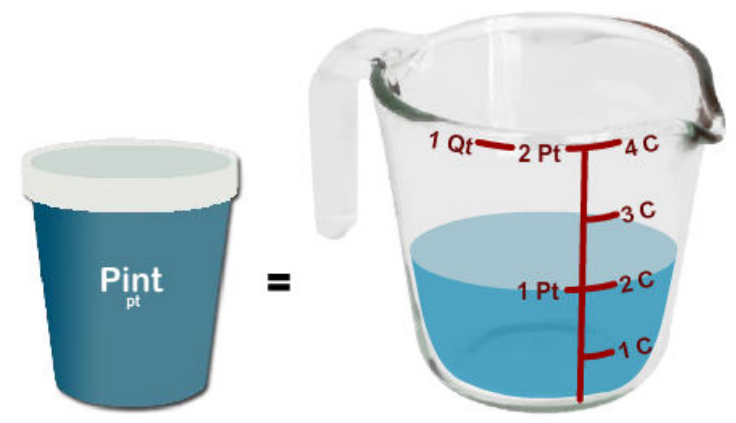
[replay](#)

Questions continue with the next frame.

This is frame 10

Back Next 20% Complete

A pint of ice cream equals 2 cup(s). [check answer](#)



1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint?

Yes No

[comment](#)

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes No

[comment](#)

This is frame 11

Back 22% Complete Next

Quart (Qt)
A unit of volume that is **larger** than a Pint

Questions continue with the next frame.

This is frame 12

Back 24% Complete Next

Regarding frames 11 and 12

1. Do the graphics and text on each screen convey the same information?
 Yes No
comment

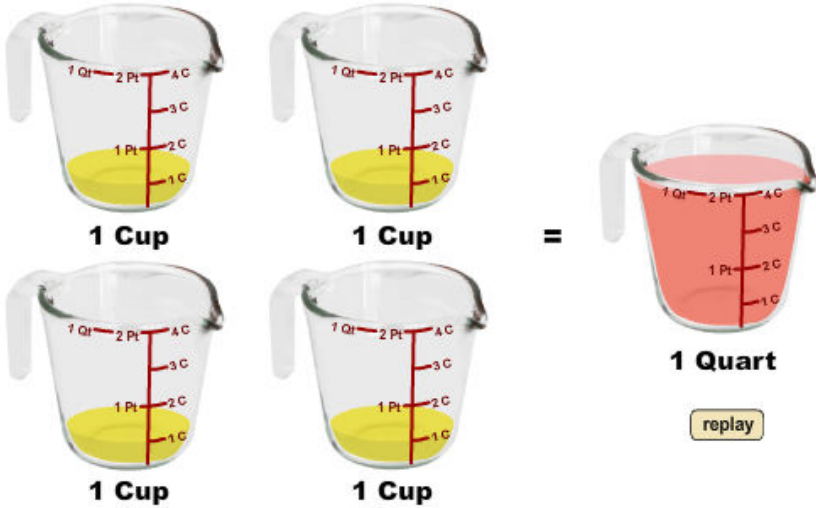
2. Do the graphics and animation on these screens facilitate learning?
 Yes No
comment

3. Is the presentation of the content conversational rather than formal?
 Yes No
comment

This is frame 13

Back 26% Complete Next

4 Cups equals 1 Quart.



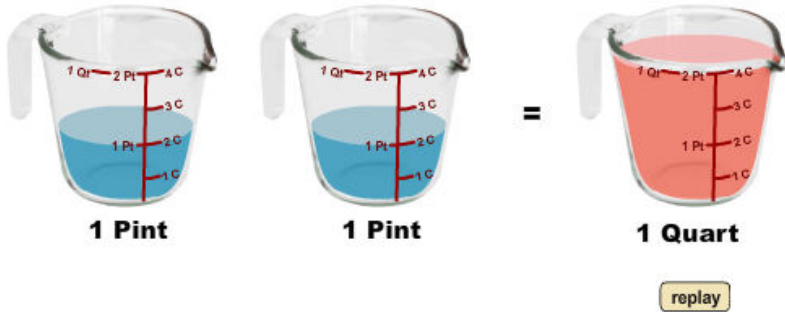
The diagram illustrates the conversion of 4 cups to 1 quart. On the left, four identical measuring cups are arranged in a 2x2 grid. Each cup has a scale with markings for 1 Cup, 2 Cups, 3 Cups, 1 Pint, 2 Pints, and 1 Quart. The liquid level in each cup is at the 1 Cup mark. Below each cup is the label "1 Cup". To the right of these four cups is an equals sign. To the right of the equals sign is a single measuring cup with the same scale, but the liquid level is at the 1 Quart mark. Below this cup is the label "1 Quart". A "replay" button is located below the 1 Quart cup.

Questions continue in two frames.

This is frame 14

Back 29% Complete Next

2 Pints equals 1 Quart.





The diagram illustrates the conversion of 2 pints to 1 quart. On the left, two identical measuring cups are arranged side-by-side. Each cup has a scale with markings for 1 Cup, 2 Cups, 3 Cups, 1 Pint, 2 Pints, and 1 Quart. The liquid level in each cup is at the 1 Pint mark. Below each cup is the label "1 Pint". To the right of these two cups is an equals sign. To the right of the equals sign is a single measuring cup with the same scale, but the liquid level is at the 1 Quart mark. Below this cup is the label "1 Quart". A "replay" button is located below the 1 Quart cup.

Questions continue with the next frame.

This is frame 15

◀ Back 30% Complete Next ▶

A quart of oil equals 4 cup(s). check answer


=


Regarding frames 13 — 15

1. Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart?

Yes No

comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?


Yes No

comment

This is frame 16

◀ Back 32% Complete Next ▶

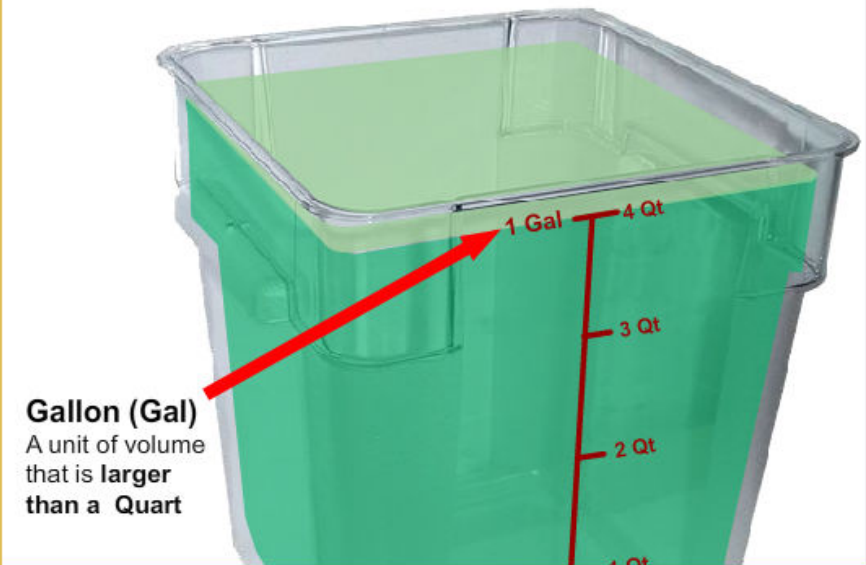
We need a bigger container to measure a gallon.



Questions continue in two frames.

This is frame 17

Back 34% Complete Next

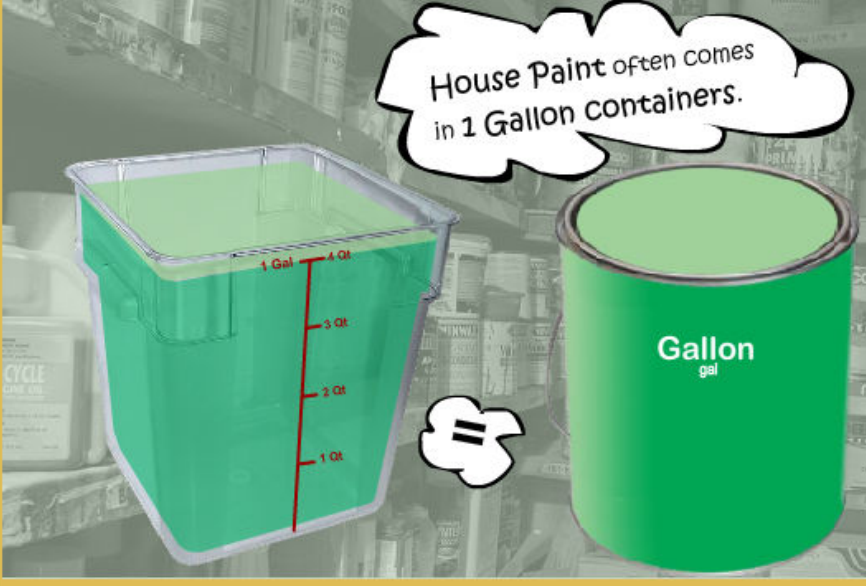


Gallon (Gal)
A unit of volume that is larger than a Quart

Questions continue with the next frame.

This is frame 18

Back 36% Complete Next



House Paint often comes in 2 Gallon containers.

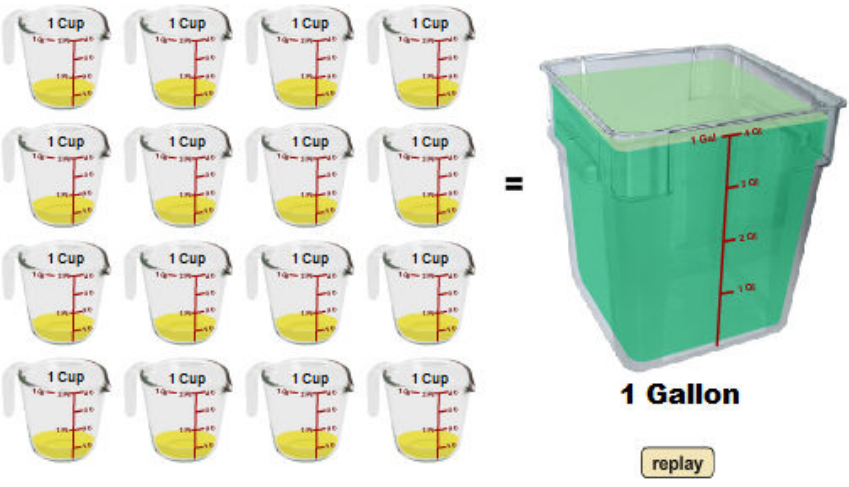
1. Do the graphics and text on each screen convey the same information?
 Yes No
 comment

2. Do the graphics and animation on these screens facilitate learning?
 Yes No
 comment

3. Is the presentation of the content conversational rather than formal?
 Yes No
 comment

Back 38% Complete Next

16 Cups equals 1 Gallon.



1 Gallon

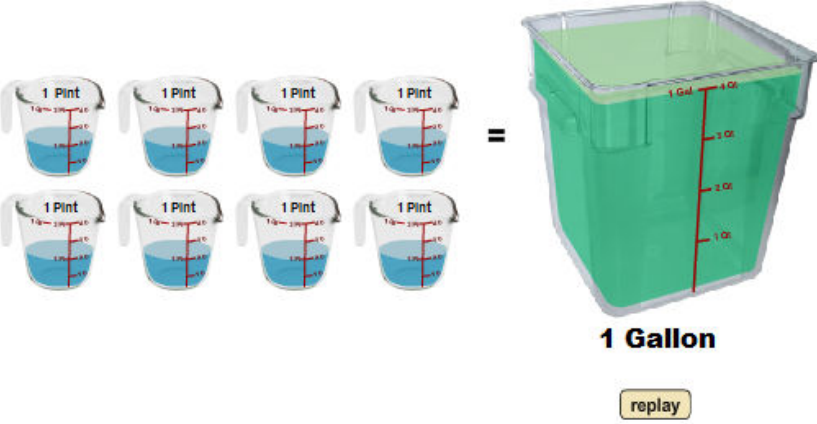
replay

This is frame 19

Questions continue in two frames.

Back 40% Complete Next

8 Pints equals 1 Gallon.



1 Gallon

replay

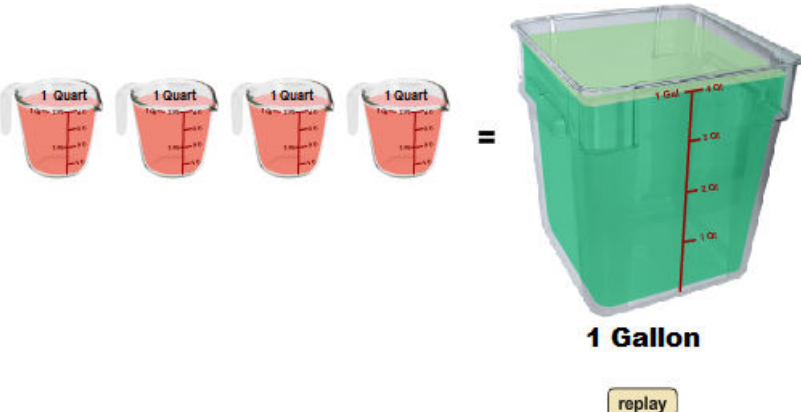
This is frame 20

Questions continue with the next frame.

This is frame 21

Back 42% Complete Next

4 Quarts equals 1 Gallon.



1 Gallon

replay

Regarding frames 19 — 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon?

Yes No

comment

2. Do these screens provide enough opportunity for manipulation to enhance learning?

Yes No

comment


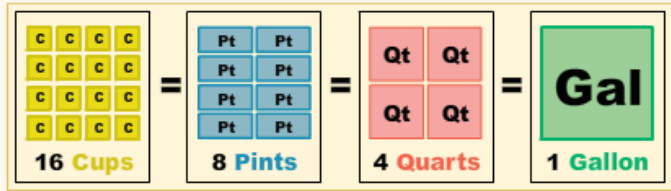
This is frame 22

Back 44% Complete Next

1. One gallon equals 16 cups. check answer

2. How many pints are there in a gallon? 8 check answer

3. There are 4 quarts in a gallon. check answer

Questions for this section of the tutorial will appear with frame 28.

This is frame 23

← Back 46% Complete Next →

1. There are 8 pints in 1 gallon. True False
2. Two pints are equal to one quart. True False
3. A pint equals 4 cups. True False
4. A quart is smaller than a pint. True False
5. Four pints make one quart. True False

← Hint

<table style="width: 100%; text-align: center;"> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> </table> <p>16 Cups</p>	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	=	<table style="width: 100%; text-align: center;"> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> </table> <p>8 Pints</p>	Pt	Pt	Pt	Pt	Pt	Pt	Pt	Pt	=	<table style="width: 100%; text-align: center;"> <tr><td>Qt</td><td>Qt</td></tr> <tr><td>Qt</td><td>Qt</td></tr> </table> <p>4 Quarts</p>	Qt	Qt	Qt	Qt	=	<div style="background-color: #90EE90; width: 60px; height: 60px; display: flex; align-items: center; justify-content: center; margin: 0 auto;"> Gal </div> <p>1 Gallon</p>
C	C	C	C																															
C	C	C	C																															
C	C	C	C																															
C	C	C	C																															
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Qt	Qt																																	
Qt	Qt																																	

Questions for this section of the tutorial will appear with frame 28.

This is frame 24

← Back 48% Complete Next →

Smallest ----- Largest

1 Cup

1 Pint

1 Quart

1 Gallon

Questions for this section of the tutorial will appear with frame 28.

← Back 50% Complete Next →

Smallest ┌──────────┐ ┌──────────┐ ┌──────────┐ ┌──────────┐ Largest

Cup

Pint

Quart

Gallon

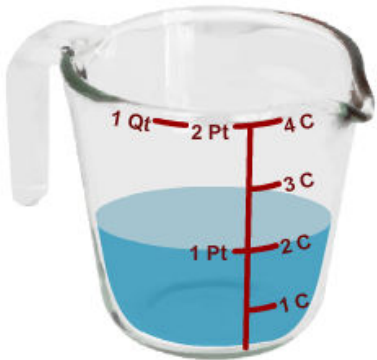
replay

This is frame 25

Questions for this section of the tutorial will appear with frame 28.

← Back 52% Complete Next →

How many cups make up a pint? check answer




This is frame 26

Questions for this section of the tutorial will appear with frame 28.

This is frame 27

◀ Back 54% Complete Next ▶

How many pints make up a quart? 2 check answer




Questions for this section of the tutorial will appear with frame 28.

This is frame 28

◀ Back 57% Complete Next ▶

How many quarts make up a gallon? 4 check answer




Regarding frames 22–28 (feel free to use the Back and Next buttons to refresh your memory):

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student?
 Yes No
comment
2. Does this section allow students to progress at their own pace?
 Yes No
comment
3. Are the graphics employed in this section relevant to the skill or concept?
 Yes No
comment
4. Do these screens provide enough opportunity for manipulation to enhance learning?
 Yes No
comment
5. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
comment

◀ Back
58 % Complete
Next ▶

Let's learn how to find **the total volume of more than 1 container.**



This is frame 29

Questions continue with the next frame.




◀ Back
60 % Complete
Next ▶

How to Find Total Volume

replay **Step 1. Group** - Group containers by volume

replay **Step 2. Convert** - Convert between groups

replay **Step 3. Count** - Count each group

1	0	3	1
Cups	Pints	Quarts	Gallons
 1		 1 2 3	 1

This is frame 30

Regarding frames 29—30:


- Is the tutorial content in this section appropriate for a typically achieving 4th grade student?
 Yes No
 comment
- Does this section allow students to progress at their own pace?
 Yes No
 comment
- Are the graphics, employed in this section relevant to the skill or concept?
 Yes No
 comment
- Does the screen provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment
- Does the tutorial provide enough feedback and guidance to engage students and support learning?
 Yes No
 comment

This is frame 31

Back 62% Complete Next

How to Find Total Volume

➔ **Step 1. Group**
 Step 2. Convert
 Step 3. Count







Questions will continue on the next frame

This is frame 33

Back 66% Complete Next

Step 1. Group - Practice

Cups	Pints	Quarts	Gallons
			

replay

Regarding frames 30-33

1. Do these screens provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment




2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment

3. Do these screens allow students to progress at their own pace?
 Yes No
 comment

◀ Back 68% Complete Next ▶

How to Find Total Volume

Step 1. Group
 ▶ **Step 2. Convert**
 Step 3. Count

Cups	Pints	Quarts	Gallons
			

This is frame 34







Questions will continue.

◀ Back 72% Complete Next ▶

Step 2. Convert

Earlier we saw how **smaller units can be added together to equal larger units.**

Equal Volume

2 Cups		=		1 Pint
2 Pints		=		1 Quart
4 Quarts		=		1 Gallon

This is frame 36

Questions will continue

This is frame 37

◀ Back 74% Complete Next ▶

Step 2. Convert
Conversion allows you to **change units** as long as **what you take away equals what you add**.

Equal Volume

2 Cups **C** **C** =

2 Pints **Pt** **Pt** =

4 Quarts **Qt** **Qt** **Qt** **Qt** =

Regarding frames 34-37

1. Do the graphics on these screens facilitate learning?
 Yes No
comment

2. Do the animations on these screens facilitate learning?
 Yes No
comment

3. Do the animated graphics and text convey the same information?
 Yes No
comment

4. Do these screens provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

This is frame 38

◀ Back 76% Complete Next ▶

Step 2. Convert
Convert to the largest possible units unless the question asks for smaller units.

Q: How much volume do we have?

Cups	Pints	Quarts	Gallons
c			Gal

➔

Regarding this screen

1. Do the graphics on this screen facilitate learning?
 Yes No
comment

2. Do the animations on this screen facilitate learning?
 Yes No
comment

3. Do the animated graphics and text convey the same information?
 Yes No
comment

4. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

◀ Back 78% Complete

Step 2. Convert

Q: How much volume do we have?

0 Cups	1 Pints	4 Quarts	0 Gallons
	Pt	Qt Qt Qt Qt	

Quarts → Gallons

How many quarts equal 1 gallon?
4

How many quarts can we convert into gallons?
_____ check answer

This is frame 39

Regarding this screen

- Do the graphics and text screen convey the same information?
 Yes No
 comment
- Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment
- Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment
- Does this screen allow students to progress at their own pace?
 Yes No
 comment

◀ Back 80% Complete

Step 2. Convert - Practice

Q: How much volume do we have?

Cups	Pints	Quarts	Gallons
c c		Qt Qt	Gal

This is frame 40

Regarding this frame:

- Do the graphics and text convey the same information?
 Yes No
 comment
- Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment
- Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
 Yes No
 comment
- Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment
- Does this screen allow students to progress at their own pace?
 Yes No
 comment

◀ Back 82% Complete Next ▶

Step 2. Convert
Sometimes a question will ask you to convert to smaller units.

Q: How many **pints** do we have?

Cups	Pints	Quarts	Gallon
c	PI PI PI PI PI PI PI PI		

replay

This is frame 41

Regarding this screen

1. Do the graphics on this screen facilitate learning?

Yes No

comment

2. Do the animations on this screen facilitate learning?

Yes No

comment

3. Do the animated graphics and text convey the same information?

Yes No

comment

4. Does this screen provide enough opportunity for manipulation to enhance learning?

Yes No

comment

◀ Back 84% Complete

Step 2. Convert
Q: How many **pints** can we make?

3 Cups	0 Pints	0 Quarts	1 Gallons
c c c			Gal

Quarts ← Gallons

How many quarts equal 1 gallon? <u>4</u>	How many gallons can we convert? <u>1</u>	How many quarts will we make when we convert our gallons to quarts? <u>4</u> check answer
---	--	---

This is frame 42

Regarding this screen

1. Do the graphics and text screen convey the same information?

Yes No

comment

2. Does this screen provide enough opportunity for manipulation to enhance learning?

Yes No

comment

3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes No

comment

4. Does this screen allow students to progress at their own pace?

Yes No

comment

◀ Back
86% Complete
This is frame 43

Step 2. Convert - Practice

Q: How many quarts do we have?

Cups c c	Pints Pt Pt Pt	Quarts Qt	Gallons Gal
----------------	-------------------	--------------	----------------

Regarding this frame:

- Do the graphics and text convey the same information?
 Yes No
 comment
- Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment
- Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
 Yes No
 comment
- Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment
- Does this screen allow students to progress at their own pace?
 Yes No
 comment

◀ Back
88% Complete
Next ▶
This is frame 44

How to Find Total Volume

Step 1. Group

Step 2. Convert

➔ Step 3. Count

1 Cups 1	0 Pints	3 Quarts 2 1 3 	1 Gallons
-----------------	---------	--------------------------	---------------

Regarding this screen

- Do the graphics on this screen facilitate learning?
 Yes No
 comment
- Do the animations facilitate learning?
 Yes No
 comment
- Do the animated graphics and text convey the same information?
 Yes No
 comment

This is frame 46

◀ Back 92% Complete Next ▶

Step 3. Count - Practice

Q: How much volume do we have?

2 **Cups**

c
c

1 **Pints**

Pt

3 **Quarts**

Qt
Qt
Qt

1 **Gallons**

Gal

replay

Regarding this screen

1. Do the graphics and text screen convey the same information?
 Yes No
comment

2. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
comment

4. Does this screen allow students to progress at their own pace?
 Yes No
comment

This is frame 47

◀ Back 94% Complete Next ▶

Finding Total = Volume

1. **Group**

Group containers into cups, pints, quarts, & gallons

➔

2. **Convert**

Convert to largest units or to the units asked for in the question

➔

3. **Count**

Count the number of containers in each group

replay

Regarding this screen

1. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
comment

3. Does this screen allow students to progress at their own pace?
 Yes No
comment

◀ Back 96 % Complete Next ▶

Planning a Party

Aaron is planning to have a party for 14 of his friends. He thinks that each friend will drink one cup of juice. He has 1 gallon of juice. Does he have enough juice for each of his friends?

Lets convert Aaron's gallon to cups to see if he has enough juice for his friends:


1 gallon = 4 quarts

1 quart = 2 pints

4 quarts = 8 pints

1 pint = 2 cups

8 pints = 16 cups



Problem Complete

This is frame 48

Regarding this screen

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student

 Yes No

comment

2. Is the content in this section of the tutorial conversational rather than formal?

 Yes No

comment

3. Does this screen allow students to progress at their own pace?

 Yes No

comment

4. Does this screen provide enough opportunity for manipulation to enhance learning?

 Yes No

comment

5. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

 Yes No

comment

◀ Back 98 % Complete Next ▶

Snack Time

A teacher wants to give her 16 students chocolate milk at snack time. She thinks each student will drink 1 pint. She has 1 gallon and 3 quarts of chocolate milk. Does she have enough?


Lets convert the teachers chocolate milk to pints to see if she has enough:

1 gallon = 4 quarts

The teacher already has 3 quarts, so she now has 3 quarts + 4 = 7 quarts

1 quart = 2 pints

7 quarts = 14 pints



Problem Complete

This is frame 49

Regarding this screen

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student

 Yes No

comment

2. Does the tutorial in this section provide enough opportunity for manipulation to enhance learning?

 Yes No

comment

3. Is the content in this section of the tutorial conversational rather than formal?

 Yes No

comment

4. Does this screen allow students to progress at their own pace?

 Yes No

comment

5. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

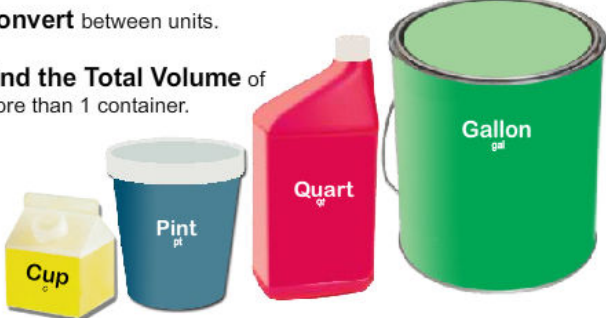
 Yes No

comment

◀ Back
100% Complete

In this lesson you learned how to...

1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.



This is frame 50

Now, consider the entire tutorial:

1. Are the skills and concepts in the tutorial aligned with the intent of the Kansas indicator below?
The Kansas Standard: 3.2. k2b category 3b
Standard: *Geometry . The student uses geometric concepts and procedures in a variety of situations.*
Benchmark: *Measurement and Estimation . The student measures using standard units of measure including the use of concrete objects in a variety of situations.*
Indicator: *The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure - volume to the nearest cup, pint, quart, or gallon;*

Yes No

comment

Appendix D

Screen Shots of Tutorial

Sent to special education teachers.

0% Complete
Next ▶

In this lesson you will learn how to...

1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.

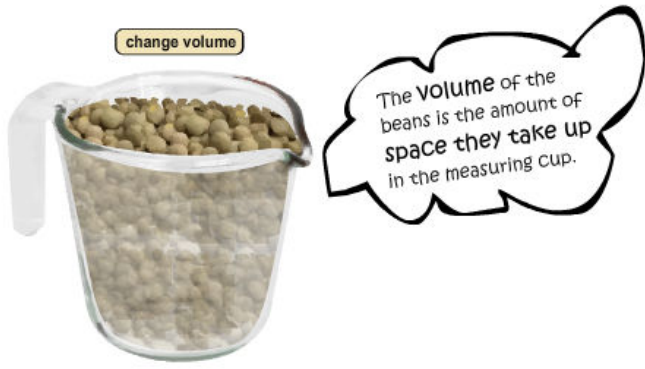


This is frame 1

When we want feedback, questions will appear in this section of your screen. This will begin with the next frame. Use the 'Next' button in the tutorial to proceed.

◀ Back
4% Complete
Next ▶

Volume is the amount of space something takes up.



This is frame 2

1. Does the ability to change the volume aid in the representation of the instructional concepts?

Yes
 No

comment
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

Yes
 No

comment
3. Is the reading level of text on this screen appropriate for students with learning disabilities?

Yes
 No


comment

This is frame 3

Back 6% Complete Next

Units help us describe how much of something there is.

change units



We can use different size units to describe the same volume of beans.

1. Does the ability to change the units aid in the representation of the instructional concepts?

Yes No

comment
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

Yes No

comment
3. Is the reading level of text on this screen appropriate for students with learning disabilities?

Yes No


comment

This is frame 4


Back Gmail - Logins to re-test - baipsience@gmail.com Next

Cup, Pint, Quart, and Gallon are units that hold different amounts of volume.


Cup




Pint



Quart



Gallon



replay

1. Do the graphics on this screen facilitate learning?

Yes No

comment
2. Do the animations on this screen facilitate learning?

Yes No

comment
3. Do the animated graphics and text convey the same information?

Yes No

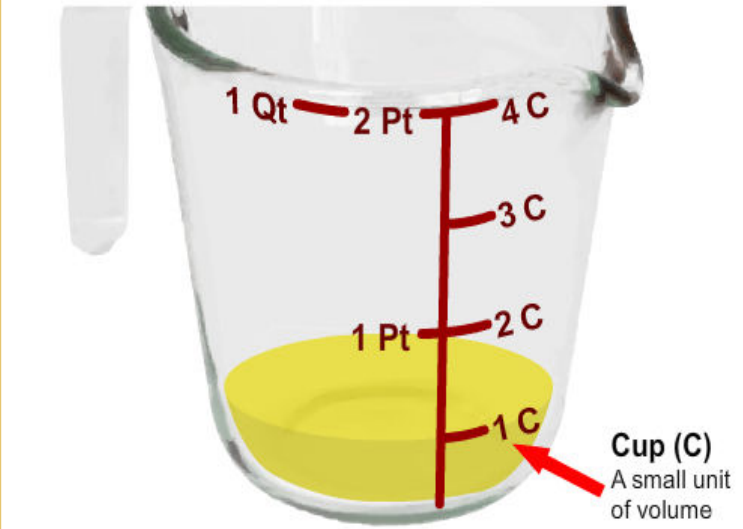
comment
4. Do the animations and interactivity on this screen accommodate the needs of students with learning disabilities?

Yes No

comment

This is frame 5

Back 10% Complete Next



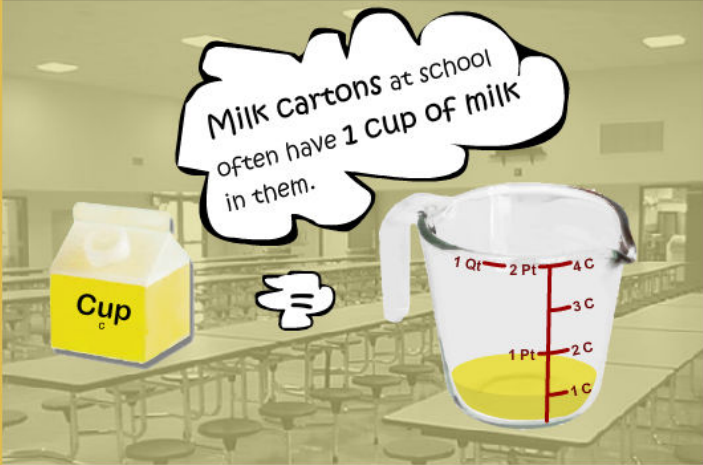
1 Qt — 2 Pt — 4 C
3 C
1 Pt — 2 C
1 C

Cup (C)
A small unit of volume

Questions continue with the next frame.

This is frame 6

Back 12% Complete Next



Milk cartons at school often have 1 cup of milk in them.

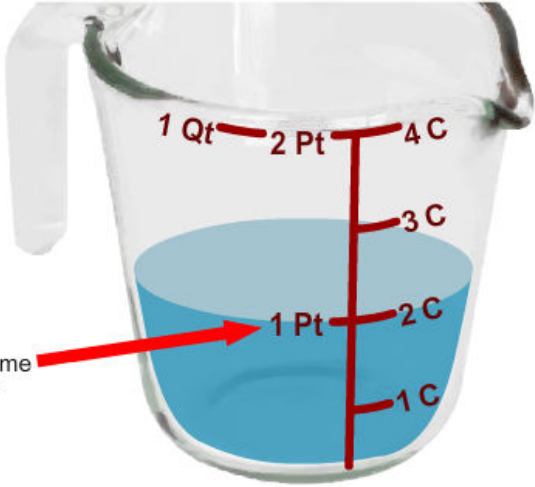
Cup

1 Qt — 2 Pt — 4 C
3 C
1 Pt — 2 C
1 C

Regarding frames 5 and 6

- Do the graphics and text on each screen convey the same information?
 Yes No
 comment
- Do the graphics on these screens facilitate learning?
 Yes No
 comment
- Do the animations on these screens facilitate learning?
 Yes No
 comment
- Is the presentation of the content conversational rather than formal?
 Yes No
 comment

◀ Back 15% Complete Next ▶

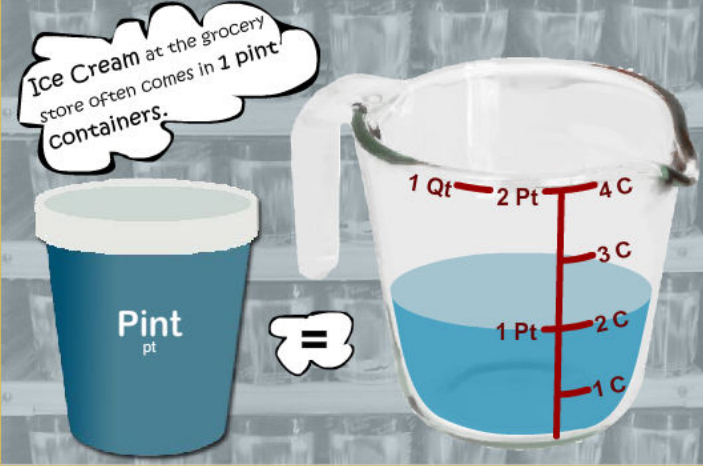


Pint (Pt)
A unit of volume that is **larger** than a Cup

This is frame 7

Questions continue with the next frame.

◀ Back 16% Complete Next ▶



Ice Cream at the grocery store often comes in 1 pint containers.

Pint
pt

This is frame 8

Regarding frames 5 and 6

1. Do the graphics and text on each screen convey the same information?

 Yes No

comment

2. Do the graphics on these screens facilitate learning?

 Yes No

comment

3. Do the animations on these screens facilitate learning?

 Yes No

comment

4. Is the presentation of the content conversational rather than formal?

 Yes No

comment

◀ Back 18% Complete Next ▶

This is frame 9

Questions continue with the next frame.

1 Cup + 1 Cup = 1 Pint

[replay](#)

◀ Back 20% Complete

A pint of ice cream equals 2 cup(s). [check answer](#)

This is frame 10

Regarding frames 9 and 10

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint?

Yes No

comment

2. Do the animations and interactions accommodate learning needs of students with learning disabilities?

Yes No

comment

3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

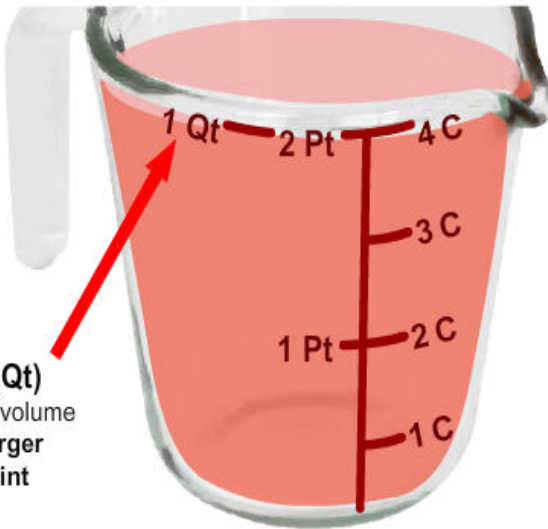
Yes No

comment

◀ Back 22% Complete Next ▶

This is frame 11

Questions continue with the next frame.



Quart (Qt)
A unit of volume that is larger than a Pint

◀ Back 24% Complete Next ▶

This is frame 12


Regarding frames 5 and 6

1. Do the graphics and text on each screen convey the same information?
 Yes No
 comment

2. Do the graphics on these screens facilitate learning?
 Yes No
 comment

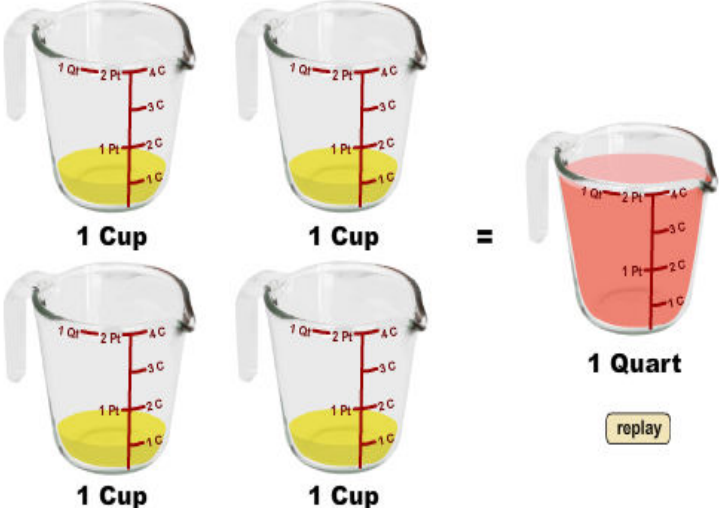
3. Do the animations on these screens facilitate learning?
 Yes No
 comment

4. Is the presentation of the content conversational rather than formal?
 Yes No
 comment



← Back 26% Complete Next →

4 Cups equals 1 Quart.



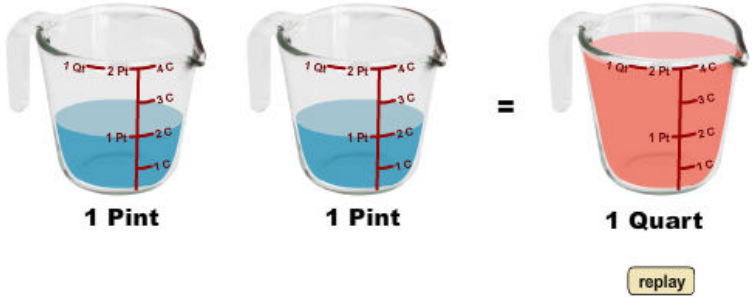
The diagram illustrates the conversion of cups to quarts. On the left, four measuring cups are shown, each containing 1 cup of yellow liquid. Each cup has a scale with markings for 1 Cup, 2 Cups, 3 Cups, 1 Pint, 2 Pints, and 1 Quart. Below each cup is the label "1 Cup". An equals sign follows. On the right, a single measuring cup is shown, filled with red liquid up to the 1 Quart mark. Below it is the label "1 Quart" and a "replay" button.

This is frame 13

Questions continue in two frames.

← Back 29% Complete Next →

2 Pints equals 1 Quart.



The diagram illustrates the conversion of pints to quarts. On the left, two measuring cups are shown, each containing 1 pint of blue liquid. Each cup has a scale with markings for 1 Cup, 2 Cups, 3 Cups, 1 Pint, 2 Pints, and 1 Quart. Below each cup is the label "1 Pint". An equals sign follows. On the right, a single measuring cup is shown, filled with red liquid up to the 1 Quart mark. Below it is the label "1 Quart" and a "replay" button.


This is frame 14

Questions continue with the next frame.

This is frame 15

← Back 30% Complete

A quart of oil equals ____ cup(s). check answer



Regarding frames 13 — 15

- Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart?

Yes No

comment
- Do the animations and interactions accommodate the needs of students with learning disabilities?

Yes No

comment
- Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?


Yes No

comment

This is frame 16

← Back 32% Complete Next →

We need a bigger container to measure a gallon.



Questions continue in two frames.

This is frame 17

Back 34% Complete Next

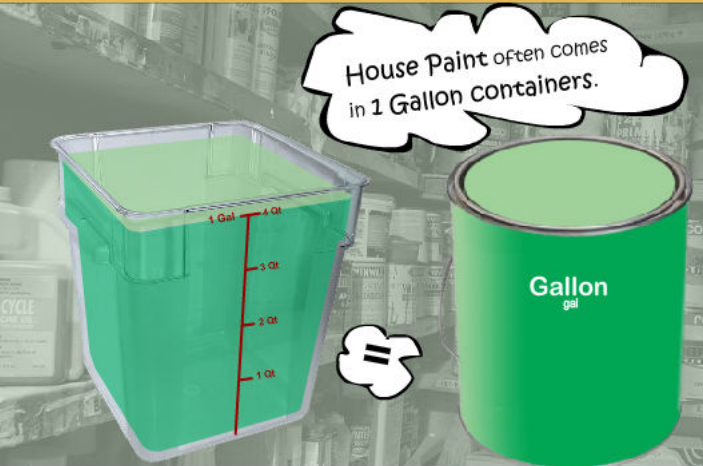


Gallon (Gal)
A unit of volume that is larger than a Quart

Questions continue with the next frame.

This is frame 18

Back 36% Complete Next



House Paint often comes in 1 Gallon containers.

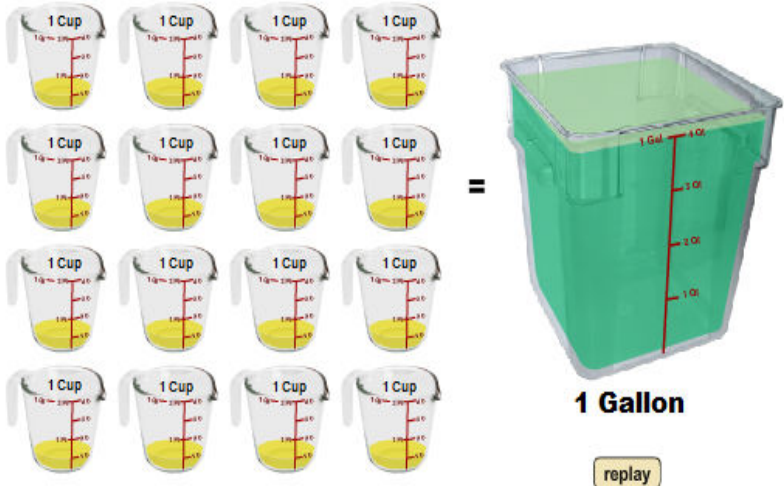
Gallon
gal

Regarding frames 5 and 6

- Do the graphics and text on each screen convey the same information?
 Yes No
 comment
- Do the graphics on these screens facilitate learning?
 Yes No
 comment
- Do the animations on these screens facilitate learning?
 Yes No
 comment
- Is the presentation of the content conversational rather than formal?
 Yes No
 comment

← Back 38 % Complete Next →

16 Cups equals 1 Gallon.



1 Gallon

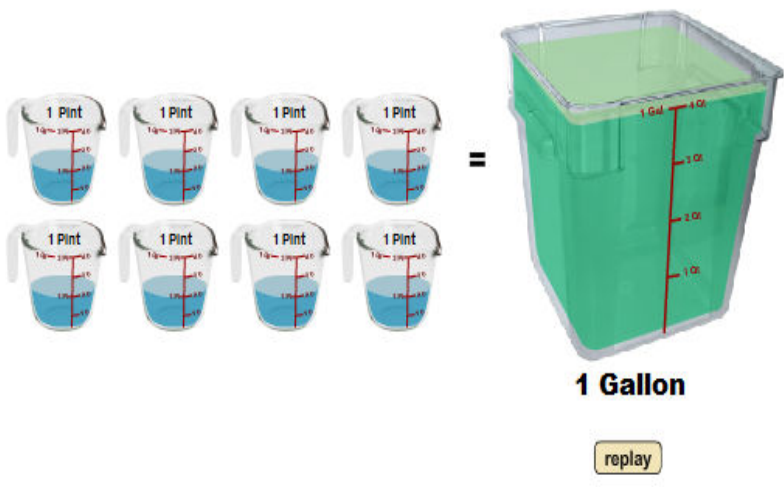
replay

This is frame 19

Questions continue in two frames.

← Back 40 % Complete Next →

8 Pints equals 1 Gallon.



1 Gallon

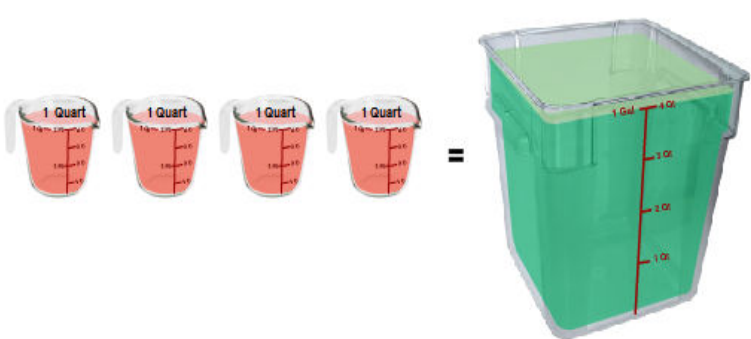
replay

This is frame 20

Questions continue with the next frame.

← Back 42% Complete Next →

4 Quarts equals 1 Gallon.



1 Gallon

This is frame 21

Regarding frames 19 — 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon?

Yes No

comment

2. Do the animations and interactions accommodate needs of students with learning disabilities?

Yes No

comment


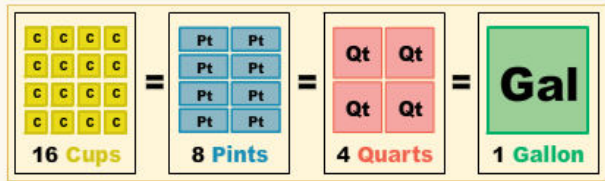
3. Do these screens provide enough opportunity for manipulation to enhance learning?

Yes No

comment

← Back 44% Complete Next →

- One gallon equals 16 cups.
- How many pints are there in a gallon? 8
- There are 4 quarts in a gallon.

16 Cups **8 Pints** **4 Quarts** **1 Gallon**

This is frame 22

Questions for this section of the tutorial will appear with frame 28.

← Back 46% Complete Next →

1. There are 8 pints in 1 gallon. True False
2. Two pints are equal to one quart. True False
3. A pint equals 4 cups. True False
4. A quart is smaller than a pint. True False
5. Four pints make one quart. True False

← Hint

<table style="width: 100%; text-align: center;"> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> </table> <p>16 Cups</p>	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	=	<table style="width: 100%; text-align: center;"> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> </table> <p>8 Pints</p>	Pt	Pt	Pt	Pt	Pt	Pt	Pt	Pt	=	<table style="width: 100%; text-align: center;"> <tr><td>Qt</td><td>Qt</td></tr> <tr><td>Qt</td><td>Qt</td></tr> </table> <p>4 Quarts</p>	Qt	Qt	Qt	Qt	=	<div style="background-color: #90EE90; padding: 10px; font-size: 2em; font-weight: bold;">Gal</div> <p>1 Gallon</p>
C	C	C	C																															
C	C	C	C																															
C	C	C	C																															
C	C	C	C																															
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Qt	Qt																																	
Qt	Qt																																	

This is frame 23

Questions for this section of the tutorial will appear with frame 28.

← Back 48% Complete Next →


Smallest ————— Largest



1 Cup



1 Pint



1 Quart




1 Gallon

This is frame 24

Questions for this section of the tutorial will appear with frame 28.

◀ Back 50% Complete Next ▶

Smallest  Largest

Cup Pint Quart Gallon

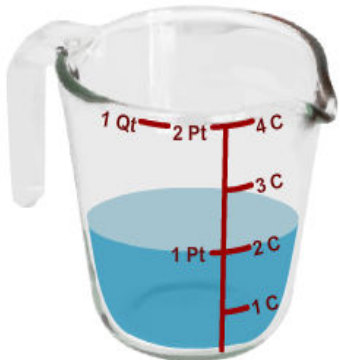
replay

This is frame 25

Questions for this section of the tutorial will appear with frame 28.

◀ Back 52% Complete Next ▶

How many cups make up a pint? 2 [check answer](#)



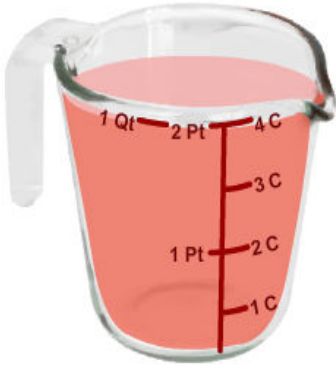
This is frame 26

Questions for this section of the tutorial will appear with frame 28.

This is frame 27

◀ Back 54% Complete Next ▶

How many pints make up a quart? 2 check answer




Questions for this section of the tutorial will appear with frame 28.

This is frame 28

◀ Back 57% Complete

How many quarts make up a gallon? 4 check answer



Regarding frames 22–28 (feel free to use the Back and Next buttons to refresh your memory):

- Do you feel the tutorial content in this section is appropriate for a typically achieving 4th grade student?
 Yes No
comment
- Is the tutorial content in this section appropriate for a 4th grade student with learning disabilities?
 Yes No
comment
- Does this section allow students to progress at their own pace?
 Yes No
comment
- Do the graphics, animations, and interactivity employed in this section accommodate needs of students with learning disability?
 Yes No
comment
- Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as
 Yes No
comment

◀ Back 58% Complete Next ▶

Let's learn how to find **the total volume of more than 1 container.**

This is frame 29

Questions continue with the next frame.

◀ Back 60% Complete Next ▶

How to Find Total Volume

replay **Step 1. Group** - Group containers by volume

replay **Step 2. Convert** - Convert between groups

replay **Step 3. Count** - Count each group

1	0	3	1
Cups	Pints	Quarts	Gallons
1		2	1

This is frame 30

Regarding frames 29—30:

1. Do you feel the tutorial content in this section is appropriate for a typically achieving 4th grade student?

Yes No

comment

2. Is the tutorial content appropriate for a 4th grade student with learning disabilities?

Yes No

comment

3. Do these screens provide enough opportunity for manipulation to enhance learning?

Yes No

comment

4. Do the graphics facilitate learning?

Yes No

comment

5. Do the animations facilitate learning?

Yes No


comment

This is frame 31

Back 62% Complete Next

How to Find Total Volume

➔ **Step 1. Group**
 Step 2. Convert
 Step 3. Count




Questions will continue on the next frame

This is frame 33

Back 66% Complete

Step 1. Group - Practice

Cups	Pints	Quarts	Gallons



Regarding frames 30-33

1. Do these screens provide enough opportunity for manipulation to enhance learning?
 Yes No
 comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment

3. Do these screens allow students to progress at their own pace?
 Yes No
 comment




4. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
 Yes No
 comment

This is frame 34

◀ Back
68 % Complete
Next ▶

How to Find Total Volume

Step 1. Group
 ➔ **Step 2. Convert**
 Step 3. Count

Cups	Pints	Quarts	Gallons
			

Questions will continue.







This is frame 36

◀ Back
72 % Complete
Next ▶

Step 2. Convert

Earlier we saw how **smaller units can be added together to equal larger units.**

Equal Volume

2 Cups		=		1 Pint
2 Pints		=		1 Quart
4 Quarts		=		1 Gallon

Questions will continue

◀ Back
74 % Complete
Next ▶

Step 2. Convert

Conversion allows you to **change units** as long as **what you take away equals what you add.**

Equal Volume

2 Cups c c = convert

2 Pints Pt Pt = convert

4 Quarts Qt Qt Qt Qt = convert

This is frame 37

Regarding frames 34-37

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities?
 Yes No
comment

2. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

3. Do the graphics, animations and interactions accommodate the needs of students with learning disabilities?
 Yes No
comment

4. Is this content on the screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
 Yes No
comment

5. Is the reading level of the text appropriate students with learning disabilities?
 Yes No

◀ Back
76 % Complete
Next ▶

Step 2. Convert

Convert to the largest possible units unless the question asks for smaller units.

Q: How much volume do we have?

Cups	Pints	Quarts	Gallons
c			Gal

replay

This is frame 38

Questions continue on the next frame.

Back 78% Complete

Step 2. Convert

Q: How much volume do we have?

0 Cups	1 Pints Pt	4 Quarts Qt Qt Qt Qt	0 Gallons
---------------	----------------------	-----------------------------------	------------------

Quarts → Gallons

How many quarts equal 1 gallon? 4

How many quarts can we convert into gallons? check answer

This is frame 39

Regarding frames 38-39

1. Is the tutorial content appropriate for a 4th grade student with a learning disability?

 Yes No

comment

2. Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?

 Yes No

comment

3. Is the content on the screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

 Yes No

comment

4. Is the reading level of the text appropriate for students with learning disabilities? Yes No

comment

5. Does this screen provide enough opportunity for manipulation to enhance learning?

 Yes No

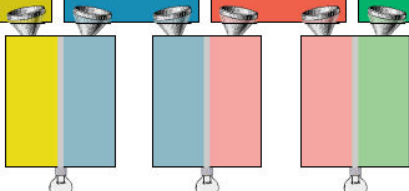
comment

Back 80% Complete Next

Step 2. Convert - Practice

Q: How much volume do we have?

Cups c	Pints Pt	Quarts Qt Qt Qt	Gallons Gal
-----------	-------------	-----------------------	----------------



replay

This is frame 40

Regarding this frame:

1. Does this screen provide enough opportunity for manipulation to reinforce learning?

 Yes No

comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

 Yes No

comment

3. Does this screen allow students to progress at their own pace?

 Yes No

comment

4. Do the movements and sounds inside the funnel interfere with the understanding of the second step?

 Yes No

comment

5. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

 Yes No

comment

◀ Back
82% Complete
Next ▶

This is frame 41

Step 2. Convert

Sometimes a question will ask you to convert to smaller units.

Q: How many **pints** do we have?

Cups

C

Pints

Pt Pt
Pt Pt
Pt Pt
Pt Pt

Quarts

Gallon

replay

➔
➔

Questions will continue on the next frame.

◀ Back
84% Complete
This is frame 42

Step 2. Convert

Q: How many **pints** can we make?

3 **Cups**

c c c

0 **Pints**

4 **Quarts**

Qt Qt
Qt Qt

0 **Gallons**

←
↔
→

How many pints equal 1 quart?

2

How many quarts can we convert?

4

How many pints will we create when we convert our quarts to pints?

8

check answer

Regarding frames 41-42

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities?

Yes
 No
2. Do the graphics, animations and interactions on accommodate learning attributes of students with learning disabilities?

Yes
 No
3. Is the content on the screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

Yes
 No
4. Is the reading level appropriate for students with learning disabilities?

Yes
 No
5. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes
 No

← Back 86 % Complete

Step 2. Convert - Practice
 Q: How many quarts do we have?

This is frame 43

Regarding this frame:

1. Is there enough opportunity for manipulation to reinforce learning?
 Yes No
 comment
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment
3. Does this screen allow students to progress at their own pace?
 Yes No
 comment
4. Do the movements and sounds inside the funnel interfere with the understanding of the second step?
 Yes No
 comment
5. Is this section of the tutorial designed and functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
 Yes No
 comment

← Back 88 % Complete Next →

How to Find Total Volume

Step 1. Group
 Step 2. Convert
 → Step 3. Count

This is frame 44

Regarding this screen

1. Do the animated graphics and text on this screen convey the same information?
 Yes No
 comment
2. Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?
 Yes No
 comment

◀ Back
92 % Complete
Next ▶

Step 3. Count - Practice

Q: How much volume do we have?

3

Cups

c

c c

1

Pints

Pt

2

Quarts

Qt

Qt

1

Gallons

Gal

replay

This is frame 46

Regarding this screen

1. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
comment

3. Does this screen allow students to progress at their own pace?
 Yes No
comment

4. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
 Yes No
comment

◀ Back
94 % Complete
Next ▶

Finding
Total =
Volume

1. Group

Group containers into cups, pints, quarts, & gallons

▶

2. Convert

Convert to largest units or to the units asked for in the question

▶

3. Count

Count the number of containers in each group

replay

This is frame 47

Regarding this screen

1. Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
 Yes No
comment

2. Is the reading level of the text appropriate for students with learning disabilities?
 Yes No
comment

3. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
comment

◀ Back
96 % Complete
Next ▶

Planning a Party

Aaron is planning to have a party for 14 of his friends. He thinks that each friend will drink one cup of juice. He has 1 gallon of juice. Does he have enough juice for each of his friends?

Let's convert Aaron's gallon to cups to see if he has enough juice for his friends:

1 gallon = 4 quarts

1 quart = 2 pints

4 quarts = 8 pints

1 pint = 2 cups

8 pints = 16 cups

Problem Complete

This is frame 48

Regarding this screen

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities?
 Yes No
comment
2. Does this section of the tutorial allow students to progress at their own pace?
 Yes No
comment
3. Is the reading level of the text appropriate for students with learning disabilities?
 Yes No
comment
4. Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
 Yes No
comment
5. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

◀ Back
98 % Complete
Next ▶

Snack Time

A teacher wants to give her 16 students chocolate milk at snack time. She thinks each student will drink 1 pint. She has 1 gallon and 3 quarts of chocolate milk. Does she have enough?

Let's convert the teachers chocolate milk to pints to see if she has enough:

1 gallon = 4 quarts

The teacher already has 3 quarts, so she now has 3 quarts + 4 = 7 quarts

1 quart = 2 pints

7 quarts = 14 pints

Problem Complete

This is frame 49

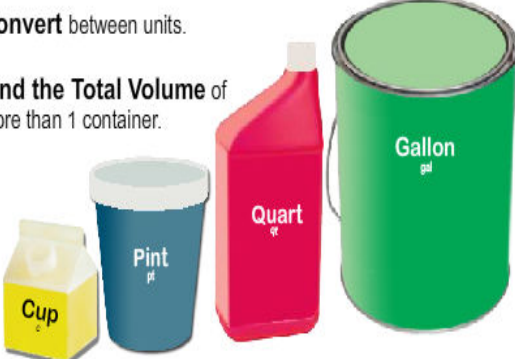
Regarding this screen

1. Is the tutorial content in this section appropriate for a 4th grade student with learning disabilities?
 Yes No
comment
2. Does this section of the tutorial allow students to progress at their own pace?
 Yes No
comment
3. Is the reading level of the text appropriate for students with learning disabilities?
 Yes No
comment
4. Is this screen designed and functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
 Yes No
comment
5. Does this screen provide enough opportunity for manipulation to enhance learning?
 Yes No
comment

← Back100 % Complete

In this lesson you learned how to...

1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.



1. Are the skills and concepts in the tutorial aligned with the intent of the Kansas indicator below?

The Kansas Standard: 3.2. K2b category 3b
Standard: Geometry . The student uses geometric concepts and procedures in a variety of situations.
Benchmark: Measurement and Estimation . The student measures using standard units of measure including the use of concrete objects in a variety of situations.
Indicator: The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure - volume to the nearest cup, pint, quart, or gallon.

Yes No

comment

Submit this survey

This is frame 50

Appendix E

Screen Shots of Tutorial

Sent to multimedia/technology experts.

0% Complete
Next

This is frame 1

In this lesson you will learn how to...

1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.

Cup
Pint
Quart
Gallon

cup
pt
qt
gal

When we want feedback, questions will appear in this section of your screen. This will begin with the next frame. Use the 'Next' button in the tutorial to proceed.

Back
4% Complete
Next

This is frame 2

Volume is the amount of space something takes up.

1. Does the ability to change the volume aid in the representation of the instructional concepts?

Yes
 No

comment
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

Yes
 No

comment
3. Do the graphics and text convey the same information?

Yes
 No

comment

◀ Back 6% Complete Next ▶

Units help us describe how much of something there is.

This is frame 3

1. Does the ability to change the units aid in the representation of the instructional concepts?

Yes No

comment

2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

Yes No

comment

3. Do the graphics and text convey the same information?

Yes No

comment

◀ Back 8% Complete Next ▶

Cup, Pint, Quart, and Gallon are units that hold different amounts of volume.

This is frame 4

1. Do the graphics on this screen facilitate learning?

Yes No

comment

2. Do the animations on this screen facilitate learning?

Yes No

comment

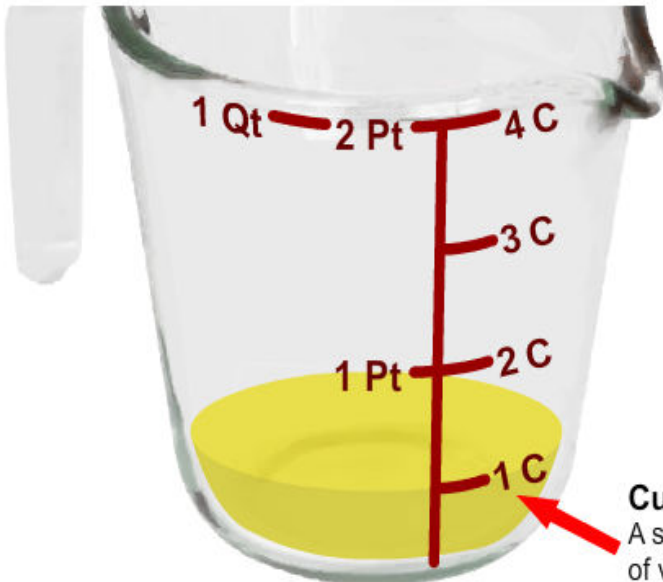
3. Do the animated graphics and text convey the same information?

Yes No

comment

This is frame 5

Back 10% Complete Next



Cup (C)
A small unit of volume

Questions continue with the next frame.

This is frame 6

Back 12% Complete Next



Milk cartons at school often have 1 cup of milk in them.

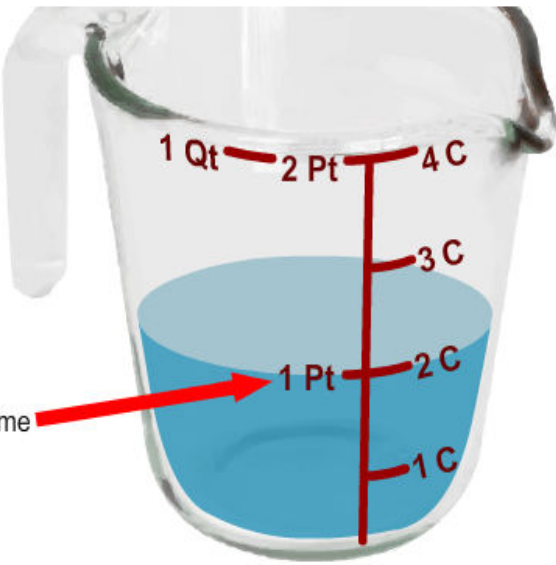
Cup

Regarding frames 5 and 6

- Do the graphics and text on each screen convey the same information?
 Yes No
comment
- Is the presentation of the content conversational rather than formal?
 Yes No
comment
- Do the virtual manipulative objects used here [e.g. measuring cup, milk carton] accurately represent concrete real life objects?
 Yes No
comment

This is frame 7

Back 15% Complete Next

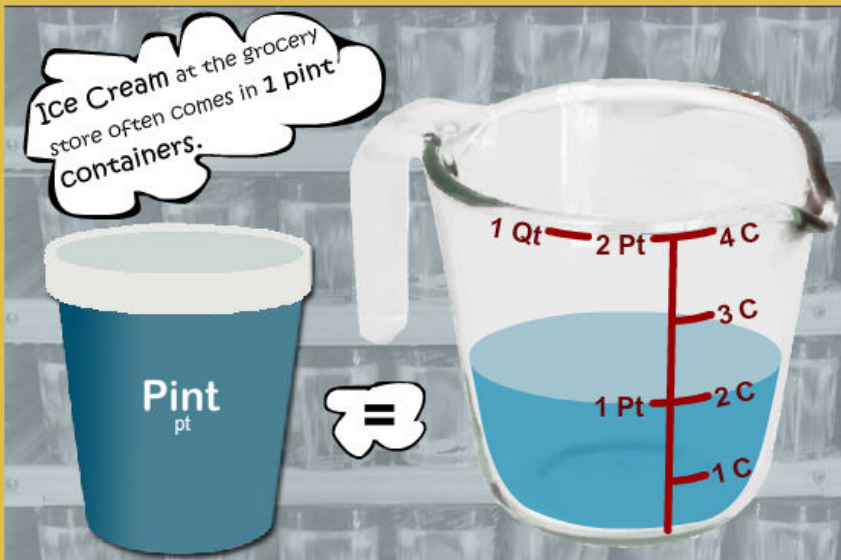


Pint (Pt)
A unit of volume that is larger than a Cup

Questions continue with the next frame.

This is frame 8

Back 16% Complete Next



Ice Cream at the grocery store often comes in 1 pint containers.

Pint
pt

Regarding frames 7 and 8

- Do the graphics and text on each screen convey the same information?
 Yes No
 comment
- Is the presentation of the content conversational rather than formal?
 Yes No
 comment
- Do the virtual manipulative objects used here [e.g. measuring cup, ice-cream container] accurately represent concrete real life objects?
 Yes No
 comment

This is frame 9

Back 18% Complete Next

replay

Questions continue with the next frame.

Back 20% Complete

A pint of ice cream equals ____ cup(s). check answer

This is frame 10

Regarding frames 9 and 10

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint?

Yes No

comment

2. Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?

Yes No

comment

3. Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?

Yes No

comment

4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes No

comment

This is frame 11

Back 22% Complete Next

Quart (Qt)
A unit of volume that is **larger** than a Pint

Questions continue with the next frame.

This is frame 12

Back 24% Complete Next

Car Oil often comes in 1 Quart containers.

Regarding frames 11 and 12

1. Do the graphics and text on each screen convey the same information?

Yes No

comment

2. Is the presentation of the content conversational rather than formal?

Yes No

comment

3. Do the virtual manipulative objects used here [e.g. measuring cup, oil can] accurately represent concrete real life objects?

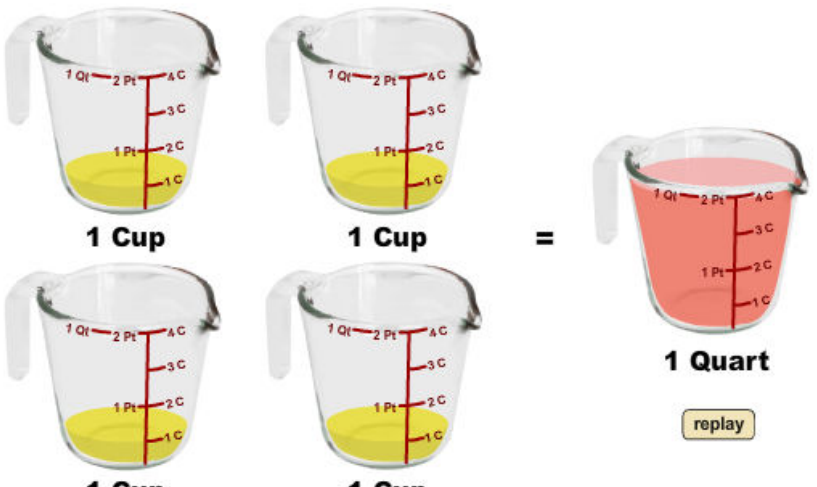
Yes No

comment

This is frame 13

← Back 26% Complete Next →

4 Cups equals 1 Quart.



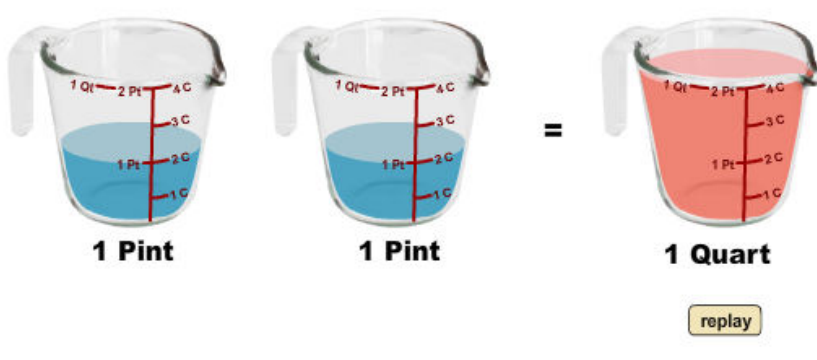
The diagram illustrates the conversion of 4 cups to 1 quart. On the left, four identical measuring cups are arranged in a 2x2 grid. Each cup is filled with yellow liquid up to the 1-cup mark. Below each cup is the label "1 Cup". An equals sign "=" is placed to the right of the cups. To the right of the equals sign is a single measuring cup filled with red liquid up to the 1-quart mark. Below this cup is the label "1 Quart". A "replay" button is located below the 1 quart cup.

Questions continue in two frames.

This is frame 14

← Back 29% Complete Next →

2 Pints equals 1 Quart.





The diagram illustrates the conversion of 2 pints to 1 quart. On the left, two identical measuring cups are arranged side-by-side. Each cup is filled with blue liquid up to the 1-pint mark. Below each cup is the label "1 Pint". An equals sign "=" is placed to the right of the cups. To the right of the equals sign is a single measuring cup filled with red liquid up to the 1-quart mark. Below this cup is the label "1 Quart". A "replay" button is located below the 1 quart cup.

Questions continue with the next frame.

This is frame 15

◀ Back 30% Complete Next ▶

A quart of oil equals 4 cup(s). check answer


=


Regarding frames 13—15

- Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart?

 Yes No

comment
- Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction as needed?

 Yes No

comment
- Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?

 Yes No

comment
- Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?


 Yes No

comment

This is frame 16

◀ Back 32% Complete Next ▶

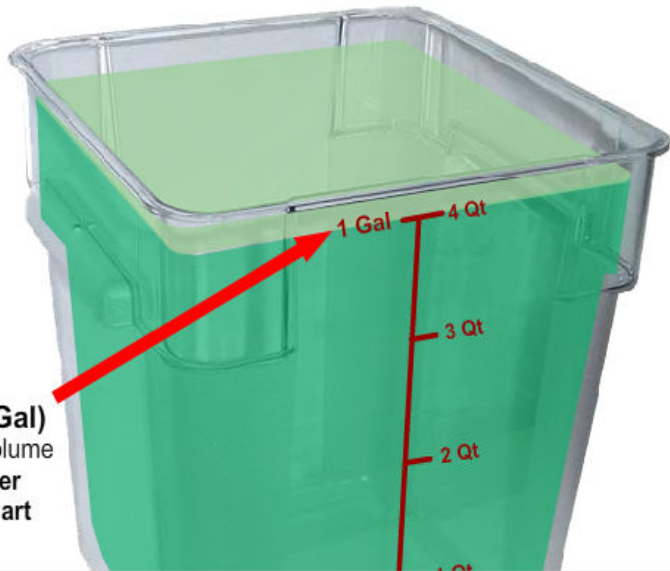
We need a bigger container to measure a gallon.



Questions continue in two frames.

This is frame 17

Back 34% Complete Next

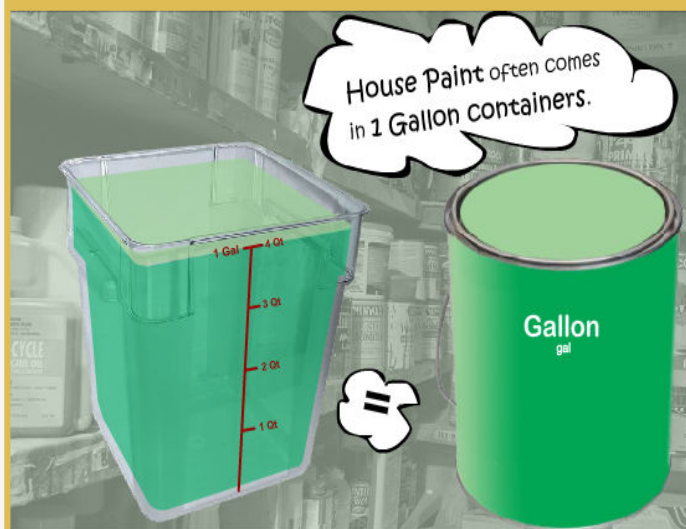


Gallon (Gal)
A unit of volume that is **larger** than a **Quart**

Questions continue with the next frame.

This is frame 18

Back 36% Complete Next



House Paint often comes in 1 Gallon containers.

Gallon
gal

Regarding frames 16 — 18

1. Do the graphics and text on each screen convey the same information?
 Yes No
 comment

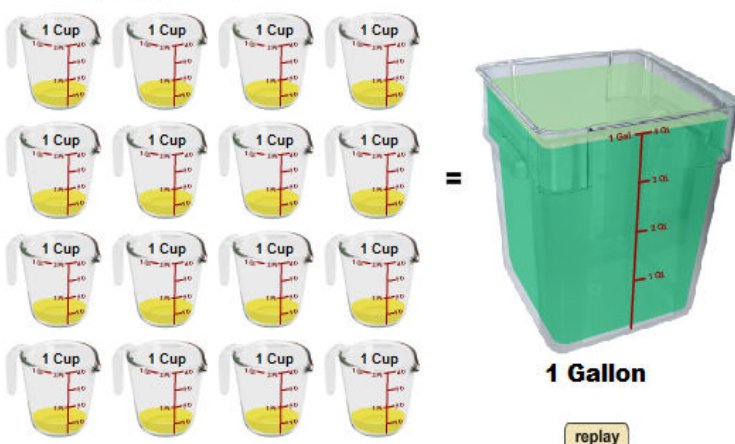
2. Is the presentation of the content conversational rather than formal?
 Yes No
 comment

3. Do the virtual manipulative objects used here [e.g. measuring cup, house paint] accurately represent concrete real life objects?
 Yes No
 comment

This is frame 19

Back 38% Complete Next

16 Cups equals 1 Gallon.



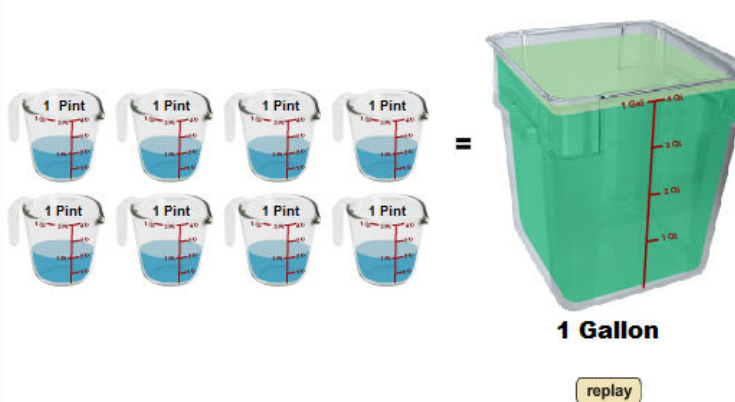
16 measuring cups, each labeled "1 Cup", are shown in a 4x4 grid. Each cup contains yellow liquid. An equals sign follows, leading to a large green measuring jug labeled "1 Gallon" which is filled with yellow liquid. A "replay" button is located below the jug.

Questions continue in two frames.

This is frame 20

Back 40% Complete Next

8 Pints equals 1 Gallon.



8 measuring cups, each labeled "1 Pint", are shown in a 2x4 grid. Each cup contains blue liquid. An equals sign follows, leading to a large green measuring jug labeled "1 Gallon" which is filled with blue liquid. A "replay" button is located below the jug.

Questions continue with the next frame.

← Back 42% Complete Next ▶

4 Quarts equals 1 Gallon.

1 Gallon

replay

This is frame 21

Regarding frames 19 — 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon?

Yes No

comment

2. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?

Yes No

comment

3. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently the instruction as needed?

Yes No

comment

4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes No

comment

← Back 44% Complete Next ▶

1. One gallon equals 16 cups. check answer

2. How many pints are there in a gallon? 8 check answer

3. There are 4 quarts in a gallon. check answer

Hint

<table style="border-collapse: collapse;"> <tr><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td></tr> <tr><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td></tr> <tr><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td></tr> <tr><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td><td style="padding: 2px 5px;">c</td></tr> </table> <p>16 Cups</p>	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	=	<table style="border-collapse: collapse;"> <tr><td style="padding: 2px 5px;">Pt</td><td style="padding: 2px 5px;">Pt</td></tr> <tr><td style="padding: 2px 5px;">Pt</td><td style="padding: 2px 5px;">Pt</td></tr> <tr><td style="padding: 2px 5px;">Pt</td><td style="padding: 2px 5px;">Pt</td></tr> <tr><td style="padding: 2px 5px;">Pt</td><td style="padding: 2px 5px;">Pt</td></tr> </table> <p>8 Pints</p>	Pt	Pt	Pt	Pt	Pt	Pt	Pt	Pt	=	<table style="border-collapse: collapse;"> <tr><td style="padding: 2px 5px;">qt</td><td style="padding: 2px 5px;">qt</td></tr> <tr><td style="padding: 2px 5px;">qt</td><td style="padding: 2px 5px;">qt</td></tr> </table> <p>4 Quarts</p>	qt	qt	qt	qt	=	<div style="background-color: #90EE90; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 0 auto;"> Gal </div> <p>1 Gallon</p>
c	c	c	c																															
c	c	c	c																															
c	c	c	c																															
c	c	c	c																															
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
qt	qt																																	
qt	qt																																	

This is frame 22

Questions for this section of the tutorial will appear with frame 28.

← Back 46% Complete Next →

1. There are 8 pints in 1 gallon. True False
2. Two pints are equal to one quart. True False
3. A pint equals 4 cups. True False
4. A quart is smaller than a pint. True False
5. Four pints make one quart. True False

← Hint

<table style="width: 100%; text-align: center;"> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> <tr><td>C</td><td>C</td><td>C</td><td>C</td></tr> </table> <p>16 Cups</p>	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	=	<table style="width: 100%; text-align: center;"> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> <tr><td>Pt</td><td>Pt</td></tr> </table> <p>8 Pints</p>	Pt	Pt	Pt	Pt	Pt	Pt	Pt	Pt	=	<table style="width: 100%; text-align: center;"> <tr><td>Qt</td><td>Qt</td></tr> <tr><td>Qt</td><td>Qt</td></tr> </table> <p>4 Quarts</p>	Qt	Qt	Qt	Qt	=	<div style="background-color: #90EE90; width: 60px; height: 60px; display: flex; align-items: center; justify-content: center; margin: 0 auto;"> Gal </div> <p>1 Gallon</p>
C	C	C	C																															
C	C	C	C																															
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C	C	C	C																															
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Pt	Pt																																	
Qt	Qt																																	
Qt	Qt																																	

This is frame 23

Questions for this section of the tutorial will appear with frame 28.

← Back 48% Complete Next →

Smallest ----- Largest

1 Cup

1 Pint

1 Quart

1 Gallon

This is frame 24

Questions for this section of the tutorial will appear with frame 28.

◀ Back 50% Complete Next ▶

This is frame 25

Questions for this section of the tutorial will appear with frame 28.

Smallest _____ Largest

Cup Pint Quart Gallon

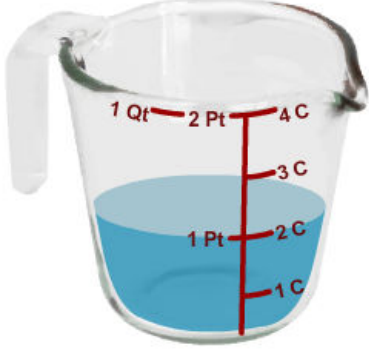
replay

◀ Back 52% Complete Next ▶

This is frame 26

Questions for this section of the tutorial will appear with frame 28.


How many cups make up a pint? 2



This is frame 27

← Back 54% Complete Next →

How many pints make up a quart? 2 check answer




Questions for this section of the tutorial will appear with frame 28.

This is frame 28

← Back 57% Complete Next →

How many quarts make up a gallon? 4 check answer



Regarding frames 22—28 (feel free to use the Back and Next buttons to refresh your memory):

- Do the graphics in this section facilitate learning?
 Yes No
comment
- Do the animations in this section facilitate learning?
 Yes No
comment
- Does this section of the tutorial provide enough feedback to support learning?
 Yes No
comment
- Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate and the instruct needed?
 Yes No
comment
- Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as needed?
 Yes No
comment

◀ Back 58% Complete Next ▶

Let's learn how to find **the total volume of more than 1 container.**

This is frame 29

Questions continue with the next frame.

◀ Back 60% Complete Next ▶

How to Find Total Volume

Step 1. Group - Group containers by volume

Step 2. Convert - Convert between groups

Step 3. Count - Count each group

1 Cups	0 Pints	3 Quarts	1 Gallons

This is frame 30

Regarding frames 29—30:

1. Is there enough opportunity for manipulation to enhance learning?

Yes No

comment

2. Do the graphics facilitate learning?

Yes No

comment

3. Do the animations facilitate learning?

Yes No

comment

4. Are the words in bold and/or highlighted relevant to the concept being learned?

Yes No


comment

This is frame 31

Questions will continue on the next frame

How to Find Total Volume




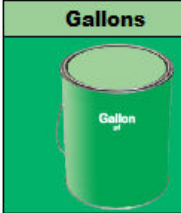
➔ **Step 1. Group**
 Step 2. Convert
 Step 3. Count



This is frame 33

Regarding frames 30-33

Step 1. Group - Practice

Cups	Pints	Quarts	Gallons
			

[replay](#)

1. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment

2. Does this screen allow students to progress at their own pace?
 Yes No
 comment

This is frame 34




◀ Back
68% Complete
Next ▶

How to Find Total Volume

Step 1. Group

➔ **Step 2. Convert**

Step 3. Count

Cups	Pints	Quarts	Gallons
			

Questions will continue.







This is frame 36

◀ Back
72% Complete
Next ▶

Step 2. Convert

Earlier we saw how **smaller units can be added together to equal larger units.**

Equal Volume

2 Cups		=		1 Pint
2 Pints		=		1 Quart
4 Quarts		=		1 Gallon

Questions will continue

This is frame 37

◀ Back 74% Complete Next ▶

Step 2. Convert
Conversion allows you to **change units** as long as **what you take away equals what you add**.

Equal Volume

2 Cups c c = convert

2 Pints Pt Pt = convert

4 Quarts Qt Qt Qt Qt = convert

Regarding frames 34-37

1. Is there enough opportunity for manipulation to enhance learning?
 Yes No
 comment

2. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
 Yes No
 comment

3. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?
 Yes No
 comment

This is frame 38

◀ Back 76% Complete Next ▶

Step 2. Convert
Convert to the largest possible units unless the question asks for smaller units.

Q: How much volume do we have?

Cups
c

Pints

Quarts

Gallons
Gal

replay

Questions continue on the next frame.

◀ Back
78 % Complete

Step 2. Convert

Q: How much volume do we have?

0 Cups	1 Pints	4 Quarts	0 Gallons
	Pt	Qt Qt Qt Qt	

➔ Quarts to Gallons

How many quarts equal 1 gallon? 4

How many quarts can we convert into gallons? 4 check answer

This is frame 39

Regarding frames 38-39

1. Do the graphics facilitate learning?
 Yes No
 comment

2. Do the animations facilitate learning?
 Yes No
 comment

3. Do the animations function at the correct speed?
 Yes No
 comment

4. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
 Yes No
 comment

◀ Back
80 % Complete

Step 2. Convert - Practice

Q: How much volume do we have?

Cups	Pints	Quarts	Gallons
	Pt	Qt	Gal

This is frame 40

Regarding this frame:

1. Does this screen provide enough opportunity to manipulate and practice to reinforce learning?
 Yes No
 comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?
 Yes No
 comment

3. Does this screen allow students to progress at their own pace?
 Yes No
 comment

4. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
 Yes No
 comment

◀ Back 82% Complete Next ▶

Step 2. Convert
 Sometimes a question will ask you to convert to smaller units.

Q: How many **pints** do we have?

Two large arrows point towards each other at the bottom of the unit boxes.

This is frame 41

Questions will continue with the next frame.

◀ Back 84% Complete

Step 2. Convert
 Q: How many **pints** can we make?

How many pints equal 1 quart? **2**

How many quarts can we convert? **4**

How many pints will we create when we convert our quarts to pints? **8** check answer

This is frame 42

Regarding this screen

1. Do the graphics facilitate learning?
 Yes No
 comment

2. Do the animations facilitate learning?
 Yes No
 comment

3. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
 Yes No
 comment

4. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?
 Yes No
 comment

◀ Back 86 % Complete

Step 2. Convert - Practice
 Q: How many quarts do we have?

Cups c	Pints Pt	Quarts Qt Qt Qt	Gallons
------------------	--------------------	------------------------------	----------------

This is frame 43

Regarding this frame:

1. Does this screen provide enough opportunity to manipulate and practice to reinforce learning?

Yes No

comment

2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

Yes No

comment

3. Does this screen allow students to progress at their own pace?

Yes No

comment

4. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?

Yes No

comment

◀ Back 88 % Complete ▶ Next

How to Find Total Volume

Step 1. Group
 Step 2. Convert
 ➔ Step 3. Count

1 Cups Cup 1	0 Pints	3 Quarts 2 3 Quart Quart	1 Gallons Gallon
----------------------------------	-----------------------	--	-----------------------------------

This is frame 44

Regarding this screen

1. Do the graphics facilitate learning?

Yes No

comment

2. Do the animations facilitate learning?

Yes No

comment

3. Do the animations function at the correct speed?

Yes No

comment

4. Do the animated graphics and text on this screen convey the same information?

Yes No

comment

This is frame 46

◀ Back
92% Complete
Next ▶

Step 3. Count - Practice

Q: How much volume do we have?

3 **Cups**

c
c
c

1 **Pints**

Pt

1 **Quarts**

Qt

2 **Gallons**

Gal
ll

replay

Regarding this screen

1. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback and guidance to engage students and support learning?

Yes No

comment

2. Does this screen allow students to progress at their own pace?

Yes No

comment

This is frame 47

◀ Back
94% Complete
Next ▶

Finding
Total=
Volume

1. Group

Group containers into cups, pints, quarts, & gallons

➔

2. Convert

Convert to largest units or to the units asked for in the question

➔

3. Count

Count the number of containers in each group

replay

Consider frames 30-47 (feel free to use the Back button to review):

1. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?

Yes No

comment

2. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

Yes No

comment

This is frame 48

Back 96% Complete Next

Planning a Party

Aaron is planning to have a party for 14 of his friends. He thinks that each friend will drink one cup of juice. He has 1 gallon of juice. Does he have enough juice for each of his friends?

Let's convert Aaron's gallon to cups to see if he has enough juice for his friends:


1 gallon = 4 quarts


1 quart = 2 pints

4 quarts = 8 pints

1 pint = 2 cups

8 pints = 16 cups





Problem Complete

Questions will follow in two frames.

This is frame 49

Back 98% Complete Next

Snack Time

A teacher wants to give her 16 students chocolate milk at snack time. She thinks each student will drink 1 pint. She has 1 gallon and 3 quarts of chocolate milk. Does she have enough?

Let's convert the teacher's chocolate milk to pints to see if she has enough:


1 gallon = 4 quarts


The teacher already has 3 quarts, so she now has

3 quarts + 4 = 7 quarts

1 quart = 2 pints

7 quarts = 14 pints






Problem Complete

Questions will follow in the next frame.

◀ Back
100 % Complete

In this lesson you learned how to...

1. Measure volume using the following units:
Cups, Pints, Quarts, & Gallons.
2. **Convert** between units.
3. **Find the Total Volume** of more than 1 container.



This is frame 50

Consider frames 48-50:

1. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
 Yes No
comment

2. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?
 Yes No
comment

3. Does this section of the tutorial allow students to progress at their own pace? (Segmenting Principle)
 Yes No
comment

4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback and guidance to engage students and support learning?
 Yes No
comment

You are now through the tutorial. However, being an expert in technology, we would like to have some more feedback from you about the overall design of the tutorial. Please answer the following questions, and optionally, make comments. Thanks.

1. Do the animations function at the correct speed?
Yes No Comment
2. Are there any colors that are sensitive to changes when viewed on different computers?
Yes No Comment
3. Did you find any objects that need to be modified to be made more realistic?
Yes No Comment
4. Did you find any instructions that were not clear?
Yes No Comment
5. Did you find any screens confusing?
Yes No Comment
6. What do you consider to be the strengths of this tutorial model for students with learning disabilities?
Comment
7. What do you consider to be the weaknesses of this tutorial model for students with learning disabilities?
Comment
8. Are there any additional comments that you would like to share?
Comment

Appendix F

Subject Matter Experts (SMEs): Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria

	Independent Review			Group Review		
	1	2	3	1	2	3
Frame 2						
Does the ability to change the volume aid in the representation of the instructional concepts? (animation and interactivity)						
<ul style="list-style-type: none"> Consider changing emphasis to show volume as main concept. Reduce level of importance on sizes. Match colors with cup, pint, quart, gallon images. 	2, 3	2, 3	2, 3	2, 3	2, 3	2, 3
Are the words that are bold and/or highlighted in this section relevant to the concept being taught?						
<ul style="list-style-type: none"> Consider changing emphasis to show volume as main concept. 	3	3	3	3	3	3
Does this screen provide enough opportunity for manipulation to enhance learning?						
<ul style="list-style-type: none"> It doesn't provide any. It is an introduction to the lesson. 	9	3	9	9	9	9
<ul style="list-style-type: none"> Would help if students could both fill and empty. 	7	4	7	7	4	7
Frame 3						
Are the words that are bold and/or highlighted in this section relevant to the concept being taught?						
<ul style="list-style-type: none"> Change describe to measure 	3	3	3	3	3	3
Does this screen provide enough opportunity for manipulation to enhance learning?						
<ul style="list-style-type: none"> No manipulation provided 	9	3	9	9	9	9
<ul style="list-style-type: none"> The container looks too much like a 	2	2	2	2	2	2

cup measuring tool. Make the container less like an actual measuring tool -- more like just a cylinder.

Frame 4

Do the graphics on this screen facilitate learning?

- | | | | | | | |
|--|------|---|------|------|------|------|
| <ul style="list-style-type: none"> Consider making all lines yellow in color. Nothing definite to say the dots are representing cups. Maybe group each measurement dots to represent the 2 cups in a pint and 2 pints make a quart and so on. | 2, 3 | 2 | 2, 3 | 2, 3 | 2, 3 | 2, 3 |
|--|------|---|------|------|------|------|

Do the animated graphics and text convey the same information?

- | | | | | | | |
|--|---|---|---|---|---|---|
| <ul style="list-style-type: none"> Consider adding text next to the image to say "1 pint = 2 cups" and so on. | 2 | 3 | 3 | 2 | 3 | 3 |
|--|---|---|---|---|---|---|

Frame 6

Is the presentation of the content conversational rather than formal?

- | | | | | | | |
|---|---|---|---|---|------|---|
| <ul style="list-style-type: none"> It may convey both conversational and formal with the labels and measurements on the graphics. | 9 | 3 | 9 | 9 | 2, 3 | 9 |
| <ul style="list-style-type: none"> The container looks too much like a cup measuring tool. Make the container less like an actual measuring tool -- more like just a cylinder. | 2 | 2 | 2 | 2 | 2 | 2 |
| <ul style="list-style-type: none"> It may convey both conversational and formal with the labels and measurements on the graphics. | 9 | 2 | 9 | 9 | 2, 3 | 9 |
| <ul style="list-style-type: none"> The container looks too much like a cup measuring tool. Make the container less like an actual measuring tool -- more like just a cylinder. | 2 | 2 | 2 | 2 | 2 | 2 |

Do the graphics and animation on these screens facilitate learning?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • The carton looks bigger than the measuring cup. | 2 | 2 | 2 | 2 | 2 | 2 |
|---|---|---|---|---|---|---|

Frame 8

Do the graphics and text on each screen convey the same information?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • Good color relation between pint and liquid. | 9 | 9 | 9 | 9 | 9 | 9 |
|--|---|---|---|---|---|---|

Do the graphics and animation on these screens facilitate learning?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • The carton looks bigger than the measuring cup. | 2 | 2 | 2 | 2 | 2 | 2 |
|---|---|---|---|---|---|---|

Is the presentation of the content conversational rather than formal?

- | | | | | | | |
|--|------|------|---------|---------|---------|---------|
| • Uses both conversational and formal. Ice cream is conversational and measurements cover formal. "Equals" might be placed under the equal sign for word to symbol connection. | 9, 3 | 3, 2 | 9, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
|--|------|------|---------|---------|---------|---------|

Frame 10

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- | | | | | | | |
|---|------|---|---|------|------|---|
| • Good color change in pop-up. | 9 | 9 | 9 | 9 | 9 | 9 |
| • Direct student to check the scale on the measuring cup to point them to something that can help them. | 3, 8 | 7 | 8 | 3, 8 | 7, 8 | 8 |

Frame 12

Is the presentation of the content conversational rather than formal?

- | | | | | | | |
|----------------------------------|---|---|---|---|---|---|
| • Both conversational and formal | 9 | 3 | 9 | 9 | 9 | 9 |
|----------------------------------|---|---|---|---|---|---|

Frame 15

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- Add if wrong answer to check the

scale on the measuring cup.	7, 3	4	8	7, 3	4	8
-----------------------------	------	---	---	------	---	---

Frame 18

Do the graphics and animation on these screens facilitate learning?

- | | | | | | | |
|---|---|---|------|---|---|------|
| <ul style="list-style-type: none"> • Maybe have the gallon can earlier to convey that the gallon container can have multiple shapes. Consider a larger measuring cup or a milk carton that may be more familiar. | 2 | 7 | 2, 3 | 2 | 2 | 2, 3 |
|---|---|---|------|---|---|------|

Is the presentation of the content conversational rather than formal?

- | | | | | | | |
|---|---|---|---|---|---|---|
| <ul style="list-style-type: none"> • It uses both conversational and formal. | 9 | 3 | 9 | 9 | 9 | 9 |
|---|---|---|---|---|---|---|

Frame 21

Do these screens provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|---|---|------|------|---------|---------|---------|
| <ul style="list-style-type: none"> • maybe also show gallon filling up the 4 quarts? | 2 | 2, 3 | 3, 7 | 2, 3, 7 | 2, 3, 7 | 2, 3, 7 |
|---|---|------|------|---------|---------|---------|

Frame 28

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- | | | | | | | |
|---|------|---|---|------|------|---|
| <ul style="list-style-type: none"> • Might suggest using the "hint" option when wrong or other screen related resources. | 1, 8 | 7 | 8 | 1, 8 | 7, 8 | 8 |
|---|------|---|---|------|------|---|

Do these screens provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|---|---|---|---|---|---|---|
| <ul style="list-style-type: none"> • why have the number of quarts indicated on the gallon when you are asking the number of quarts in a gallon? | 3 | 3 | 3 | 3 | 3 | 3 |
|---|---|---|---|---|---|---|

Is the tutorial content in this section appropriate for a typically achieving 4th grade student

- | | | | | | | |
|---|---|---|---|---|---|---|
| <ul style="list-style-type: none"> • Good for remedial | 9 | 9 | 9 | 9 | 9 | 9 |
|---|---|---|---|---|---|---|

Frame 30

Is the tutorial content in this section appropriate for a typically achieving 4th grade student

- moves too quickly without intermediate steps. 3, 8 7 7 3, 8 7 7

Does the tutorial provide enough feedback and guidance to engage students and support learning?

- As it is, it appears confusing to me. Suggest trying this with several groups of students at various levels to see how they rate it at clarity. 7, 8 3 9 7, 8 3, 8 9
- I'd suggest more student work, unless that's next... 4 4 4 4 4

Do these screens provide enough opportunity for manipulation to enhance learning?

- could you have students do the grouping and moving? 4, 7 7 4, 7 4, 7 7 4, 7

Frame 33

Do these screens allow students to progress at their own pace?

- I would suggest that the amount in each container not be written on the container. 2, 3 2 2 2, 3 2 2

Frame 37

Do these screens provide enough opportunity for manipulation to enhance learning?

- A second practice example may be appropriate. 4 4 4 4 4 4
- I like screen 37 allowing conversion both ways. I don't think I agree with the statement "conversion allows you to change units as long as what you take away equals what you add." 3 2, 3 3 3 2, 3 3

You aren't really taking away or adding and I think this leads to misconceptions. It is an exchange, just like 2 nickels for a dime.

Frame 38

Do the graphics on these screens facilitate learning?

- Too fast. 7 7 7 7 7 7

Do the animations on these screens facilitate learning?

- Too fast 7 7 7 7 7 7
- Possibly slow speed or give student the opportunity to progress through each step. 7 7 7 7 7 7

Do these screens provide enough opportunity for manipulation to enhance learning?

- Consider stopping at each step. Manipulation is possibly too fast for the student to connect. 7 7 7 7 7 7

Frame 40

Does this screen provide enough opportunity for manipulation to enhance learning?

- Kids may get impatient waiting for the dragged object to show up below before they can drag another object. I did. 7 7 7 7 7 7

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- not much room for error on this page 9 3, 7 9 9 3, 7, 9 9

Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?

- Student could get confused if they drag the symbols in the reverse order. 8 7 7 7, 8 7 7

Frame 41

Do the animated graphics and text convey the same information?

- | | | | | | | |
|---|---|---|---|---------|---------|---------|
| • Misleading that the cups are converted to larger while others are converted to smaller. | 8 | 2 | 3 | 2, 3, 8 | 2, 3, 8 | 2, 3, 8 |
| • difficult to read and watch | 7 | 2 | 7 | 7 | 2 | 7 |

Do these screens provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|---|------|---|---|---|---|---|
| • Animations were possibly too fast for some learners | 7, 8 | 7 | 7 | 7 | 7 | 7 |
| • Would be nice to be able to reverse the conversion also | 7 | 7 | 7 | 7 | 7 | 7 |

Frame 42

Do the graphics and text screen convey the same information?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • Could be better illustrated. Funnel was more appropriate. | 2 | 2 | 2 | 2 | 2 | 2 |
|---|---|---|---|---|---|---|

Frame 43

Does this screen provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • Better than the last example. The previous was more abstract. | 9 | 9 | 9 | 9 | 9 | 9 |
| • Same concern about kids getting impatient while waiting to drag the next object. | 7 | 7 | 7 | 7 | 7 | 7 |

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- | | | | | | | |
|---|------|------|------|------|------|------|
| • the animation doesn't really let you make an error, does it? I did it wrong (converted all to Gallons) and got no error message -- no message at all. | 6, 8 | 7, 8 | 7, 8 | 7, 8 | 7, 8 | 7, 8 |
|---|------|------|------|------|------|------|

Do the movements and sounds inside the funnel interfere with the understanding

and practice of the second step?

- I can't really count how many quarts I end up with. Could you add some numbers at the top as you have in some of the frames? 3 2, 8 3 3, 8 2, 8 3, 8

Does this screen allow students to progress at their own pace?

- Although it may slow them down a bit. Same concern about kids getting impatient while waiting to drag the next object. 7 7 7 7 7 7

Frame 44

Do the animations on these screens facilitate learning?

- The animations were not natural and led misunderstanding. 7 3, 7 7 7 3, 7 7
- minimally 7 7 7 7 7

Do the graphics on these screens facilitate learning?

- The concept was confusing. Counting was demonstrated, but the organization or process was not natural. 3, 7 3, 7 7, 8 3, 7 3, 7
- They don't match what I did on frame 43 and that's a bit confusing. why not count something I've worked with before? 2, 3, 7 3, 7 3, 7 2, 3, 7 3, 7

Frame 46

Does this screen provide enough opportunity for manipulation to enhance learning?

- it might be helpful to allow student to convert between units and count each time. 8 3 3 8 3 3

Frame 47

Does this screen allow students to progress at their own pace?

- seems kind of boring though 9 3 9 9 9 9

Does this screen provide enough opportunity for manipulation to enhance learning?

- Could possibly identify counting as essential before conversion and then counting again after the conversion. 3 3, 8 3 3 3, 8 3

Frame 48

Is the tutorial content in this section appropriate for a typically achieving 4th grade student?

- Need to bold key words, "each, one cup, one gallon". Need to show the 16 in the question, so they can see if it is more. Maybe show they would have 1pt extra. 3 3 3 3 3 3

Is the content in this section of the tutorial conversational rather than formal?

- Yes, conversational print 9 3 9 9 9 9

Does this screen provide enough opportunity for manipulation to enhance learning?

- Could have more examples or more possible answers at the end of the exercise to choose from. 3, 4 4 4 3, 4 4 4
- May be have the visual rep of each gallon, quart, etc 2 2 3 2 2 3

Frame 49

Is the content in this section of the tutorial conversational rather than formal?

- Not shown other than in abstract format. Not concrete manipulation. 9 3 3 3 3 3
- Should there be a manipulation prompt when the student answers incorrectly? 8 8 7, 8 8 8 7, 8
- would still like to have some images of the containers 2 2 2 2 2 2

Does this screen allow students to progress at their own pace?

- Textually it is formal

9

3

9

9

9

9

Appendix G

Special Education Teachers: Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria

	Independent Review			Group Review		
	1	2	3	1	2	3
Frame 2						
Does the ability to change the volume aid in the representation of the instructional concepts?						
• it was nice to see that volume was not restricted to the full cup	9	4	9	9	9	9
• If possible, having a 3rd volume would be even better!	3, 4	4	4	3, 4	4	4
• Because it shows the student the cup filling up. So those students with a language delay could visually see the space being taken up.	5	5	5	5	5	5
Are the words that are bold and/or highlighted in this section relevant to the concept being taught?						
• It might be helpful to a actually show some measurements on the cup itself so it looks like a real measuring cup	2	2, 4	2	2	2	2
Is the reading level of text on this screen appropriate for students with learning disabilities?						
• the one concern I might have is that students might miss the critical thought that it is that volume is the space the BEANS take up in the cup.	3, 8	3	3	3, 8	3	3
Frame 3						
Does the ability to change the unit aid in the representation of the instructional concepts?						

- | | | | | | | |
|---|------|---|------|------|------|------|
| • once again the opportunity to see the definition displayed is critical | 3 | 9 | 9 | 9 | 9 | 9 |
| • It serves as a visual aid for students. It would be beneficial to all, especially those with a language delay. | 5 | 9 | 5 | 5 | 9, 5 | 5 |
| • Why is the text in the text-bubble slanted? For children with visual issues it might be better to have it level | 3, 5 | 3 | 2, 5 | 3, 5 | 3, 5 | 2, 5 |

Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

- | | | | | | | |
|--|---|------|---|------|------|------|
| • They are bolded, but so is the definition....What about having an arrow highlight the "units"? | 3 | 2, 3 | 2 | 2, 3 | 2, 3 | 2, 3 |
|--|---|------|---|------|------|------|

Is the reading level of text on this screen appropriate for students with learning disabilities?

- | | | | | | | |
|---|---|------|---|------|------|------|
| • While the words are at the right reading level the concept is rather abstract - can voice over be added so students can hear the statement as well as read it? I even had to read it twice to be sure I knew exactly what was being talked about. | 3 | 1, 3 | 1 | 1, 3 | 1, 3 | 1, 3 |
|---|---|------|---|------|------|------|

Frame 4

Do the graphics on this screen facilitate learning?

- | | | | | | | |
|--|------|---|---|------|---|---|
| • It visually shows the difference to the students and allows them to easily see | 9 | 9 | 9 | 9 | 9 | 9 |
| • The writing on the objects needs to be larger so it can be read | 2, 3 | 3 | 2 | 2, 3 | 3 | 3 |

Do the animations on this screen facilitate learning?

- the equivalency of units is great and critical! 9 9 9 9 9 9

Do the animated graphics and text convey the same information?

- the text discusses the fact that each holds different amounts - the graphics while each different begins to address the relationship between the different units as well. 9 9 9 9 9 9

Do the animations and interactivity on this screen accommodate the needs of students with learning disabilities?

- For these animations, it is not clear what the intent of the page is (relationship between the different units or the fact each holds a different volume - which by the way is lost because the volume is represented linearly rather than within each container. 3 3, 7 3 3 3, 7 3
- Without knowing the nature of the learning disability, I would say yes. 5 5 5 5 5 5

Frame 6

Do the graphics and text on each screen convey the same information?

- Milk is white in color- the choice of using yellow as the color of the liquid might be confusing-it looks like juice 2 2 2 2 2 2

Is the presentation of the content conversational rather than formal?

- I might make the space around the equal sign larger...It 3 2 2 2 2 2

- almost looks like a bird.
- assuming you mean formal is a formal math equation of defining the unit as 8 oz. 9 3 9 9 9 9

Do the graphics and animations on these screens facilitate learning?

- no real animations on this page. can the milk carton be poured into the cup measure? 7 7 7 7 7 7
- provides the students with a common reference 3 9 9 9 9 9
- The milk carton is something that most students are familiar with, therefore, it gives them background knowledge. 8 2 9 9 9 9
- with change of coloration 9 2 2 2 2 2
- There is no animation on this screen, but the previous screen was good 7 7 9 7 7 9

Frame 8

Do the graphics and text on each screen convey the same information?

- But my ice cream comes in half gallon containers not pints thus the real world connection is lost here 8 2 9 8 2 2, 9
- The first screen is good, but you need to delineate that a pint of a solid- such as ice cream is equal to a pint in liquid. this might be confusing to my students who are so concrete. 3, 5 2, 3 3 3, 5 2, 3 3

Do the graphics and the animations on these screens facilitate learning?

- but the inability to replay the animations limits it to a learning that occurred in the 3, 5 7 7 3, 5 7 7

past or based on memory						
• Depends on the level of the student	9	5	9	9	5	9
• As long as the students can move back and forth between screens	6	7	6	6, 7	6, 7	6, 7

Frame 10

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

• very cute guy	9	9	9	9	9	9
• That being said, some of my kids with autism would purposely do the wrong answer just to see the sad guy.	5	5	5	5	5	5
• I would make the type a little bolder in his response caption-easier to read	3	3	3	3	3	3

Frame 12

Do the graphics and text on each screen convey the same information?

• It is confusing that you have car oil depicted as pink. They might associate lemonade with this color.	2	2	2	2	2	2
--	---	---	---	---	---	---

Do the graphics and animations on these screens facilitate learning?

• wish the quart container would fill the measuring cup	7	2	7	7	7	7
---	---	---	---	---	---	---

Frame 15

Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart?

• the emphasis on 4 cups was	3	2, 3	3, 7	3	3, 7	3, 7
------------------------------	---	------	------	---	------	------

clear but the idea of 2 pints seemed lacking. I expected the first page to include the pint unit once two cups were poured into the quart but it did not appear :(

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- I like this "guy"!!! He's great! 9 9 9 9 9 9

Do the animations and interactions accommodate the needs of students with learning disabilities?

- need to stress the pint as the half way point to a quart or else it would be lost. 3 3 3 3 3 3

Frame 18

Do the graphics and animations on these screens facilitate learning?

- Milk gallons are common knowledge too. 8 9 9 9 9 9
- would like the paint to pour into the gallon container 7 7 7 7 7 7

Frame 21

Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon?

- I like that the student has to watch it before moving to the next graphic. 6 9 9 9 9 9
- As long as the students can manipulate back and forth between screens 6 7 6 6 7 6

Do these screens provide enough opportunity for manipulation to

enhance learning?

- It would be more engaging for students to be able to drag and click the quarts to fill up the gallon- more interactive 7 7 7 7 7 7

Frame 28

Do these screens provide enough opportunity for manipulation to enhance learning?

- It just depends.... Some will need more than this. 4 5 4 4 4, 5 4
- my first attempt at ordering the units only required one move to place them in sequence, multiple tries might be encouraged. 4 4 6 4 4 4

Does this section allow students to progress at their own pace?

- Yes but if you hit backspace it goes all the back to the beginning instead of backspacing 6 6 6 6 6 6

Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

- Is there an auditory part for those who struggle with reading? Like an e-reader? 3 1 1 1 1 1

Is the tutorial content in this section appropriate for a 4th grade student with learning disabilities?

- But I think it may take more time for a 4th grader with a LD to master this. 5 5 5 5 5 5
- The visuals really help! 9 9 9 9 9 9

Do the graphics, animations, and interactivity employed in this

section accommodate needs of students with learning disability?

- However, I think having the t/f quiz at the end of the practice would be best, or even having it again at the end to review would be good. I had trouble the first time around!!!
- | | | | | | |
|---|------|---|------|------|------|
| 4 | 3, 4 | 4 | 3, 4 | 3, 4 | 3, 4 |
|---|------|---|------|------|------|

Frame 30

Do the graphics facilitate learning?

- First time I have heard any noise. I think having things read to the students would help as well, or at least having the option.
- | | | | | | |
|---|---|---|---|---|---|
| 3 | 1 | 1 | 1 | 1 | 1 |
|---|---|---|---|---|---|

Do these screens provide enough opportunity for manipulation to enhance learning?

- should include multiple volume options or attempts. When I replayed the screen it presented the exact same volume.
- | | | | | | |
|---|---|------|---------|---------|------|
| 3 | 1 | 4, 6 | 3, 4, 6 | 1, 4, 6 | 4, 6 |
|---|---|------|---------|---------|------|

Do the animations and interactions accommodate learning attributes of students with learning disabilities?

- I like this!!
 - they do, but may have to be repeated several times.
- | | | | | | |
|---|---|---|---|---|---|
| 3 | 9 | 9 | 9 | 9 | 9 |
| | 9 | 4 | 3 | 4 | 4 |

Frame 33

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- might want to encourage the students to try again with a different volume (which is
- | | | | | | |
|---|--|---|---|---|---|
| 4 | | 4 | 4 | 4 | 4 |
|---|--|---|---|---|---|

provided on this example :) to ensure they did not just randomly group the items.

Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

- need a cue to practice again 4 8 4 4, 8 4, 8 4, 8

Frame 37

Do these screens provide enough opportunity for manipulation to enhance learning?

- I like that the user can convert back and forth. 6 9 9 9 9 9

Do the graphics, animations and interactions accommodate the needs of students with learning disabilities?

- You should be able know that you can reverse the conversion also 6 7 8, 9 6 7 8

Frame 39

Does this screen provide enough opportunity for manipulation to enhance learning?

- need additional practice and examples where the answer is not always 4 4 4 4 4 4

Is the content on the screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

- But I do think it may be hard for some students to keep that conversion information in 5 5 9 5 5 9

their short term memory..

Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?

- no opportunity for additional practice on this stage 4 4 4 4 4 4

Frame 40

Does this screen provide enough opportunity for manipulation to enhance learning?

- does not allow the student to try and convert more than necessary - also the example does not involve converting to gallons nor are additional practice items presented 4 4 4, 6 4 4 4

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- never saw the feedback guy until I was done (which was before I fully processed that I was done) - no way for my answer to be wrong 6, 8 3, 8 8 6, 8 6, 8 6, 8
- It is confusing 8 3 9 8 8 8

Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?

- I REALLY like the movement/sounds/funnel... I think that may help so much!!! 9 9 9 9 9 9
- The movements and sounds came before I even processed that I had the right number - thus there was no place for me to identify if I was correct or not- rather I was moved on to 6 6 6 6 6 6

the next stage regardless of my understanding

Does this screen allow students to progress at their own pace?

- this example requires everyone to answer correctly even without understanding. 9 3, 8 9 9 9 9

Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

- this just allows them to practice it correctly no opportunity for error or thinking 4, 6 4, 6 4, 6 4, 6

Frame 42

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- I especially like the hints he provides (too big/too small). 2 9 9 9 9 9

Does this screen provide enough opportunity for manipulation to enhance learning?

- restricted to one example 4 4 4 4 4 4
- Although, more practice would be super too! 4 4 4 4 4 4

Is the tutorial content appropriate for a 4th grade student with learning disabilities?

- At some points I think a calculator or a conversion chart would be helpful to those students with severe learning disabilities 5 1 1 1, 5 1, 5 1, 5

Do the graphics, animations and interactions on accommodate

learning attributes of students with learning disabilities?

- | | | | | | |
|--|------|------|------|------|------|
| • It is confusing to show 3 pints when you want the answer to be 2 | 2, 3 | 3, 9 | 2, 3 | 2, 3 | 2, 3 |
|--|------|------|------|------|------|

Frame 43

Do the movements and sounds inside the funnel interfere with the understanding of the second step?

- | | | | | | | |
|---|------|---|---|---------|------|---------|
| • I do REALLY like this function! | 9 | 9 | 9 | 9 | 9 | 9 |
| • once again the sounds and movements occur automatically thus leaving the student out of the decision making process | 6, 8 | 7 | 6 | 6, 8, 7 | 7, 8 | 6, 7, 8 |
| • My students with autism would perseverate on the sound. | 5 | 5 | 5 | 5 | 5 | 5 |

Frame 44

Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?

- | | | | | | | |
|--|---|------|---|---|---|---|
| • but once again the sounds might be highly annoying | 6 | 3, 5 | 6 | 6 | 6 | 6 |
|--|---|------|---|---|---|---|

Frame 46

Does this screen provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • great practice with multiple opportunities | 4 | 9 | 9 | 9 | 9 | 9 |
|--|---|---|---|---|---|---|

Frame 47

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • The clanging bell.... not sure why it won't fade or stop. | 6 | 6 | 6 | 6 | 6 | 6 |
|---|---|---|---|---|---|---|

Does this screen provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|--|---|---|---|------|------|------|
| • first sequence cards were already in order | 7 | 6 | 6 | 6, 7 | 6, 7 | 6, 7 |
|--|---|---|---|------|------|------|

Frame 48

Does this screen provide enough opportunity for manipulation to enhance learning?

- | | | | | | | |
|---|------|------|---|------|---|------|
| • I think there is a possibility that some kids with LD would lose track of the conversions here...there are many steps (multiplication problems) that he/she would need to complete. | 5, 7 | 5 | 5 | 5, 7 | 5 | 5 |
| • might be nice to have a place where students can manipulate the individual cups, pints, etc in case they can't multiply in their head | 7 | 4, 7 | 1 | 4 | 4 | 1, 4 |

Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • The question should be read to the student | 3 | 1 | 1 | 1 | 1 | 1 |
|--|---|---|---|---|---|---|

Frame 49

Does this screen allow students to progress at their own pace?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • I like how each question takes the student step by step through the problem solving method | 9 | 9 | 9 | 9 | 9 | 9 |
|--|---|---|---|---|---|---|

Does this screen provide enough opportunity for manipulation to

enhance learning?

- | | | | | | | |
|--|------|------|---|------|------|---|
| • IDK-I have the same concern here...that some kids with LD may lose track of what they are doing. | 5 | 5 | 5 | 5 | 5 | 5 |
| • need something to help with the multiplication | 3, 7 | 1, 5 | 1 | 3, 7 | 1, 5 | 1 |

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- | | | | | | | |
|---|---|------|---|------|------|------|
| • I typed in 3 pints for the final answer and was told my answer was wrong and too BIG when it was wrong but too small. | 6 | 3, 8 | 8 | 3, 8 | 3, 8 | 3, 8 |
|---|---|------|---|------|------|------|
-

Appendix H

Multimedia/Technology Experts: Independent and Group Coding of Survey Comments by Three Reviewers Using Formative Criteria

	Independent Review			Group Review		
	1	2	3	1	2	3
Frame 2						
Does the ability to change the volume aid in the representation of the instructional concepts?						
<ul style="list-style-type: none"> Although I wonder if some basic measurement markings on the cup would also assist with this visual 	2	2	2	2	2	2
Are the words that are bold and/or highlighted in this section relevant to the concept being taught?						
<ul style="list-style-type: none"> The usability studies recommend using a simple Sans-serif-type font because it is more readable. 	5	3	3	3	3	3
Frame 3						
Does the ability to change the unit aid in the representation of the instructional concepts?						
<ul style="list-style-type: none"> It would be better to explicitly show XX cups, YY quarts, and ZZ pints. While this is helpful to be able to change units- I already have a mental model of this image as a measuring cup. In this example- using a gallon container would better represent this concept so the units match this visual model of volume. 	3	3	3	3	3	3
	2	2	2, 3	2	2	2

Are the words that are bold and/or highlighted in this section relevant to the concept being taught?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • Showing the actual numbers would be more effective to convey the concept, in addition to the description. | 3 | 3 | 3 | 3 | 3 | 3 |
|---|---|---|---|---|---|---|

Do the graphics and text convey the same information?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • need to use a larger container size. | 2 | 2 | 2 | 2 | 2 | 2 |
| • If possible, text should change to match with the units that are changing. | 3 | 2 | 3 | 3 | 2 | 3 |

Frame 4

Do the graphics on this screen facilitate learning?

- | | | | | | | |
|---|---|------|------|------|------|------|
| • Some students may not understand what the square mean. More description about the square may need. Or more explicit examples, 2 cups of water need to fill up one pint, etc., might work better than using number of squares. | 3 | 2, 5 | 2, 3 | 2, 3 | 2, 5 | 2, 3 |
|---|---|------|------|------|------|------|

Do the animations on this screen facilitate learning?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • Although the animation is not totally necessary | 7 | 7 | 7 | 7 | 7 | 7 |
|---|---|---|---|---|---|---|

Frame 6

Do the graphics and text on each screen convey the same information?

- | | | | | | | |
|---|---|---|---|---|---|---|
| • The one cup volume in the measuring cup looks smaller than the cup on the | 2 | 2 | 2 | 2 | 2 | 2 |
|---|---|---|---|---|---|---|

- left
- Although the graphics are the same, the equal symbol is almost hidden, furthermore, the visual comparison of milk carton and the 1 cup volume are not visually equal. 2, 3 2 2 2, 3 2 2

Do the virtual manipulative objects used here [e.g. measuring cup, milk carton] accurately represent concrete real life objects?

- I would not call them virtual manipulative b/c we cannot play with them. 7 7 9 7 7 7
- no- this should be a measuring cup consistently throughout the experience. 2 2 2 2 2 2
- As mention earlier, the visual comparison seems unequal. 2 2 2 2 2 2

Frame 8

Do the graphics and text on each screen convey the same information?

- Except for the cup measurement 2 2 9 2 2 2

Do the virtual manipulative objects used here [e.g. measuring cup, ice-cream container] accurately represent concrete real life objects?

- I would not call them virtual manipulative because I cannot play with them. 7 7 9 7 7 9
- The ice cream concept is nice but the representation does not clearly stated ice cream. 3 2 2, 9 3 2 2, 9

Frame 10

Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint?

- I think the content is easy to understand. So, I think children can answer this. 9 9 9 9 9 9

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- although the sad guy looks too distressed 9 2 9 9 9 9

Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?

- Although highlighting the underline & cursor area would be helpful 3 7 2 7 7 7

Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?

- although need to be able to move forward and backwards using the keyboard without a mouse for greater accessibility 7 5, 7 1 7 5, 7 7
- If the students do not need any help using a mouse. If not, alternative navigation such as keyboard may be needed. (Adding shortcut key into the programming is one way to achieve this. Normal people do not need to see this but those who want to use the keyboard can use the navigation.) 6, 7 5, 7 1 5, 7 5, 7 7

Frame 12

Do the graphics and text on each screen convey the same information?

- here again think about using 4 cups side by side 2 2 3 2 2 3

Frame 21

Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?

- I think seeing the 1 cup as a visual to represent pints and quarts as well as cups is confusing. 2 2 9 2 2 2

Frame 28

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning?

- More sophisticated feedback mechanism is needed. 8 8 8 8 8 8

Do the graphics in this section facilitate learning?

- measuring devices need to be differentiated visually. 2 2 2 2 2 2

Does this section of the tutorial provide enough feedback to support learning?

- The hints function is well implemented. 9 9 9 9 9 9
- Sometimes, tutorial provides feedback too soon. For example, while shuffling objects students may get the correct sequence by chance (and 7, 8 8 8 7, 8 8 8

they may continue to shuffle). But, as soon as students get the correct sequence (even by chance) the tutorial confirms that students got it correct, which cannot facilitate learning.

Frame 30

Are the words in bold and/or highlighted relevant to the topic being learned?

- "Convert" maybe too complex a word for 4th graders? 3 3 9 3 3 9

Is there enough opportunity for manipulation to enhance learning?

- frame 30 should allow user to manipulate independently 7 7 7 7 7 7
- Once showing how to find total volume, students should be given an opportunity to try it out by themselves. 4 4 4 4 4 4

Frame 37

Is there enough opportunity for manipulation to enhance learning?

- more manipulation with being able to convert is needed 4, 7 7 4, 7 4, 7 7 4, 7

Frame 39

Do the animations facilitate learning?

- I think the animation and the questions may confuse some students about what 2 3, 7 2, 3 3, 7 3, 7 3, 7

the question is looking for. Asking "How many cups can we convert into pints?" The answer can be 4 and 6 since the graphics in pints has three of them. I think what I feel is that the questions and the graphics are somewhat not match with each other well enough.

Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

- | | | | | | | |
|---|---|------|------|------|------|------|
| <ul style="list-style-type: none"> • I think the animation and the questions may confuse some students about what the question is looking for. Asking "How many cups can we convert into pints?" The answer can be 4 and 6 since the graphics in pints has three of them. I think what I feel is that the questions and the graphics are somewhat not match with each other well enough. | 3 | 3, 7 | 2, 3 | 3, 7 | 3, 7 | 3, 7 |
|---|---|------|------|------|------|------|

Frame 40

Does this screen provide enough opportunity to manipulate and practice to reinforce learning?

- | | | | | | | |
|---|------|---|---|------|---|---|
| <ul style="list-style-type: none"> • Students will probably try to put cups into the Gallons converters, which is not supported by the current tutorial. | 6, 7 | 7 | 7 | 6, 7 | 7 | 7 |
|---|------|---|---|------|---|---|

Does the multimedia agent

(pop-up 'sad' or 'happy' guy)
provide enough feedback to
support learning?

- | | | | | | | |
|---|---|------|---|---|------|------|
| • I am not sure if I can see a sad guy since I think you almost cannot make a wrong choice. | 7 | 2, 8 | 9 | 7 | 8 | 8 |
| • At the current tutorial, the multimedia agent is fine. But, if we are going to provide more sophisticated tutorial, we need more elaborate agent than this. | 6 | 2, 7 | 8 | 6 | 7, 8 | 7, 8 |

Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?

- | | | | | | | |
|---|---|------|---|---|------|------|
| • No, we need more sophisticated tutorial as is described in the previous comments. | 6 | 2, 7 | 8 | 6 | 7, 8 | 7, 8 |
|---|---|------|---|---|------|------|

Does this screen allow students to progress at their own pace?

- | | | | | | | |
|--|---|---|---|---|---|---|
| • While animation is being played, students will try to use the animation, which is not supported in the current tutorial, and it will confuse students. | 7 | 7 | 7 | 7 | 7 | 7 |
|--|---|---|---|---|---|---|

Are there any colors that are sensitive to changes when viewed on different computers?

- | | | | | | | |
|---|---|------|---|---|------|---|
| • red and green hue colors should not be used together since people with color blindness would see those colors the same. | 5 | 2, 5 | 5 | 5 | 2, 5 | 5 |
|---|---|------|---|---|------|---|

Frame 42

Do the animations facilitate learning?

- I think somehow the directions on Cups is not convert from Pints to Cup but going back to the previous direction (cup to pint) 3 3 3 3 3 3

Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

- Too many questions on this page, when going from larger to smaller, asking "How many ____ is unnecessary." 3 3, 5 3, 7 3 3, 5 3, 7

Frame 43

Does this screen provide enough opportunity to manipulate and practice to reinforce learning?

- This was good practice, but I missed the question and couldn't move forward until I made all the conversions. I think the question needs to be spelled out more. Also, when moving the cups around too quickly, I ended up in a loop where the light bulb kept dinging. 3, 6, 7 6 6 3, 6, 7 3, 6, 7 3, 6, 7
- When students got stuck, they may not know what to do. In that case, the tutorial should provide some guidance to the students. 6, 8 7, 8 8 7, 8 7, 8 7, 8

Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to

support learning?

- More sophisticated feedback would increase student learning. 8 8 8 8 8

Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?

- Sound may be too loud. May need a way to turn on and off the sound. Also, the way objects show and disappear could be enhanced. 6, 7 6 1 6, 7 6, 7 6, 7
- Too many dings for the light bulb, perhaps just once? Also, an additional sound when moved from the light bulb area up to the top area might be helpful. 6 6 7 6 6 6

Does this screen allow students to progress at their own pace?

- They may not want to hear the sound from the funnel and may want to proceed fast, which is not supported. 6 6 7 6 6 7

Are there any colors that are sensitive to changes when viewed on different computers?

- red and green 5 5 5 5 5 5

Frame 44

Do the animations facilitate learning?

- I think there is something wrong with the background sound effects. It just does not stop. 6 6 6 6 6 6

Do the animations function at

the correct speed?

- a little too fast

7 7 7 7 7 7

Frame 46

Does this screen allow students to progress at their own pace?

- This question seems too basic

3 3 9 3 3 3

Frame 47

Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

- too many words on the page, should also have graphical re-enforcement
- If the students do not have difficulties when using a mouse pointer.

3 2, 5 2, 3 3 2, 5 2, 3

5 5 5 5 5 5

Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?

- 43 needs to be spelled out a bit more, 46 seems too basic and not as relevant

3 3 3 3 3 3

Wrap-up Questions

Do the animations function at the correct speed?

- But, the user may want to have more control of the animation and sound, which is not allowed.
- I think the animation speed

7 7 7 7 7 7

9 9 9 9 9 9

for all of them run at a good speed. Also, the chance for replay is provided. Thus, students can review it at anytime

Are there any colors that are sensitive to changes when viewed on different computers?

- | | | | | | | |
|---|---|------|------|------|------|------|
| • Only have one computer to view through. | 9 | 9 | 9 | 9 | 9 | 9 |
| • The colors are simple and plain enough that the differences on different computers can be minimal. I'm not sure if the web safe color rules were applied but they all seem ok. The problem with the colors are that there are cases that the colors such as red and green hue are together (Gallon). This may make students with color blindness not able to differentiate the two. | 5 | 2, 9 | 5, 9 | 5, 9 | 5, 9 | 5, 9 |

Did you find and objects that need to be modified to be made more realistic?

- | | | | | | | |
|---|------|---|---|------|------|------|
| • Only have one computer to view through. | 9 | 9 | 9 | 9 | 9 | 9 |
| • I think the objects such as the measuring cup and measuring boxes are photos. However, the milk, ice cream, oil, paint are graphics and they do not have any labels. Thus, I think having a label may help. On the other hand, if the shape is already universal knowledge in the U.S., I think it should be ok | 5, 3 | 2 | 2 | 2, 5 | 2, 5 | 2, 5 |

since if we have too many information, students with learning disabilities could confuse.

Did you find any screens confusing?

- | | | | | | | |
|---|---|------|---|------|------|---|
| <ul style="list-style-type: none"> • While students doing the activity, they may forget what they are supposed to do. Of course, they can click on the back button to check it, but many students would not find that option. Thus, when students got stuck or confused, they should be able to get some help on the current screen. | 7 | 5, 8 | 8 | 7, 8 | 5, 8 | 8 |
| <ul style="list-style-type: none"> • Only have one computer to view through. | 9 | 9 | 9 | 9 | 9 | 9 |
| <ul style="list-style-type: none"> • The instruction on the activities are somewhat not clear especially on the "convert" section. | 3 | 3 | 3 | 3 | 3 | 3 |

What do you consider to be the strengths of this tutorial model for students with learning disabilities?

- | | | | | | | |
|---|---|---|---|---|---|---|
| <ul style="list-style-type: none"> • visual simplicity, use of common examples | 9 | 9 | 9 | 9 | 9 | 9 |
| <ul style="list-style-type: none"> • The simplicity and clarity of graphics. All graphics use only elements that is necessary. The simplicity of navigation. Linear and straightforward. | 9 | 9 | 9 | 9 | 9 | 9 |

What do you consider to be the weaknesses of this tutorial model for students with learning disabilities?

- | | | | | | | |
|--|---|---|---|---|---|---|
| <ul style="list-style-type: none"> • miss use of measuring cup for multiple units of measurement. Need to | 2 | 2 | 2 | 2 | 2 | 2 |
|--|---|---|---|---|---|---|

establish consistent visuals at the beginning and stay consistent throughout the tutorial.

- | | | | | | | |
|---|------|---------|------|------|---------|------|
| <ul style="list-style-type: none"> • All of the content is presented without sound at all. Thus, students need to read and understand from what is available to them. In certain activities such as questions and drag and drop interaction, there are a lot of information to be processed since the content focus on several concepts together. For example, on one of the conversion, students are seeing cups, pints, quarts, and gallon at the same time and they need to process all of the concepts together to answer the question. For normal students, I think it is ok, for students with learning disabilities, each question may be divided into smaller units. | 6, 5 | 3, 5, 6 | 1, 5 | 6, 5 | 3, 5, 6 | 1, 5 |
|---|------|---------|------|------|---------|------|

Are there any additional comments that you would like to share?

- | | | | | | | |
|---|------|---|------|------|------|------|
| <ul style="list-style-type: none"> • More elaborate tutorial/feedback. Reducing the scaffolding as students are learning the concepts. | 3 | 8 | 8 | 3, 8 | 3, 8 | 3, 8 |
| <ul style="list-style-type: none"> • This is a great module, and I realize how difficult it can be to remain simple, clear and consistent. | 9 | 9 | 9 | 9 | 9 | 9 |
| <ul style="list-style-type: none"> • I think that the tutorials should be done better if using audio with graphics instead of text with | 3, 6 | 6 | 3, 6 | 3, 6 | 6 | 6 |

graphics. I think that it
would make the
presentation more
interesting than it is now.
There is a problem with the
audio

Appendix I

Questions Relating to Eight of 10 Principles of Multimedia Instructional Design Given by Mayer

Subject Matter Expert (SMEs)

Frame 2

1. Does the ability to change the volume aid in the representation of the instructional concepts? (Animation and Interactivity Principle)
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 3

1. Does the ability to change the unit aid in the representation of the instructional concepts?
(Animation and Interactivity Principle)
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 4

1. Do the graphics on this screen facilitate learning? (Animation and Interactivity Principle)
2. Do the animations on this screen facilitate learning? (Animation and Interactivity Principle)

3. Do the animated graphics and text convey the same information? (Split-attention Principle, Redundancy Principle)

Frame 6

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics and animation on these screens facilitate learning? (Animation and Interactivity Principle)
3. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 8

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics and animation on these screens facilitate learning? (Animation and Interactivity Principle)
3. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 10

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint? (Worked-out Examples Principle)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 12

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics and animation on these screens facilitate learning? (Animation and Interactivity Principle)
3. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 15

1. Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart? (Worked-out Examples Principle)
2. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 18

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics and animation on these screens facilitate learning? (Animation and Interactivity Principle)
3. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon? (Worked-out Examples Principle)

2. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 28

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (Pre-training Principle)
2. Does this section allow students to progress at their own pace? (Segmenting Principle)
3. Are the graphics employed in this section relevant to the skill or concept? (Split-attention Principle, Redundancy Principle)
4. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 30

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (Pre-training Principle)
2. Does this section allow students to progress at their own pace? (Segmenting Principle)
3. Are the graphics employed in this section relevant to the skill or concept? (Split-attention Principle, Redundancy Principle)
4. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
5. Does the tutorial provide enough feedback and guidance to engage students and support learning? (Guided Discovery Principle- Immediate feedback)

Frame 33

1. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
2. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
3. Do these screens allow students to progress at their own pace? (Segmenting Principle)

Frame 37

1. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
2. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animated graphics and text convey the same information? (Split-attention Principle, Redundancy Principle)
4. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 38

1. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
2. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animated graphics and text convey the same information? (Split-attention Principle, Redundancy Principle)

4. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 39

1. Do the graphics and text screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
4. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 40

1. Do the graphics and text screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
3. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
5. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 41

1. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)

2. Do the animations on these screens facilitate learning? (**Animation and Interactivity Principle**)
3. Do the animated graphics and text convey the same information? (**Split-attention Principle, Redundancy Principle**)
4. Do these screens provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)

Frame 42

1. Do the graphics and text screen convey the same information? (**Split-attention Principle, Redundancy Principle**)
2. Does this screen provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
3. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)
4. Does this screen allow students to progress at their own pace? (**Segmenting Principle**)

Frame 43

1. Do the graphics and text screen convey the same information? (**Split-attention Principle, Redundancy Principle**)
2. Does this screen provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
3. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
4. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)

5. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 44

1. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
2. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animated graphics and text convey the same information? (Split-attention Principle, Redundancy Principle)

Frame 46

1. Do the animated graphics and text convey the same information? (Split-attention Principle, Redundancy Principle)
2. Does this screen provide enough opportunity for manipulation to enhance learning? (Animation and Interactivity Principle)
3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
4. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 47

1. Does this screen provide enough opportunity for manipulation to enhance learning? (Animation and Interactivity Principle)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
3. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 48

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (Pre-training Principle)
2. Is the content in this section of the tutorial conversational rather than formal? (Personalization Principle)
3. Does this screen allow students to progress at their own pace? (Segmenting Principle)
4. Does this screen provide enough opportunity for manipulation to enhance learning? (Animation and Interactivity Principle)
5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 49

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (Pre-training Principle)
2. Is the content in this section of the tutorial conversational rather than formal? (Personalization Principle)
3. Does this screen allow students to progress at their own pace? (Segmenting Principle)
4. Does this screen provide enough opportunity for manipulation to enhance learning? (Animation and Interactivity Principle)
5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 50

1. Are the skills and concepts in the tutorial aligned with the intent of the Kansas indicator below?

The Kansas Standard: 3.2. k2b category 3b

Standard: Geometry . The student uses geometric concepts and procedures in a variety of situations.

Benchmark: Measurement and Estimation . The student measures using standard units of measure including the use of concrete objects in a variety of situations.

Indicator: The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure - volume to the nearest cup, pint, quart, or gallon;

Questions Relating to Eight of 10 Principles of Multimedia Instructional Design Given by Mayer

Special Education Teachers.

Frame 2

1. Does the ability to change the volume aid in the representation of the instructional concepts? **(Animation and Interactivity Principle)**
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 3

1. Does the ability to change the unit aid in the representation of the instructional concepts?
(Animation and Interactivity Principle)
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)

Frame 4

1. Do the graphics on this screen facilitate learning? **(Animation and Interactivity Principle)**
2. Do the animations on this screen facilitate learning? **(Animation and Interactivity Principle)**
3. Do the animated graphics and text convey the same information? **(Split-attention Principle, Redundancy Principle)**

4. Do the animations and interactivity on this screen accommodate the needs of students with learning disabilities?

Frame 6

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
4. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 8

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
4. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 10

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint? (Worked-out Examples Principle)

2. Do the animations and interactions accommodate learning needs of students with learning disabilities?
3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 12

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Do the graphics on these screens facilitate learning? (Animation and Interactivity Principle)
3. Do the animations on these screens facilitate learning? (Animation and Interactivity Principle)
4. Is the presentation of the content conversational rather than formal? (Personalization Principle)

Frame 15

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint? (Worked-out Examples Principle)
2. Do the animations and interactions accommodate learning needs of students with learning disabilities?
3. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 18

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)

2. Do the graphics on these screens facilitate learning? (**Animation and Interactivity Principle**)
3. Do the animations on these screens facilitate learning? (**Animation and Interactivity Principle**)
4. Is the presentation of the content conversational rather than formal? (**Personalization Principle**)

Frame 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups or 8 pints or 4 quarts make up a gallon? (**Worked-out Examples Principle**)
2. Do the animations and interactions accommodate the needs of students with learning disabilities?
3. Do these screens provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)

Frame 28

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (**Pre-training Principle**)
2. Is the tutorial content in this section appropriate for a 4th grade student with learning disabilities? (**Pre-training Principle**)
3. Does this section allow students to progress at their own pace? (**Segmenting Principle**)
4. Do the graphics, animations, and interactivity employed in this section accommodate needs of students with learning disability?
5. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

6. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
7. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
8. Is the reading level of the text in this section of the tutorial appropriate for students with learning disabilities?

Frame 30

1. Is the tutorial content in this section appropriate for a typically achieving 4th grade student? (Pre-training Principle)
2. Is the tutorial content appropriate for a 4th grade student with learning disabilities? (Pre-training Principle)
3. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
4. Do the graphics facilitate learning? (Animation and Interactivity Principle)
5. Do the animations facilitate learning? (Animation and Interactivity Principle)
6. Are the words in bold and/or highlighted relevant to the topic being learned?
7. Do the animations and interactions accommodate learning attributes of students with learning disabilities?

Frame 33

1. Do these screens provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

3. Do these screens allow students to progress at their own pace? (**Segmenting Principle**)
4. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?

Frame 37

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities? (**Pre-training Principle**)
2. Do these screens provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
3. Do the graphics, animations and interactions accommodate the needs of students with learning disabilities?
4. Is this content on the screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
5. Is the reading level of the text appropriate students with learning disabilities?

Frame 39

1. Is the tutorial content appropriate for a 4th grade student with a learning disability? (**Pre-training Principle**)
2. Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?
3. Is the content on the screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as intended?
4. Is the reading level of the text appropriate for students with learning disabilities?
5. Does this screen provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)

6. Do these screens allow students to progress at their own pace? **(Segmenting Principle)**
7. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? **(Guided Discovery Principle: Immediate Feedback)**

Frame 40

1. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
2. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? **(Guided Discovery Principle: Immediate Feedback)**
3. Does this screen allow students to progress at their own pace? **(Segmenting Principle)**
4. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
5. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

Frame 42

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities? **(Pre-training Principle)**
2. Do the graphics, animations and interactions on accommodate learning attributes of students with learning disabilities?
3. Is the content on the screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
4. Is the reading level appropriate for students with learning disabilities?
5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? **(Guided Discovery Principle: Immediate Feedback)**

6. Do these screens allow students to progress at their own pace? (**Segmenting Principle**)
7. Does this screen provide enough opportunity for manipulation to enhance learning?
(**Animation and Interactivity Principle**)

Frame 43

1. Is there enough opportunity for manipulation to reinforce learning? (**Animation and Interactivity Principle**)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle: Immediate Feedback**)
3. Does this screen allow students to progress at their own pace? (**Segmenting Principle**)
4. Do the movements and sounds inside the funnel interfere with the understanding of the second step?
5. Is this section of the tutorial designed and functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

Frame 44

1. Do the animated graphics and text convey the same information? (**Split Attention, Redundancy Principle**)
2. Do the graphics, animations and interactions accommodate the learning needs of students with learning disabilities?

Frame 46

1. Does this screen provide enough opportunity for manipulation to enhance learning?
(**Animation and Interactivity Principle**)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle: Immediate Feedback**)

3. Does this screen allow students to progress at their own pace? (Segmenting Principle)
4. Is this section of the tutorial functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?

Frame 47

1. Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
2. Is the reading level of the text appropriate for students with learning disabilities?
3. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle: Immediate Feedback)

Frame 48

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities? (Pre-training Principle)
2. Does this screen allow students to progress at their own pace? (Segmenting Principle)
3. Is the reading level of the text appropriate for students with learning disabilities?
4. Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
5. Does this screen provide enough opportunity for manipulation to enhance learning?
(Animation and Interactivity Principle)
6. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle: Immediate Feedback)

Frame 49

1. Is the tutorial content appropriate for a 4th grade student with learning disabilities? (**Pre-training Principle**)
2. Does this screen allow students to progress at their own pace? (**Segmenting Principle**)
3. Is the reading level of the text appropriate for students with learning disabilities?
4. Is this screen functionally reliable to allow students with learning disabilities to independently navigate the instruction as intended?
4. Does this screen provide enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (**Guided Discovery Principle: Immediate Feedback**)

Frame 50

1. Are the skills and concepts in the tutorial aligned with the intent of the Kansas indicator below?

The Kansas Standard: 3.2. k2b category 3b

Standard: *Geometry . The student uses geometric concepts and procedures in a variety of situations.*

Benchmark: *Measurement and Estimation . The student measures using standard units of measure including the use of concrete objects in a variety of situations.*

Indicator: *The student selects, explains the selection of, and uses measurement tools, units of measure, and degree of accuracy appropriate for a given situation to measure - volume to the nearest cup, pint, quart, or gallon;*

Questions Relating to Eight of 10 Principles of Multimedia Instructional Design Given by Mayer

Multimedia/Technology Experts.

Frame 2

1. Does the ability to change the volume aid in the representation of the instructional concepts? (**Animation and Interactivity Principle**)
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Do the graphics and text convey the same information? (**Split-attention Principle, Redundancy Principle**)

Frame 3

1. Does the ability to change the unit aid in the representation of the instructional concepts? (**Animation and Interactivity Principle**)
2. Are the words that are bold and/or highlighted in this section relevant to the concept being taught?
3. Do the graphics and text convey the same information? (**Split-attention Principle, Redundancy Principle**)

Frame 4

1. Do the graphics on this screen facilitate learning? (**Animation and Interactivity Principle**)
2. Do the animations on this screen facilitate learning? (**Animation and Interactivity Principle**)
3. Do the animated graphics and text convey the same information? (**Split-attention Principle, Redundancy Principle**)

Frame 6

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Is the presentation of the content conversational rather than formal? (Personalization Principle)
3. Do the virtual manipulative objects used here [e.g. measuring cup, milk carton] accurately represent concrete real life objects?

Frame 8

1. Do the graphics and text on each screen convey the same information? (Split-attention Principle, Redundancy Principle)
2. Is the presentation of the content conversational rather than formal? (Personalization Principle)
3. Do the virtual manipulative objects used here [e.g. measuring cup, ice-cream container] accurately represent concrete real life objects?

Frame 10

1. Does the tutorial in this section provide enough examples to illustrate that 2 cups = 1 pint? (Worked-out Examples Principle)
2. Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?
3. Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?
4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)

Frame 12

1. Do the graphics and text on each screen convey the same information? (**Split-attention Principle, Redundancy Principle**)
2. Is the presentation of the content conversational rather than formal? (**Personalization Principle**)
3. Do the virtual manipulative objects used here [e.g. measuring cup, oil can] accurately represent concrete real life objects?

Frame 15

1. Does the tutorial in this section provide enough examples to illustrate that 4 cups or 2 pints = 1 quart? (**Worked-out Examples Principle**)
2. Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?
3. Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?
4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)

Frame 18

1. Do the graphics and text on each screen convey the same information? (**Split-attention Principle, Redundancy Principle**)
2. Is the presentation of the content conversational rather than formal? (**Personalization Principle**)
3. Do the virtual manipulative objects used here [e.g. measuring cup, oil can] accurately represent concrete real life objects?

Frame 21

1. Does the tutorial in this section provide enough examples to illustrate that 16 cups, 8 pints or 4 quarts = 1 gallon? (**Worked-out Examples Principle**)
2. Does the tutorial design allow typically achieving 4th grade students to independently navigate the instruction?
3. Does the tutorial design allow students with learning disabilities to independently navigate the instruction as needed?
4. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)

Frame 28

1. Do the graphics in this section facilitate learning? (**Animation and Interactivity Principle**)
2. Do the animations in this section facilitate learning? (**Animation and Interactivity Principle**)
3. Does this section of the tutorial provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)
4. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate and complete the instruction as needed?
5. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate and the instruction as needed?
6. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)

Frame 30

1. Is there enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
2. Do the graphics facilitate learning? (**Animation and Interactivity Principle**)
3. Do the animations facilitate learning? (**Animation and Interactivity Principle**)
4. Are the words in bold and/or highlighted relevant to the topic being learned?
5. Do the animations function at the correct speed? (**Animation and Interactivity Principle**)

Frame 33

1. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)
2. Does this screen allow students to progress at their own pace? (**Segmenting Principle**)

Frame 37

1. Is there enough opportunity for manipulation to enhance learning? (**Animation and Interactivity Principle**)
2. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
3. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

Frame 39

1. Do the graphics facilitate learning? (**Animation and Interactivity Principle**)
2. Do the animations facilitate learning? (**Animation and Interactivity Principle**)
3. Do the animations function at the correct speed? (**Animation and Interactivity Principle**)

4. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
5. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?
6. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)

Frame 40

1. Does this screen provide enough opportunity to manipulate and practice to reinforce learning? (**Animation and Interactivity Principle**)
2. Does the multimedia agent (pop-up 'sad' or 'happy' guy) provide enough feedback to support learning? (**Guided Discovery Principle- Immediate feedback**)
3. Does this screen allow students to progress at their own pace? (**Segmenting Principle**)
4. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
5. Are there any colors that are sensitive to changes when viewed on different computers?

Frame 42

1. Do the graphics facilitate learning? (**Animation and Interactivity Principle**)
2. Do the animations facilitate learning? (**Animation and Interactivity Principle**)
3. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
4. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

5. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
6. Are there any colors that are sensitive to changes when viewed on different computers?

Frame 43

1. Does this screen provide enough opportunity to manipulate and practice to reinforce learning? (Animation and Interactivity Principle)
2. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
3. Does this screen allow students to progress at their own pace? (Segmenting Principle)
4. Do the movements and sounds inside the funnel interfere with the understanding and practice of the second step?
5. Are there any colors that are sensitive to changes when viewed on different computers?

Frame 44

1. Do the graphics facilitate learning? (Animation and Interactivity Principle)
2. Do the animations facilitate learning? (Animation and Interactivity Principle)
3. Do the animations function at the correct speed? (Animation and Interactivity Principle)
4. Do the animated graphics and text on this screen convey the same information? (Split-attention Principle, Redundancy Principle)

Frame 46

1. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback to support learning? (Guided Discovery Principle- Immediate feedback)
2. Does this screen allow students to progress at their own pace? (Segmenting Principle)

Frame 47

1. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
2. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?

Frame 50

1. Is the tutorial design on these screens functionally reliable to allow typically achieving 4th grade students to independently navigate the instruction as needed?
2. Is the tutorial design on these screens functionally reliable to allow students with learning disabilities to independently navigate the instruction as needed?
3. Does this section of the tutorial allow students to progress at their own pace?

(Segmenting Principle)

4. Does the multimedia agent (pop-up ‘sad’ or ‘happy’ guy) provide enough feedback and guidance to engage students and support learning? (Guided Discovery Principle- Immediate feedback)

Wrap-up Questions at the end of the tutorial

1. Do the animations function at the correct speed? (Animation and Interactivity Principle)
2. Are there any colors that are sensitive to changes when viewed on different computers?
3. Did you find any objects that need to be modified to be made more realistic?
4. Did you find any screens confusing?
5. What do you consider to be the strengths of this tutorial model for students with learning disabilities?

6. What do you consider to be the weaknesses of this tutorial model for students with learning disabilities?
7. Are there any additional comments that you would like to share?