Instructional design document: Determining forest stocking levels.

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Design Document- Part 1

Overview

This online instructional module will provide the necessary background, description, and demonstration to allow forest landowners to effectively evaluate the stocking level or overall productiveness of their woodland properties. Stocking level is a domain-specific term for the estimated status of tree growth potential or productivity on a forested property. The degree of stocking represents a relationship between tree size, canopy cover, and competition for growth and, for deciduous forests, may be determined with the help of a Gingrich stocking chart (Krajicek, Brinkman, & Gingrich, 1961; Gingrich, 1967). Forest landowners are responsible for the overall health and productivity of their properties. Whether a property is meant for recreation or for financial investment, management costs are often offset by intermittent timber harvests, a part of management practices. The ability to accurately estimate stocking levels provides the landowner with a meaningful gauge by which to evaluate when or if a forest stand will benefit from a harvest. Inappropriate harvesting intervals may negatively impact tree growth and overall forest health, and hinder future acquisition of the income required to continue management activity.

Forest landowners are typically familiar with their woodlands including the trees species present, the lay of the land, and the extent of their property. Due to the nature of land ownership, landowners frequently also have at least basic skills in map reading and outdoor orientation. While many have pursued at least some post-secondary education, far fewer have completed a degree program in forestry or agriculture (Butler & Ma, 2011). As such, it is unlikely that they have more than casual familiarity with the domain-specific terms and the associated measurement tools used in forest management (Kuhns & Brunson, 1998, Ross-Davis &

Broussard, 2007). A lack of access to the specific tools required to determine stocking levels may be overcome, but the knowledge of the mathematical relationships required is not likely to be common knowledge. Table 1 further summarizes this needs assessment. This module intends to provide the fundamental information and procedures necessary for the typical forest landowner to successfully conduct their own assessment of forest stocking levels to aid in current and future management decisions.

Table 1

Needs Assessment

Goal	Optimal forest health and production efficiency requires balanced relationships between tree sizes and forest density. Tree harvesting is a management tool that manipulates this relationship. To make beneficial harvesting decisions, woodland owners must be able to identify the current status of these relationships.
Expectation	Landowners understand the significance of these relationships, how the current status may be determined, what tools are involved, and how to properly use the tools.
Reality	Landowners typically have some understanding of harvesting as a tool to reduce forest density.
Need	Landowners typically lack understanding of the relationships between tree size and forest density, how they might determine the current relationship, and what this relationship suggests in regard to harvesting decisions.

Instructional Goal

Indiana forest landowners will be able to estimate the stocking level (i.e., productivity) of their deciduous woodland property using a Gingrich stocking chart. Referencing Gagne (1985), this goal consists of a combination of verbal, intellectual, and psychomotor skills (as cited in Dick, Carey, & Carey, 2015).

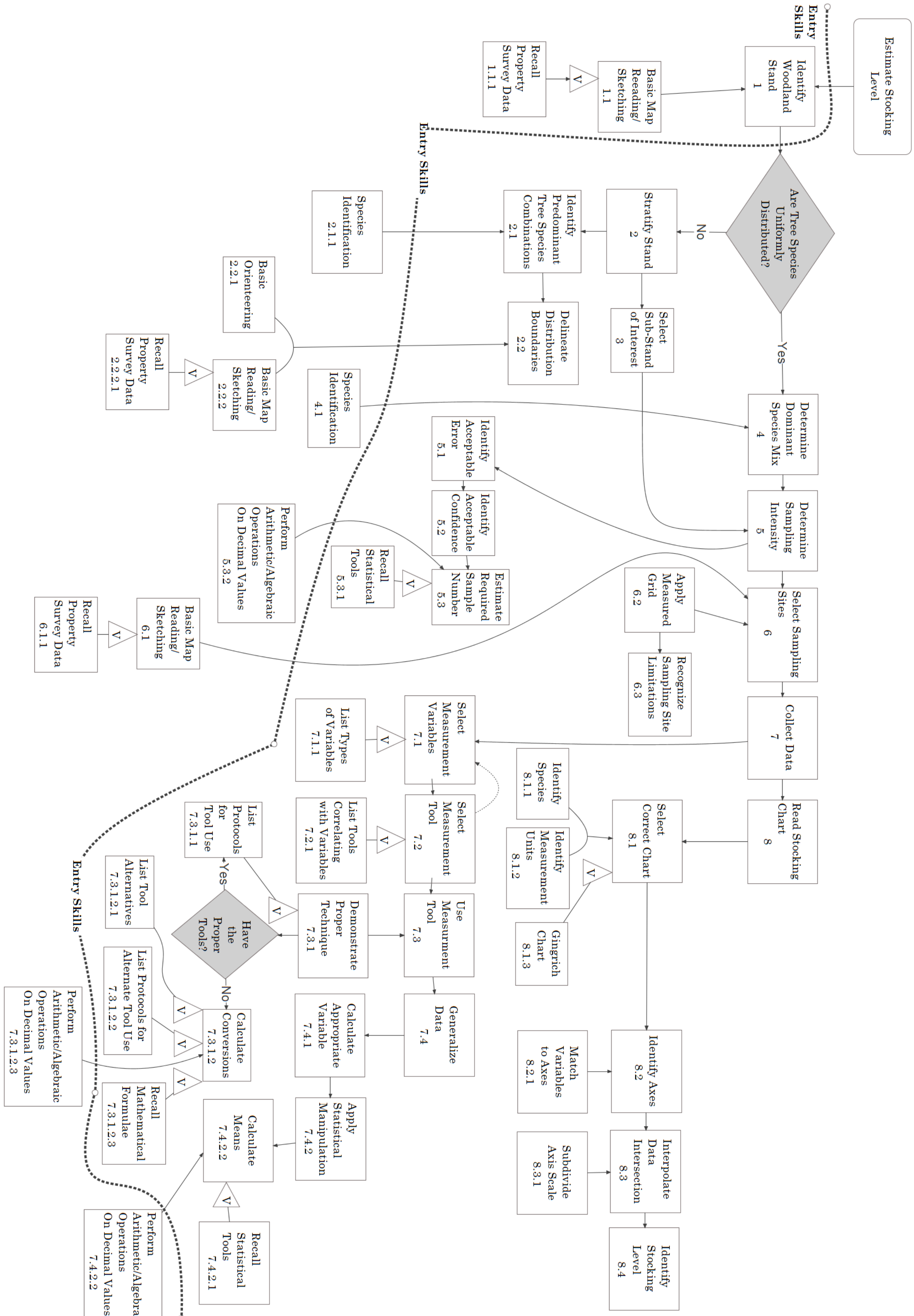

Figure 1. Goal analysis with a breakdown of sub-procedures, subordinate skills, and specific verbal information.

Table 2

Cluster Analysis

Property Data	Equations and Formulae
1.1.1 Recall Property Survey Data	5.3.1 Recall Statistical Tools
1.1.1.1 Types of Data	5.3.1.1 Sample Size Formula
1. Surveyor Report	1. $n = \left(\frac{t_{confidence} \times s}{Error}\right)^2$
2. County Map	5.3.1.2 Student's-*t* Distribution Table
3. Aerial Imagery	
	7.3.1.2.3 Recall Mathematical Formulae
2.2.2.1 Recall Property Survey Data	7.3.1.2.3.1 Circumference to Diameter
2.2.2.1.1 Types of Data	1. $diameter = \frac{Circumference}{\pi}$
1. Surveyor Report	7.3.1.2.3.2 Arbitrary Basal Area Factor (BAF)
2. County Map	1. $BAF = \left(\frac{8.696 \times Diameter}{Distance}\right)^2$
3. Aerial Imagery	7.3.1.2.3.3 Plot Radius Factor (PRF)
	1. $PRF = \frac{8.696}{\sqrt{BAF}}$
6.1.1 Recall Property Survey Data	
6.1.1.1 Types of Data	7.4.2.1 Recall Statistical Tools
1. Surveyor Report	7.4.2.1.1 Arithmetic Mean
2. County Map	2. $\bar{x} = \frac{\sum x}{n}$
3. Aerial Imagery	7.4.2.1.2 Quadratic Mean
	2. $x_{rms} = \sqrt{\frac{1}{n}\left(\sum x^2\right)}$

Table 2 (continued)

Cluster Analysis

Variables, Tools, and Protocols
7.1.1 List Types of Variables
7.1.1.1 Measurement Variables
1. Basal Area per Acre
2. Trees per Acre
3. Quadratic Mean Diameter
7.2.1 List Tools Correlating with Variables
7.2.1.1 Basal Area per Acre
1. Wedge Prism
2. Angle Gauge
7.2.1.2 Trees per Acre
1. Reel Tape Measure
2. Wedge Prism
3. Angle Gauge
7.2.1.3 Quadratic Mean Diameter
1. Diameter Tape Measure
2. Biltmore Stick
7.3.1.1 List of Protocols for Tool Use
7.3.1.1.1 Protocols
1. Wedge Prism
2. Angle Gauge
3. Reel Tape Measure
4. Diameter Tape Measure
5. Biltmore Stick

Variables, Tools, and Protocols (cont.)
7.3.1.2.1 List Tool Alternatives
7.3.1.1.2 Basal Area per Acre
1. Coin (e.g., dime, quarter)
2. Thumb
7.3.1.1.3 Quadratic Mean Diameter
1. Flexible Tape Measure
2. String & Yard Stick
7.3.1.2.3 List of Protocols for Tool Use
7.3.1.2.3.1 Protocols
1. Coin
2. Thumb
3. Flexible Tape Measure
4. String & Yard Stick

Reflection

I opted to select a topic that required mastery of some simple concepts and application of some straightforward procedures, suitable for an e-learning module. The most meaningful application would allow in person and in situ training, but this would not be practical for many potential participants. I worked the goal execution process in reverse, asking what knowledge and data would be required to achieve each particular step from the end to the beginning. This allowed for a clearer breakdown of steps and reduced the number of assumptions made. I tried to include the relevant sub-procedures and supporting knowledge that is required for each goal step, but only down to a reasonable level of assumed knowledge. All verbal/factual reference knowledge is described further in Table 2.

Initially, deciding upon a topic that fit within the scope of the workshop parameters was difficult. It took some time to come up with something that could be covered effectively and relatively quickly. The peer feedback suggested that I improve the specificity of my audience and/or context, which I did by narrowing the forest cover type. Additional suggestions involved further labeling of the sub-procedures to link them to specific goals, which was also implemented, and linearizing the break between entry skills and workshop content, which was not implemented due to space limitations in the goal analysis (Figure 1).

Design Document- Part 2

Learner Analysis

Introduction. The primary learners for this design project are private deciduous woodland owners interested in improving effective property management. The majority of learners are expected to be males over 40 years of age, married, and living on their properties (Ross-Davis & Broussard, 2007). The majority likely have some experience with post-secondary education (Butler & Ma, 2011) and therefore have basic mathematics skills. They generally share an interest in their forest properties (Ross-Davis & Broussard, 2007) and have actively sought out other forestry related educational resources, such as basic tree identification and forest management concepts (Kuhns & Brunson, 1998). Property owners may be roughly categorized into three levels of proactivity: Forest managers, new forest owners, and passive forest owners (Ross-Davis & Broussard, 2007).

Data source. The learner data, summarized in Table 3, was derived from a number of research reports analyzing forest landowner characteristics in the Midwest and northern United States. Additional data (hypothetically) was derived from mailed surveys for information on base knowledge, education, and motivation and through personal interviews to clarify attitudes toward content delivery and confidence in Purdue University as an information source.

Table 3

Learner Analysis

Information Categories	Data Sources	Learner Characteristics
Entry skills	Butler & Ma, 2011 Ross-Davis & Broussard, 2007 Survey	Learners have basic math skills, the ability to identify and navigate woodland properties, and the ability to identify tress species to the genus level.
Prior knowledge	Kuhns & Brunson, 1998 Ross-Davis & Broussard, 2007 Survey	Learners have some familiarity with forestry terminology and basic forest management concepts.
Attitudes toward content	Ross-Davis & Broussard, 2007	Learners have a demonstrated interest in advancing their forest property related knowledge.
Attitudes toward delivery system	Survey Interview	More advance age groups and more production oriented groups may have less interest in online versus in-person training.
Motivation for instruction	Ross-Davis & Broussard, 2007 Survey	Learners have an interest in effective property management, although end goals may differ.
Education and ability levels	Butler & Ma, 2011 Survey	Learner education level is typically higher than the general public with roughly 1/3 holding a

		college degree and 2/3 having at least some college.
General learning preferences	Ross-Davis & Broussard, 2007 Survey	Learners currently seek information in print media (≈45%), online (≈20%), and through interpersonal interactions (≈20%).
Attitudes toward training organization	Survey Interview	Learners indicate a generally positive attitude toward Purdue's College of Agriculture and its associated programs.
General group characteristics		
Heterogeneity Size Impressions	Ross-Davis & Broussard, 2007	Learners categorized as Forest Managers, New Forest Owners, or Passive Forest Owners Typically resident landowners, male, and married Mean age range 40 – 70 years.

Performance Context

Introduction. As this design project addresses an aspect of analysis useful to forest management, the performance context is in the field, within the Midwestern United States woodland owner's deciduous forest properties (Ross-Davis & Broussard, 2007). Execution of the instructional goal will normally be according to the needs and to the degree desired by the property owner, so external supervision is limited to non-existent (Ross-Davis & Broussard, 2007). Properties are typically 6-25 acres (Ross-Davis & Broussard, 2007), so decisions regarding execution intensity will be at the discretion of the learner/owner. The properties are private, but interactions with contracted third parties may require use of the results from this instruction to make further informed decisions.

Data source. The context data, summarized in Table 4, was derived from a combination of research reports analyzing forest landowner characteristics in the Midwest and northern United States; (hypothetically) mailed surveys for information on property management and social interaction; and observation of typical property sites and personal knowledge of the value of the instructional goal to effective property management.

Table 4

Performance Context

Information Categories	Data Sources	Performance Site Characteristics
Managerial support	Ross-Davis & Broussard, 2007 Survey	Not applicable. Learners typically self-manage their own properties, so no immediate supervision exists.
Physical aspects of the site	Ross-Davis & Broussard, 2007 Observations	Deciduous, temperate, hardwood forest stands in Indiana and surrounding Midwest region. 6 – 25 acre average.
Social aspects of the site	Survey Observations	Private property settings but with periodic interaction with contracted third parties required.
Relevance of skills	Observations Interviews	Determination of stocking level is valuable as it influences property management decisions and aids in evaluation of third party advice.

Learning Context

Introduction. The selected learning context, based entirely online through internet delivery, relies upon the learner's own technological infrastructure. Use of home PCs, laptops, tablet, or mobile devices is expected. Shared resources such as public access sites may also be used. The web-based eLearning platform will provide access to all required resources, as well as interactive links to additional supplementary materials that may be of benefit to or required by some learners. Use of the learners' own computing resources allows increased user control in the interaction (e.g., mouse versus touch screen), display sizes, and preference of training site (e.g., home or office versus in the field). While it is evident that the instructional goal coupled with the performance context may be more effectively achieved in person and in situ, the distributed nature of property ownership can seriously limit the ability of potential learners to participate in the training. Selecting an exclusive online medium may allow for more equal access for any interested learner.

Data source. All data for the learning context, summarized in Table 5, was derived from personal observation and experience with the potential computing resources and eLearning platform.

Table 5

Learning Context

Information Categories	**Data Sources**	**Learning Site Characteristics**
Number/nature of sites	Observation	Learning accomplished through web access via PC, tablet, or mobile device from private location of learner's choice. eLearning module hosted on local network server.
Site compatibility with instructional needs	Observation	Web-based instruction provides access to all required resources.
Site compatibility with learner needs	Observation	Learner may utilize traditional or touch technology, fixed or mobile, of any visual display size.
Feasibility for simulating performance site	Observation	Multimedia resources available for information and demonstration of techniques. Printable supplemental resources. Mobile access provides in-field use if desired.

Performance Objectives

Table 6 summarizes the overall instructional goal and the main and primary sub-steps comprising the goal. Learning objectives are provided for each.

Table 6

Performance Objectives

Main Instructional Goal	**Terminal Objective**
Forest landowners will be able to estimate the stocking level of their deciduous woodland property using a Gingrich stocking chart	Given the data derived from online sample case studies of deciduous woodlands, learners will be able to estimate Gingrich stocking levels to within ±5%.
Main Step (Entry Skill) in Instructional Goal	**Objective**
(1) Identify woodland stand	Given a map, survey, or aerial photo learners will identify a woodland stand by its natural and manmade boundaries.
Entry Skills	**Objective**
(1.1) Basic map reading	Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types.
Main Step in Instructional Goal	**Objective**
(4) Determine dominant species mix	Given the representative proportion of tree species within the identified woodland stand, learners will correctly identify the dominant species groupings for that stand.
Entry Skills	**Objective**
(4.1) Identify tree species	Given tree leaves, bark, or buds learner will identify tree species to genus level.
Main Step in Instructional Goal	**Objective**
(2, 3) Stratify and select sub-stand	Given a map, survey, or aerial photo that depicts visual clustering of different tree species, learners will correctly recognize these clusters and choose a sub-unit of the presented woodland.
Subordinate Skills	**Objective**
(2.1) Identify predominant tree species combinations	Given the representative proportion of tree species within the identified woodland stand, learners will

	correctly identify the dominant species groupings for that stand.
(2.2) Delineate distribution boundaries	Given visual representations of different tree species clusters, learners will correctly distinguish the point of transition from one group to another.
Main Step in Instructional Goal	**Objective**
(5) Determine sampling intensity	Given specific acceptable error and required confidence levels, learners will correctly calculate the number of measurement locations required.
Subordinate Skills	**Objective**
(5.1) Identify acceptable error	Learner will recognize the relationship between error level and accuracy of measurement and correctly infer the range of values an error level represents.
(5.2) Identify desired confidence	Learner will recognize the relationship between confidence level and reliability and correctly infer the likelihood of accuracy for a measurement.
(5.3) Estimate required sample size	Given defined error and confidence levels, learner will correctly calculate the estimated number of measurements required.
Main Step in Instructional Goal	**Objective**
(6) Select sampling sites	Given a map, survey, or aerial photo of the selected woodland stand, learners will diagram a measured grid and choose the correct number of sampling locations.
Subordinate Skills	**Objective**
(6.2) Apply a measured grid	Given a map, survey, or aerial photo, learner will accurately measure and subdivide the image into a predetermined number of gridded, equally sized cells.
(6.3) Recognize sampling site limitations	Given a map, survey, or aerial photo overlaid with a sampling grid, learner will recognize potential limitations associated with certain sampling locations in the grid.
Entry Skills	**Objective**
(6.1) Basic map reading	Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types.
Main Step in Instructional Goal	**Objective**

(7) Collect data	Given a specific measurement tool, learners will recall its correct operation, what data it generates, and the proper protocol for collecting measurement data.
Subordinate Skills	**Objective**
(7.1) Select measurement variables	Given a specific measurement tool, correctly identify the data the tool generates.
(7.2) Select measurement tool	Given a specific measurement variable, correctly identify the tool generates this data.
(7.3) Use measurement tool	Given a specific measurement tool, recognize the correct measurement protocol required and recall the steps of this protocol.
(7.4) Generalize data	Given a set of measured data, calculate the appropriate statistical mean for the data.
Main Step in Instructional Goal	**Objective**
(8) Read stocking chart	Given a dominant group of woodland tree species and the data results for two of three measurement variables, learners will estimate stocking levels from the appropriate Gingrich chart to within ±5%.
Subordinate Skills	**Objective**
(8.1) Select the correct cart version	Given specific tree species groupings and measurement data units, learner will correctly select the matching Gingrich chart.
(8.2) Identify the charts axes	Given a specific Gingrich chart and specific measurement data types, the learner will correctly identify which chart axes match the given data.
(8.3) Interpolate intersecting data	Given a specific Gingrich chart and specific measurement data, learner will identify the corresponding location on each appropriate chart axis.
(8.4) Identify the stocking level	Given a specific Gingrich chart with identified axis locations, learner will estimate the interpolated stocking level to within ±5%.

Assessment Plan

Entry skills test. This online instructional module will not include an evaluation of entry skills. It is designed to introduce a simple but useful forest management concept. The entry skills are relatively basic, excepting tree species identification, and it is expected that most participants will have an adequate baseline skill. Tree species identification is more specialized and beyond the scope of this module. Learners who lack this skill will be referred to additional online resources that may be used to offset shortcomings in this area.

Pretest. There will be no formal pretest. This online instructional module is intended for self-paced improvement and reference. Incoming prior topic knowledge is not considered key to this goal. The instruction is intended to be stand-alone, providing everything needed by novice learners, but may also act as a refresher to those learners who have some incoming familiarity with the concepts. Learners with extensive prior knowledge are not likely to benefit from this eLearning module.

Practice test. Practice quizzes will be used in this module. These will primarily serve to highlight the important points from each major section of material and simultaneously break the instruction into discrete chunks that must be acknowledged and addressed by the learner. The goal is to force the learner to pause and consider what was just covered, reinforcing the concepts before moving onto additional material. This also prohibits skipping ahead to the final assessment with little to no engagement with the learning materials.

The module is intended for self-paced standalone use, so the assessments are necessarily self-evaluating. This, combined with the delivery platform, limits assessments to variations of multiple choice, matching, true/false, calculation, and some simple graphical interactions.

Posttest. The final assessment for the module will attempt to simulate a scenario with a combination of text, graphics, and multimedia where the learner will carry out the primary instructional goal and determine a final result. As this is a self-paced instruction, the final assessment will consist of a sequence of related assessment sub-steps, each contributing to the final solution. The sub-steps will necessarily use feedback to guide the learner toward the correct answer as needed so that progress may occur and weaknesses identified by the learner. The intent is to minimize learner frustration and avoid reinforcement of misunderstood concepts while executing the main instructional goal. Multiple scenario versions may be provided to allow progressive improvement in execution of the overall goal.

Reflection

The analysis portion of this document provided deeper insight into details that are often overlooked during the initial planning phases. Much more consideration of the learners, environments, and the intended goals is required. I found that the more detailed the goal analysis, the more daunting the required analysis of performance objectives becomes. To cope with this, only the highest level goal steps and sub-steps are included in this document. To properly execute all aspects of the design project is the available timeframe, I would stress simplicity in deciding upon the original instructional goal. The resulting analyses may seem overly simplistic, but the simplicity may allow for an actual attempt at learner or context analysis with real learners or contexts. Goals that are too complex or require learners that are too inaccessible to the student require too much guesswork and assumption to adequately progress through this stage of the document. Although thought of the analyses provides some good insight, having time to actually analyze learners and contexts would undoubtedly provide additional unconsidered perspectives.

The peer review did not raise any particular issues that I could consider when completing this portion of the document, but it did provide opportunities to seek clarification on constructing objectives with related criteria.

Design Document- Part 3

Design Evaluation

Table 7

Design Evaluation Chart

Main Step (Entry Skill) in Instructional Goal	**Objective**	**Test Items**
(1) Identify woodland stand	Given a map, survey, or aerial photo learners will identify a woodland stand by its natural and manmade boundaries.	1. Using the displayed aerial image, click on the woodland portion and then click on what you consider to be the natural or manmade boundaries of this woodland. Consider the feedback provided.
Entry Skills	**Objective**	
(1.1) Basic map reading	Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types.	1. Examine the aerial photograph shown. Match each of the legend indicators with the corresponding description of the item.
Main Step in Instructional Goal	**Objective**	**Test Items**
(4) Determine dominant species mix	Given the representative proportion of tree species within the identified woodland stand, learners will correctly identify the dominant species groupings for that stand.	1. You observe 100 trees in a woodland stand and find 15 maple, 10 hackberry, 35 oak, 13 walnut, and 27 hickory. This stand is best described as a ______ forest: a. Mixed Oak b. Walnut/Hickory c. Maple/Oak d. Oak/Hickory
Entry Skills	**Objective**	
(4.1) Identify tree species	Given tree leaves, bark, or buds learner will identify tree species to genus level.	1. Match each of the displayed leaf, bud, and bark images with the

		appropriate tree genus from the list.
Main Step in Instructional Goal	**Objective**	**Test Items**
(2, 3) Stratify and select sub-stand	Given a map, survey, or aerial photo that depicts visual clustering of different tree species, learners will correctly recognize these clusters and choose a sub-unit of the presented woodland.	1. For the interactive aerial photo shown, examine the woodland and determine which region (A-G) represents a true maple/beech sub-stand. (Photo shows woodlands with various boundaries, clicking provides data on species composition in that area.)
Subordinate Skills	**Objective**	
(2.1) Identify predominant tree species combinations	Given the representative proportion of tree species within the identified woodland stand, learners will correctly identify the dominant species groupings for that stand.	1. You observe 100 trees in a woodland stand and find 15 maple, 10 hackberry, 35 oak, 13 walnut, and 27 hickory. This stand is best described as a ______ forest: a. Mixed Oak b. Walnut/Hickory c. Maple/Oak d. Oak/Hickory
(2.2) Delineate distribution boundaries	Given visual representations of different tree species clusters, learners will correctly distinguish the point of transition from one group to another.	1. On the displayed aerial photo, click on each area of the woodland that suggests transition between dominant tree species.
Main Step in Instructional Goal	**Objective**	**Test Items**
(5) Determine sampling intensity	Given specific acceptable error and required confidence levels, learners will correctly calculate the number of measurement locations required.	1. If a woodland owner wants to estimate a measurement with 95% confidence of being within 10% of the average, how many sample measurements should they complete?

Subordinate Skills	Objective	
(5.1) Identify acceptable error	Learner will recognize the relationship between error level and accuracy of measurement and correctly infer the range of values an error level represents.	1. If the true value of a measure is 10 and you make 5 measurements (4.5, 4.3 5.7, 6.7, 5.1), what is the error level (%) of your estimated average?
(5.2) Identify desired confidence	Learner will recognize the relationship between confidence level and reliability and correctly infer the likelihood of accuracy for a measurement.	1. If the true value of a measure is 25 and three people each made a set of measurements as shown below, which set do you have the highest confidence in its accuracy? (show data with the following characteristics) a. $\bar{x}$=25, n=4, s=0.2 b. $\bar{x}$=25, n=9, s=0.4 c. $\bar{x}$=25, n=2, s=0.1
(5.3) Estimate required sample size	Given defined error and confidence levels, learner will correctly calculate the estimated number of measurements required.	1. If a woodland owner wants to estimate a measurement with 95% confidence of being within 10% of the average, how many sample measurements should they complete?
Main Step in Instructional Goal	**Objective**	**Test Items**
(6) Select sampling sites	Given a map, survey, or aerial photo of the selected woodland stand, learners will diagram a measured grid and choose the correct number of sampling locations.	1. For the image provided, use the legend scale to apply a uniform grid of 100 m by 100 m squares over the woodland area. Select the correct final image from the list of options. 2. If you were to estimate the need for 12 sampling sites, select the most appropriate final 3 sites on the

		displayed image already showing the first 9 sites.
Subordinate Skills	**Objective**	
(6.2) Apply a measured grid	Given a map, survey, or aerial photo, learner will accurately measure and subdivide the image into a predetermined number of gridded, equally sized cells.	1. For the image provided, use the legend scale to apply a uniform grid of 100 m by 100 m squares. Select the correct final image from the list of options.
(6.3) Recognize sampling site limitations	Given a map, survey, or aerial photo overlaid with a sampling grid, learner will recognize potential limitations associated with certain sampling locations in the grid.	1. Which of the following best describes the potential issues with the sampling selection displayed on the given map?
Entry Skills	**Objective**	
(6.1) Basic map reading	Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types.	1. Examine the aerial photograph shown. Match each of the legend indicators with the corresponding description of the item.
Main Step in Instructional Goal	**Objective**	**Test Items**
(7) Collect data	Given a specific measurement tool, learners will recall its correct operation, what data it generates, and the proper protocol for collecting measurement data.	Represented by a combination of the following subskill items.
Subordinate Skills	**Objective**	
(7.1) Select measurement variables	Given a specific measurement tool, correctly identify the data the tool generates.	1. Match the following types of measurement data with the corresponding measurement tools.
(7.2) Select measurement tool	Given a specific measurement variable, correctly identify the tool generates this data.	1. Which measurement tool best captures the

		following forest measurements?
(7.3) Use measurement tool	Given a specific measurement tool, recognize the correct measurement protocol required and recall the steps of this protocol.	1. Based upon the proper use of a wedge prism, place the following steps in order to describe to correct procedure. Note: Not all steps may be used.
(7.4) Generalize data	Given a set of measured data, calculate the appropriate statistical mean for the data.	1. If you measured the following tree diameters while working, what would be appropriate to report as the average for this measurement?

Main Step in Instructional Goal	**Objective**	**Test Items**
(8) Read stocking chart	Given a dominant group of woodland tree species and the data results for two of three measurement variables, learners will estimate stocking levels from the appropriate Gingrich chart to within ±5%.	1. Examine the three provided Gingrich charts. If you measured 35 oak and 40 hickory trees in a total of 0.75 acres and recorded the following values for diameters, what would you estimate the stocking level for this woodland?
Subordinate Skills	**Objective**	
(8.1) Select the correct cart version	Given specific tree species groupings and measurement data units, learner will correctly select the matching Gingrich chart.	1. Which of the following Gingrich charts is most appropriate for oak trees with diameters between 8 and 12 inches and in a 20 acre woods?
(8.2) Identify the charts axes	Given a specific Gingrich chart and specific measurement data types, the learner will correctly identify which chart axes match the given data.	1. Using the provided Gingrich chart and the following sets of measurements, click on the chart axes that

		correspond to the information given.
(8.3) Interpolate intersecting data	Given a specific Gingrich chart and specific measurement data, learner will identify the corresponding location on each appropriate chart axis.	1. Observe the marked point on this Gingrich chart. What numerical values best represent the position of the point on each axis?
(8.4) Identify the stocking level	Given a specific Gingrich chart with identified axis locations, learner will estimate the interpolated stocking level to within ±5%.	1. Observe the marked axes on this Gingrich chart. What is the estimated stocking value given by this chart? Estimate to ±5%.

Instructional Strategy Alignment

Table 8 illustrates some of the potential content that may support the various clusters of instructional goals. Cluster 1 combines sub goals 1, 2, 3, and 4 where woodland stands are identified, stratified, and characterized by dominant tree species. This will involve the use of maps or aerial imagery as well as description of the trees that makeup the stand. Learners will practice identifying stands and classifying then according to the species present. Cluster 2 combines sub goals 5 and 6 where levels of error, confidence, and distribution of samples will be determined. Content will focus on the similarities and differences between measurement errors and confidence in measured results. Images and maps will also provide practice with grid placement allowing physical segregation of properties into smaller measurable components. Cluster 3 and 4 align with sub goals 7 and 8, respectively collection of data and reading the stocking chart. Cluster 3 includes examples of tools, descriptions of their proper use, and potential problems that may negatively impact results. Protocols and alternative options are provided for users to reference. Cluster 4 similarly include examples of Gingrich charts, descriptions of their components, what the results mean to the landowner, problems that may be encountered when referencing various charts, and potential impacts on management decisions.

Table 8

Instructional Strategy Alignment

Learning Component	Design Plan
Cluster 1 • Identify and characterize specific woodland stand to be investigated.	Objectives • 1 Given a map, survey, or aerial photo learners will identify a woodland stand by its natural and manmade boundaries. • 1.1 Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types. • 2,3 Given a map, survey, or aerial photo that depicts visual clustering of different tree species, learners will correctly recognize these clusters and choose a sub-unit of the presented woodland. • 2.1 Given the representative proportion of tree species within the identified woodland stand, learners will correctly identify the dominant species groupings for that stand. • 2.2 Given visual representations of different tree species clusters, learners will correctly distinguish the point of transition from one group to another. • 4 Given the representative proportion of tree species within the identified woodland stand, learners will correctly identify the dominant species groupings for that stand. • 4.1 Given tree leaves, bark, or buds learner will identify tree species to genus level. Content Presentation Content o Examples of various property images will be provided with explanations of identifying factors, common boundaries, and terrain transitions. Explanations of common legend terms and icons will be shown. Tree species identification is summarized and examples of common grouping categories listed. Explanation of grouping guidelines provides as well as recognizing stratified species clusters in geographically separate areas of forest stand. Example o Aerial photo

	- Satellite image - Survey map - Hand drawn map sketch - Images of common tree species buds, bark, leaves - Species grouping categories Groupings and Media - Individualized, web-based, streaming video where required, practice and feedback online. Student Participation Example - Use interactive images to relate visual indicators to elements highlighted in the explanations. - Explore interactive maps to gather species data, collate and identify major grouping(s)
Cluster 2 Select sampling intensity and sampling locations	Objectives 5 Given specific acceptable error and required confidence levels, learners will correctly calculate the number of measurement locations required. 5.1 Learner will recognize the relationship between error level and accuracy of measurement and correctly infer the range of values an error level represents. 5.2 Learner will recognize the relationship between confidence level and reliability and correctly infer the likelihood of accuracy for a measurement. 5.3 Given defined error and confidence levels, learner will correctly calculate the estimated number of measurements required. 6 Given a map, survey, or aerial photo of the selected woodland stand, learners will diagram a measured grid and choose the correct number of sampling locations. 6.1 Given a map, survey, or aerial photo, learner will recognize natural and manmade structures and correctly distinguish between different terrain types. 6.2 Given a map, survey, or aerial photo, learner will accurately measure and subdivide the image into a predetermined number of gridded, equally sized cells. Content Presentation Content - Give explanation for the concepts of confidence and error in both common or lay-terms and with a mathematical formula that may be used to calculate values. Compare and contrast the concepts and demonstrate why both are important for learner to understand. Relate these concepts to the necessary number of

	measurement samples. Relate number of samples to the size of a woodland stand and have learner consider how much of the stand they can practically measure. Example o Example anecdotal descriptions of error and confidence in practical terms, set in forest context. o Formulae for error, confidence, and sample size. o Sample grid overlays onto woodland stands, showing area to cell relationships Groupings and Media o Individualized, web-based, streaming video where required, practice and feedback online Student Participation Example o Determine error and confidence values from textual or image-based examples, in forest context. o Calculate actual error, confidence, and sample number values using formulae and provided values. o Determine how what size of grid corresponds to samples of a given size.
Cluster 3 • Select variables and collect tree measurement data	Objectives • 7 Given a specific measurement tool, learners will recall its correct operation, what data it generates, and the proper protocol for collecting measurement data. • 7.1 Given a specific measurement tool, correctly identify the data the tool generates. • 7.2 Given a specific measurement variable, correctly identify the tool generates this data. • 7.3 Given a specific measurement tool, recognize the correct measurement protocol required and recall the steps of this protocol. • 7.4 Given a set of measured data, calculate the appropriate statistical mean for the data. Content Presentation Content o Various measurement tools will be identified, with images and descriptions of what they measure and brief overview of how they work. Each of the primary measurements will be described and how it corresponds to trees. Various measurement units (e.g. English, International) will be reviewed.

	Example o Images of different versions of measurement tools. o Videos of tools in user, demonstrating proper protocols. Groupings and Media o Individualized, web-based, streaming video where required, practice and feedback online Student Participation Example o Interactive simulation of tool use. o Some alternative tools (e.g. a coin instead of an angle gauge) will be described ▪ Learner may do some offline interactions with either real or alternative tools to test principles
Cluster 4 • Select and interpret Gingrich stocking chart	Objectives • 8 Given a dominant group of woodland tree species and the data results for two of three measurement variables, learners will estimate stocking levels from the appropriate Gingrich chart to within ±5%. • 8.1 Given specific tree species groupings and measurement data units, learner will correctly select the matching Gingrich chart. • 8.2 Given a specific Gingrich chart and specific measurement data types, the learner will correctly identify which chart axes match the given data. • 8.3 Given a specific Gingrich chart and specific measurement data, learner will identify the corresponding location on each appropriate chart axis. • 8.4 Given a specific Gingrich chart with identified axis locations, learner will estimate the interpolated stocking level to within ±5%. Content Presentation Content o Description forest stocking levels and the meanings applied to each of the main divisions. Examples of Gingrich stock charts and identification of the primary components. Aspects to consider when selecting a chart for a given woodland (e.g., units, species group, magnitude of measured values). Interpolation of values along chart axes. Relationship between the three variables displayed on the chart. Example

- Images of various forms of the Gingrich stocking chart.
- Measurement datasets to map onto sample Gingrich charts

Groupings and Media

- Individualized, web-based, streaming video where required, practice and feedback online

Student Participation

Example

- Interactive interpretation of various Gingrich charts using sample data.
- Use of sample scenario to derive measurement data, calculate necessary variables, select chart and interpret final stocking estimate.
- Consideration of management implications based upon chart results.

Implementation Plan

Description of potential pilot testers. As the audience for this learning module may be varied in age, education, and field-specific background, the pilot test for this module will purposely include two individuals differing in educational focus and stage in life. The target learners will consist of one undergraduate student enrolled in the Forestry program and one adult non-student, lacking any formal forestry education. The student will be sophomore to junior level, age 18 to 25 years, and will not have completed any specific coursework on the primary topic of this module (i.e., stocking level measurement by use of a Gingrich stocking chart). The adult participant, age > 25 years, will have an undergraduate degree, but not in forestry or a closely related field. They will have some general knowledge on forest make up and trees, but lack technical details. They will both have at least basic tree identification knowledge (e.g., through leaf examination or better).

Plan for conducting pilot test. The module will be conducted online, via a web link. The participant will complete the module on either a phone, laptop, or desktop PC according to their preference.

Instrument. Participants will complete a survey to assess how the module was received and the learners' perception of the material.

Sample Questions. Questions may include:

a. How do you feel about the time required to complete the entire training?
b. Which topics do you feel least confident in? Why do you feel this way?
c. Were there enough visual or textual examples to help your understanding? If not which topics and why?

Evaluation Plan

Expert review.

Process. Expert will receive technical content and formulae for module. This includes supporting video media, diagrams, and measurement protocols. Expert will review the material for technical accuracy and relevance to the learning goal. Materials will include short descriptive texts to set the stage of the scenario represented during a particular section of the learning module. For areas identified during pilot implementations as less effective by learners, experts may provide guidance on additional topics or examples that could help to clarify understanding.

Instrument. The expert will receive an evaluation form rating both the accuracy and applicability of the materials to the stated goals. A "Suggestions for improvement" column will be available for each inquiry.

Sample questions. Questions may include:

a. Formula for estimated sample size is accurate and relevant for the sampling situation described in the description?
b. Is this technique appropriate for the geographic region described?
c. Are the practices described in line with current standards?

One-to-one.

Process. The tester will complete the module while the designer observes the process. The tester will be encouraged to "think aloud" while working. The designer will observe, taking notes on the process and will answer any questions needed to clarify procedures after initial attempts are made by the tester. Topic specific content questions will not be answered in detail at this time.

Instrument. After completion, the tester will be debriefed in an interview to ascertain their perceived experience and opinions on the training. A written survey will be provided for the tester to evaluate aspects of the content and delivery system. Assessment data from the module will provide feedback on learner performance.

Sample Questions. One-on-one questions may include:

a. Can you summarize the block of material just presented in this section of the module?
b. On this particular question, can you walk me through your thought process as you evaluated each of the answer choices?

Small group.

Process. The instruction will be made available as a web link and provided to the group of learners (10 to 20 max) to complete on a particular technology platform. Learning pool will be composed of a mix of secondary and post-secondary graduates with at least casual forestry knowledge but no formal forestry education. Separate small group assessments will be made for each of the main technologies (i.e., smartphone, laptop or tablet, desktop PC). The environment will be controlled (e.g., computer workspace) but timing will be self-paced. The designer will not interact with the learners.

Instrument. The small group members will complete a survey to evaluate aspects of the content and delivery system and their attitudes toward the learning module. Interviews will target areas highlighted during the one-on-one evaluations as well as generally probe at issues of clarity and impact. Assessment data from the module will provide feedback on learner performance.

Sample Questions. Questions may include:

a. Were there adequate opportunities to practice as you learned?

b. Were the supplemental videos helpful to your understanding? Please elaborate as to why or why not.

c. Did the materials for each section directly relate to the stated topic/objectives? How did they differ?

Field trial.

Process. The instruction will be distributed to a number (as many as is practical, ideally 30 or more) of woodland land owners who have agreed to participate in the trial. Learners will be identified from extension databases, email groups, and local and regional landowner meetings. Information about the project will be provided and will include a survey related to their interest, demographics, and willingness to participate. Links to the module will be provided and the learners will engage with the materials using their preferred technologies and at the location of their choice.

Instrument. Those who return the survey and indicate an interest in participation will be provided access to the training, as well as a follow-up survey regarding their experiences. Assessments will include information on methods of access, issues encountered, time for completion, learner's approach to learning (e.g., all at once, staggered, start and stop, start over, did not finish), satisfaction with the experience, overall appeal, and perceived understanding of the main objective upon completion. Problematic areas identified in the small group trials will also receive focus.

Sample Questions. Questions may include:

a. Were the topics presented in a fashion that you could understand the objective and follow the content?
b. What were the greatest obstacles encountered in completing the module?
c. Were you able to complete the practice exercises with confidence?

Reflection

The project seems to be progressing well. The design analysis chart was helpful to aid thinking about what types of specific questions we want the learners to answer. It also uncovered an additional sub-skill objective (6.3) that was overlooked in the original plan. The design analysis prompted thought about what content to include. Ideas for student participation were more difficult to come by since the module is intended for self-paced, isolated study. The evaluation plan was helpful to consider what groups to include and how they might be identified. Formulating the later stages of evaluation becomes difficult however without solid data from earlier stages.

This project emphasizes the idea that effective instructional design is best performed by a team, especially since this module really only covers a small fraction of the material that a comprehensive introductory course would present. To form a self-administered learning module requires significant investment from the designer and can easily overwhelm them with technical details.

Peer feedback was minimal, but resulted in some grammatical fixes and clarification of learner selection.

Design Document- Final

Pilot Implementation and Formative Evaluation

Since the target learner population exhibited variability in both age and education levels, the pilot enlisted two learners with similar characteristics. One subject (subject A) was an undergraduate Purdue Forestry student, sophomore status, age 20, and without completion of any coursework directly related to the primary training topic. The other subject (subject B) was an adult, 40 years of age with an undergraduate degree not in Forestry or a closely related area, and who exhibited a general knowledge of forests and trees (e.g. basic identification skills), but lacked specific technical knowledge related to the topics covered in the training module.

The training module (for this iteration, only the final goal step of “Reading a Gingrich Stocking Chart” was included in the module) was accessed through a weblink, delivered to the participants in an invitation email. The module was completed by whatever technological means and approach the learner preferred. The email included a survey instrument, as described in in the next section. The subjects were instructed to complete the training module prior to completion of the survey, and to answer all survey questions honestly and in accordance to how they actually felt during completion of the module. The completed survey was then returned via email for evaluation. The instrument included below includes the collated responses of each subject, identified by A for the undergraduate and B for the adult.

Pilot Implementation Survey Instrument

Please complete the training module prior to answering these questions. When you complete the following items, please be honest and report how you actually felt while you were working with the training. Please type you answers into this form, save, and submit via email to nhilliar@purdue.edu.

Access.

What type of device did you use to complete the training (Ex. laptop, desktop, etc.)? Why did you choose this device?

A: Acer laptop

B: Laptop

What operating system did you use (Ex. Windows, Mac, Android, Linux, etc.)?

A: Windows 10 Home

B: Windows

Did you use a tall or wide screen orientation?

A: Landscape, laptop screen

B: Wide

Screen resolution, if known?

A: 1600x900

B: HDMI I think?

Did you use a touch screen?

A: No

B: Touchpad

What web browser did you use (include version number if known)?

A: Chrome

B: Chrome version 71

Did you use more than one device to complete the training? If yes, why?

A: No

B: Just the laptop

Did you use a wired, wireless, or cellular connection?

A: Wireless

B: Home network, no wire

What is you network speed, if known?

A: Whatever PAL is

B: Not sure

Issues.

What issues, if any, did you have with (please describe if you had problems):

Access to the training site?

A: None

B: Link worked fine

Connectivity (connection or transfer of data)?

A: Took a second for the backgrounds to load

B: Same as other sites I visit

Browser (did anything not work as you expected)?

A: Seemed OK

B: I don't think so

Responsiveness (to clicks, taps, scrolling, swiping, etc.)?

A: Worked

B: OK

Progress through training?

A: Some of the question answers scrolled out of view (too big)

B: able to complete OK

Completion of training?

A: Having to click continue slowed me down but otherwise OK

B: I was able to finish

Time Commitment.

How many session did you need to complete the training?

A: Did it all at once

B: One

How long on average was each of your sessions?

A: It took about 15 minutes

B: One session, took 20 minutes or so

How long do you feel your entire time commitment was?

A: 10 minutes

B: About 15 minutes

How do you feel about the time required to complete the entire training?

A: I think it was long enough

B: Could have some more examples added to make topic clearer

Do you feel any topic sections of the training took too long? Which?

A: Did not need the part on reading chart axis

B: Not really

Do you feel any topic sections of the training were too short? Which?

A: No

B: The part about how to read the chart, what the parts were. Could be more explanation or examples

Approach.

Did you finish the entire training? If not, which parts did you finish?

A: Yes

B: Finished it

If you did not finish, why do feel that was?

[blank]

How did you approach the training (Ex. Do it all at once, break it into chunks, on and off, stop and start over later, etc.)?

A: All at once

B: I did it all at one time

Did you find the training motivated you to continue or return to complete more later?

A: Did not need to.

B: Not sure. Maybe if I knew more about what I was doing first.

Presentation.

Did you find the training visually appealing? What did you like or dislike most?

A: It was OK. The animated parts of the text were nice. Less need to scroll.

B: I liked the background and how you could see through the white boxes a little. The layout was neat and tidy.

Were images distracting? If yes, which?

A: No

B: I liked them, could use more for examples.

Were there too many or too few images?

A: Enough

B: Maybe more in more examples

Was the text easy to read? Was the size too big or too little? Was there enough contrast between colors?

A: Text was fine. I read smaller on my phone.

B: The text was OK on my screen. The black on white and white on green seemed to be clear enough.

Were the text elements easy to access? If not, why?

A: It was there to read. Animated bits saved space but made it hard to see everything at once. Had to go back and flip through parts to find some answers.

B: Yes, it was easy to click on the text and see additional information.

Effectiveness.

Do you feel confident in your ability to gather and interpret the information required to correctly read a Gingrich stocking chart?

A: Seemed clear enough. I could read the chart and pick the value.

B: I think so. More examples might be good, especially for the different kinds of charts.

Which topics do you feel least confident in? Why do you feel this way?

A: None

B: How to tell what the chart is for and what the values represent? I do not know what some of the terms mean.

Do you feel there was adequate explanation of topic material? If not, which topics and why?

A: Yes, it seems clear enough

B: What are some of the values talked about and where did they come from?

Were there enough visual or textual examples to help your understanding? If not which topics and why?

A: Yes

B: Some more examples on the chart types and what the parts of the chart mean. And what the value you get from the chart means

Did the quiz questions match with the material presented?

A: Yes

B: Yes

Were you able to answer the quiz questions without great difficulty? If not which topics caused the most problems?

A: Had to click through some material to find the answer, which was a bit of a pain.

B: Yes, needed to go back and check some examples but found the answers.

Did the quiz questions have clear answers? If not why did they seem unclear?

A: Yes, they were obvious once you knew the answer

B: The choices did not seem as if they were trying to trick you, so yes.

Comments.

Please add any additional comments or suggestions that you feel might make the training clearer, more effective, or easier to access.

A: The module seems good. Access and navigation was easy. The animations helped make it interesting. The information was easy enough to understand. It *was hard to search for some answers since the text is all visible at once, but I found them. Maybe shrink the MC questions so they all fit on the screen. With the supporting materials added, I think this should be usable by most people.*

B: The website looks interesting. I like the visuals of the boxes. I think you definitely need to include more background information that describes the concepts mentioned in this module. It was hard to really understand what I was reading without that. More examples could make it clearer, but definitely some background.

Results and Potential Changes

There did not seem to be any issues with access to the training module. The result pool was limiting however, with only two users who used the same platform, OS, and browser types. Although not stated clearly, the subjects may have used differing screen resolutions since issues with required scrolling to view of quiz options was cited by one user. Consideration should be given to the number of items in multiple choice or matching question answer lists for users with lower resolution screens.

Since this pilot consisted of only the "Reading a Gingrich Stocking Chart" goal step, survey comments were limited to this topic. As such, no problems with the length of training were noted. With the full module including all topics, significant time invested is expected and more problems may arise. Motivation to complete the training was neutral, in that the pilot learners, as non-landowners, did not have any personal investment in the topic.

One pilot subject did suggest that additional examples and graphics may help clarify the textual explanation of the technical information presented. Possibly multiple step-by step walkthrough descriptions, set to be optional if desired (i.e., not set to inhibit progress to the next topic), could be included.

Final comments suggested that the full module would better place the included topic in context. While the subjects felt they had a grasp on how to do the topic, they were unsure due to a lack of a way to apply the information in the field. If the required skills had been developed across all of the described goals in sequence, the learners may have had more confidence in their understanding of the final skill, as presented.

Reflection

Since I was the subject matter expert for this module, this simplified and streamlined the approach for implementing the design as any portion of the module could be addressed as it was convenient. Simultaneously, this knowledge made it tempting to focus more on technical details than necessary at the cost of some planning and initial analysis. It is likely that better design decisions could have been implemented if I just needed to focus on provided topic expertise rather than having the distraction of direct access to the knowledge. Nonetheless, I think the overall plan came out as potentially effective, even though the scope extended far beyond that anticipated at the beginning of this project.

The goal analysis seemed to be one of the clearest portions of the project. Mapping out the steps that comprise the instructional goal was helpful in understanding how I might approach the goal. Less clear was the instructional strategy. It seemed at times that I was making arbitrary decisions about content and assessment, even though they were directed by goals objective previously defined. I feel I have a disconnect between the theory of instructional design and its application. Perhaps additional study around instructional strategy and theory can fill in the gaps between the two areas.

A major realization from this process is how very involved it can be to consider all of the elements that may be important to or have influence on the effectiveness of instruction. Parallel to this is how easy or tempting it can be for those tasked with education to forego certain portions of the process in the interest of time or convenience. While the step-wise procedure described by Dick an Carey (2015) is straightforward and appears very good for newcomers to instructional design, I can also see it ill-used by those in education that do not have the benefit of guided study on the topic. It would be relatively easy to pull some steps out of the whole design context and assemble what appears to be a viable design plan, only to find that it fails to effectively accomplish the intended goal. It may take significant time to realize this failure and affect several rounds of learners in the process. It is therefore important to consider the entire scope of the intended instruction goal throughout the design process.

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