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Part 4

Higher Education, Lifelong Learning & Social Inclusion

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Comparing Traditional Learning Materials with Those Created with Instructional Design and Universal Design for Learning Attributes: The Students' Perspective

Abstract

There are foundational universal design for learning (UDL) principles that support accessibility and inclusivity that can be incorporated into instructional materials. Creating instructional materials that are accessible and inclusive is a comparatively new challenge that is gaining awareness. A problem is that most professors do not know how to design for accessibility and inclusivity. Universal design for learning is also referred to as universal instructional design. This paper discusses the instructional design and UDL principles designed into instructional materials that were created to teach piping trades students how to solder and braze copper pipe. A summative quantitative and qualitative analysis was conducted to determine whether the students felt that the new materials had more instructional design and UDL attributes than the original materials. The findings showed that there were significant differences between the instructional design and UDL attributes of the new materials as compared to the original materials. There were no significant differences between some of the attributes.

Keywords: universal design for learning, accessibility, inclusivity, trades training, universal instructional design

Introduction

Although all students need their instructional materials to be designed in ways that specifically help them learn, this is particularly important for students with disabilities because they need intentionally-designed instructional resources to help them overcome their limitations. This paper discusses the UDL principles embedded into instructional materials that were designed to teach piping trades students how to solder and braze copper pipe. Although the embedded instructional design principles should support typical learners, the created instructional materials were also intended to enable a variety of individuals with disabilities to effectively learn. The resulting materials had attributes that were specifically designed to support weak readers, deaf and hard of hearing individuals, students with a loss in vision, learners

who have difficulties staying focused, academically-weak students, cognitively-gifted students, learners with low confidence, and students with different learning preferences, as will be discussed below.

The objective of this research was to determine whether specific instructional design and UDL attributes would be more positively perceived in newly-designed materials as compared to materials designed without accessibility and inclusivity in mind. Specifically, the research question was: With respect to instructional design and UDL attributes, were there significant differences between the newly-designed materials and the original materials? The independent variable was the materials presented. The dependent variable was the instructional-design and UDL attributes. The instructional design and UDL attributes of the construct, which were based on instructional design and UDL principles, addressed the learning outcomes, content organization, path to learn from, amount of content, font size, images, video, colour contrast, summaries, learning preferences, practical component, importance of the content, effectiveness of the content, and grading (Fenrich, 2014; Coolidge et al., 2015).

Literature review

The three main principles that guide the UDL framework are providing learners with multiple means of representation, action and expression, and engagement (Coolidge et al., 2015). This framework stems from brain research on cognition and learning that shows that there is variation in what individuals need to learn effectively (Rao et al., 2016). By intentionally applying the UDL framework, learning materials can be made accessible to a broader range of learners (Coolidge et al., 2015).

In general, educational materials designed based on principles of instructional design, which follow a model such as Gagné's Nine Events of Instruction, support all learners. Gagné's Nine Events of Instruction are gaining attention, informing the learner of the learning outcome, stimulating recall of prerequisites, presenting the material, providing learning guidance, eliciting the performance, providing feedback, assessing performance, and enhancing retention and transfer (Fenrich, 2015; Gagné et al., 1988).

The learning materials that were created had attributes that were specifically intended to support accessibility and inclusivity. Weak readers were supported because the content contained clear and concise language, simple word choices, short sentences, the active voice, visuals, and only what was needed. Deaf and hard of hearing students had access to detailed notes, captioned video clips, and the same support as was done for weak readers. Students with a vision loss were supported through having access to digital versions of the materials, the PowerPoint™ having high contrast colours and font sizes that met the "Web Content Accessibility Guidelines" of the World Wide Web Consortium (Henry, 2017), and described video and photographs. Students who had difficulties staying focused were provided with more things to focus their attention on (e.g., numerous questions), varied activities (e.g., the PowerPoint presentation, samples to assess, and practical assignments), and cues (e.g., "It is important to note that…", "The key points to remember are…"). For students who are academically weak, the instructors were encouraged to pause 5 to 10 seconds after asking a more difficult question and have

students participate in think-pair-share activities. These students were only given content that addressed the learning outcomes, were provided with varied ways to learn the materials, were presented with a variety of media (a combination of video, images, and text), had their attention directed to important content, had content that was broken down into manageable chunks, were provided with many practice and feedback opportunities throughout the lesson, were given elaborative feedback, were shown videos of common mistakes, received information in a logical order, had the content organized with headings and sub-headings, had subsequent content linked to previous content, were provided with meaningful and relevant content, and had summaries that highlighted key points both within and at the end of topics. Academically-gifted students were supported with being asked higher-order thinking questions, and the instructors were asked to encourage students to support each other. Instructors were asked to support students with low confidence by giving them time to think, asking them questions that they will likely get right, including think-pair-share activities, and providing positive constructive feedback. As well, the material was designed to be presented in manageable chunks. To support varied learning preferences, students experienced a variety of activities (e.g., both theoretical and practical components, assessing existing products, and conducting a final water pressure test, individual work, and class discussions), were provided with numerous interactions, were presented with different questioning techniques, were presented with a variety of media, had numerous opportunities for feedback, and had both informal and formal assessments. Accessibility and inclusion were further supported because the newly-made PowerPoint was made accessible to the learners prior to and after the lesson (Cawthorn, 2015; Fenrich, 2015; Fenrich et al., 2017; Kennedy et al., 2014; Rao et al., 2015).

Methodology

Given, a mixed-methods research design provides strengths that address weaknesses of solely quantitative or qualitative design (Rodriguez, 2009), a mixed-method research design was followed. Quantitatively, statistical analysis, based on two-tailed, two-sample, unequal variance t-tests assuming a significance of 0.05, was used to compare the students' opinions of the instructional design and UDL attributes of the original materials to the newly-created materials. Student opinions were collected through an online survey. Qualitatively, group interviews were held for students to share their opinions on what worked well and what they would like to see improved.

The treatment

One experimental group worked through the original materials that included a 16-slide PowerPoint. The slides had black text on a white background, images that were not in a workplace context, and one video of the entire soldering process that was done correctly. Each presentation was led by an instructor. Each instructor demonstrated the entire process in the lab. Students completed three soldering and brazing projects, conducted a water test, and were graded by the instructor using a rubric. The other experimental group worked through the revised materials that included 159 PowerPoint slides. The slides had white text on a dark blue background, images that were photographed in the shop, and a video of the entire

soldering process that was done correctly, videos of each step, and videos of incorrect procedures. Each presentation was led by an instructor. Each instructor demonstrated the entire process in the lab. Students evaluated previously-constructed projects to determine what was done well and what was done poorly, completed three soldering and brazing projects, conducted a water test, and were graded by the instructor using a revised rubric that better reflected the importance of each step.

The population and sample

The subjects were post-secondary students in a Piping Trades diploma program, in the province of British Columbia, Canada, learning how to solder and braze copper pipe. For the original materials, there were 46 participants from six classes with each class having a different instructor. For the newly-designed materials, there were 46 participants from six classes with each class having a different instructor, where these instructors were not the instructors who taught from the original materials. None of the subjects were known to have a disability.

Findings

The findings are based on the quantitative and qualitative analyses done.

Quantitative analysis

List of instructional design attributes of the new materials compared to the original materials t-test results:

p	*Attribute Statement*
0.070	The PowerPoint had clear and measureable learning outcomes.
0.033	The PowerPoint was well organized.
0.012	The PowerPoint provided an easy path to learn from.
1.000	The PowerPoint presented content in manageable amounts.
0.030	The size of the text on the PowerPoint was large enough for me to easily read it.
0.246	The images in the PowerPoint strongly supported learning.
0.002	The video clip(s) strongly supported learning.
0.082	There was enough contrast between the text colour and the background colour on the PowerPoint.
0.116	The PowerPoint effectively summarized the key concepts.
0.001	The PowerPoint suited my learning preferences.
0.001	The PowerPoint related well to the practical component.
0.015	The content presented in the classroom provided the information that I needed to solder and braze effectively.
0.035	The grading was consistent with the learning objectives.

Quantitatively, statistical analysis, based on two-tailed, two-sample, unequal variance t-tests assuming a significance of 0.05, was used to compare the students' opinions of the instructional design and UDL attributes of the original materials to the newly-created materials. Student opinions were collected through an online survey. The *n* value is 112. The *p* values for each attribute statement are summarized in the list above.

Qualitative analysis

Qualitatively, group interviews were held for students to share their opinions on what worked well and what they would like to see improved. Based on the students' comments, it was determined that the students felt that the newly-created PowerPoint was more effective in supporting learning. For example, comments about what worked well with respect to the effectiveness of the materials in supporting learning included "having video along with the lecture", "the materials were well organized", and "classroom time made the practical projects easier to understand". However, the students felt that the newly-created PowerPoint was too long as compared to the original PowerPoint.

Discussion

Based on quantitative and qualitative findings, the new materials were significantly better than the original materials with respect to the following instructional design and UDL attributes:

- *The PowerPoint was well organized*. This finding was expected because the new content was broken into distinct sections and there were headings and sub-headings in the new PowerPoint. The original materials did not have these features.
- *The PowerPoint provided an easy path to learn from*. This finding was anticipated because, as compared to the original content, the new content was more organized, as discussed above.
- *The size of the text on the PowerPoint was large enough for me to easily read it*. This finding was expected because the text was large enough to meet the "Web Content Accessibility Guidelines" of the World Wide Web Consortium. These guidelines were not considered in the original materials.
- *The video clip(s) strongly supported learning*. This finding was anticipated because the original content had one video clip of the whole process and the new content had video clips of the whole process, each step, and incorrect procedures.
- *The PowerPoint suited my learning preferences*. This finding was expected because, as compared to the original content, the new content had more media, existing products to assess, numerous interactions built into the materials, and the instructors were encouraged to pause to let students think and to include think-pair-share activities.
- *The PowerPoint related well to the practical component*. This finding was anticipated because, as compared to the original content, the new content had content specifically aimed at addressing each of the skills needed to complete the practical component.
- *The content presented in the classroom provided the information that I needed to solder and braze effectively*. This finding was expected because, as compared to the original content, the new content had content specifically aimed at addressing each of the skills needed to solder and braze.
- *The grading was consistent with the learning objectives*. This finding was anticipated because a newly-designed rubric was created to more closely align with the skills performed than the rubric used with the original materials.

There were no significant differences between the new materials and the original materials with respect to the following instructional design and UDL attributes:

- *The PowerPoint had clear and measureable learning outcomes*. This finding was expected because both the original and new materials had clear and measureable learning outcomes.
- *The PowerPoint presented content in manageable amounts*. This finding was not anticipated because the new content had a 159-slide PowerPoint and the original PowerPoint was 16 slides. However, the finding may be a result of both PowerPoints covering the same concepts.
- *The images in the PowerPoint strongly supported learning*. This finding was unexpected because the new PowerPoint had many more photos than the original PowerPoint and most of those photos were taken in the workshop setting. However, the finding may be due to both PowerPoints having images that supported learning.
- *There was enough contrast between the text colour and the background colour on the PowerPoint*. This finding is not surprising because the original PowerPoint had black text on a white background and the new PowerPoint had white text on a dark blue background. These colour combinations have high contrast (Fenrich, 2014).
- *The PowerPoint effectively summarized the key concepts*. Since the new PowerPoint had more summaries and more details in them than the original PowerPoint, this finding was unexpected. However, the finding may be a result of both PowerPoints containing summaries of the key concepts.
- *The content presented in the classroom emphasized what is important for me to demonstrate in the practical projects*. This finding was not anticipated. Although the new PowerPoint contained more details about what is important than the original PowerPoint, students, who were in the experimental group experiencing the original materials, might not have distinguished between what the PowerPoint contained and what the instructor also emphasized.

Conclusions

Instructional materials can be designed or redesigned to incorporate instructional design and UDL attributes. However, there might not be a significant difference between some attributes of the original and newly-designed materials due to what content is similar between the two and what the instructor also contributes to help the students learn the content.

The attributes that were specifically intended to support accessibility and inclusivity, can be designed into other instructional resources.

Limitations

The findings cannot be generalized to groups of individuals who have a specific learning disability. Although it is possible that some of the students were weak readers, have difficulties staying focused, were academically weak, were cognitively gifted, had low confidence, and had variations in their learning preferences, these characteristics were not measured because of the difficulty in reliably measuring them all, numerous tests that would be needed were beyond the scope of the project,

and likelihood that the percentage of students with those characteristics would make the sample size too small to give statistical significance. However, since principles of instructional design generally support all learners, it is reasonable to presume that the instructional design and UDL attributes that were embedded into the materials will support some students with disabilities.

Suggestion for further research

Similar research should be conducted to determine which attributes make a significant difference for different disabilities.

Similar research should be conducted where performance scores are also compared.

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