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Water Pollution and Sewage Treatment Design Rationale

Introduction:

Our main focus as a team in elevating this learning content was to present it in a clean, accessible, and streamlined manner with the learning objectives always in mind. This goal made us consider the potential of an Articulate Storyline 360 module as the platform for this lesson. Articulate Storyline 360 modules offer opportunities for students to interact directly with the learning content at a time and pace that best fits their learning needs. This module can now be incorporated into a variety of Learning Management Systems (LMS) for asynchronous learning by the instructor or shared via the web.

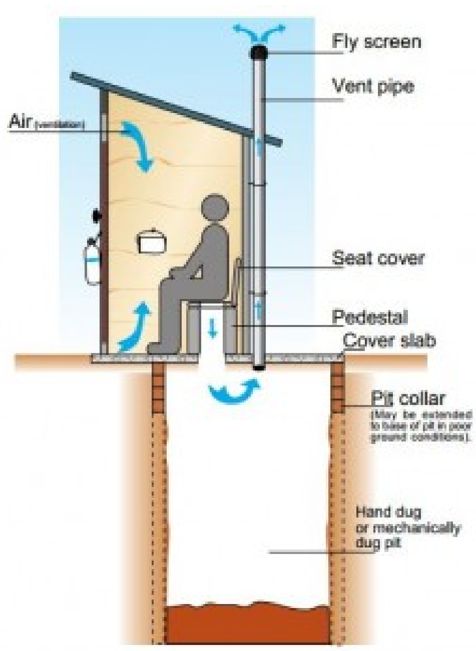
To begin, we took the PowerPoint slides that were provided by the instructor and analyzed the content to gain a more thorough understanding of the goals and objectives of the lesson. From here, we reorganized and revised the content to better fit the needs of a variety of learners. Because we had such a plethora of content, managing cognitive load was the main focus. It was essential that we identified cognitive overload in the module and remove non-essential or extraneous content in order to pair the content down to the most crucial elements. From there, we focused on engagement using it to structure the material and provide a pathway for the learner to move. All the while, we utilized Bloom's Taxonomy as a general framework to provide a research-based model for our new engaging content. In order to meet with the one-hour guideline, we did focus our product on the first two sections provided–resulting in a combined hour-long module. For the breadth of this assignment, we completed the first module which included the first two lessons or sections, however, if we were working with a client, we would create an additional hour-long module that would include the last two lessons or sections.

Overall, our new vehicle for this educational content should allow for more success among a more diverse array of learners, rather than relying on a dynamic professor. While classroom use is possible, this product will now have the ability to live in any web-based educational tool and broaden its possible uses, on top of this new efficiency.

Cognitive Load Theory and Cognitive Theory of Multimedia Learning:

When first diving into the content, one of our main concerns was the overall cognitive load due to the source material's large volume of content. With learning material in a PowerPoint, a dynamic and motivating professor can deliver it well to the majority of a classroom. This approach, however, relies on such a figure and becomes increasingly difficult the larger the class and the more removed from the instructor one is. Additionally, even the best of teachers can have their messages drowned out by the amount of content expected for a learner to take in. As a result, our first task was to identify the most important takeaways from the content and work backwards to see what could be cut. We drew on cognitive load theory because it provided a framework for understanding how to design learning content to minimize extraneous cognitive load so that the learners could use their cognitive resources towards schema development. Through "appropriately re-designing the instructional materials" we hope to eliminate or minimize extraneous cognitive load (Moreno & Park, 2010, p 12). Additionally, because we were creating a multimedia presentation from the slides and script, we drew on the cognitive theory of multimedia learning. The instructional goals of the cognitive theory of multimedia learning are to "reduce extraneous processing (for extraneous overload situations), manage essential processing (for essential overload situations), and foster generative processing (for generative underuse situations)," (Mayer, 2014, p. 43). Both of these theories aid instructional designers in ensuring that cognitive processing does not overload a learner's cognitive system. Managing the cognitive load of learners ultimately helps to create more effective learning materials.

Visually, our goal was to reduce the content down to its simplest state while still keeping the essential information related to the learning objectives front and center. This change can be seen in our newly reduced Pit Privy diagram. We used photoshop to reduce the image to its diegetic structure and remove the blurry and distracting text labels. See images below for a before and after picture.

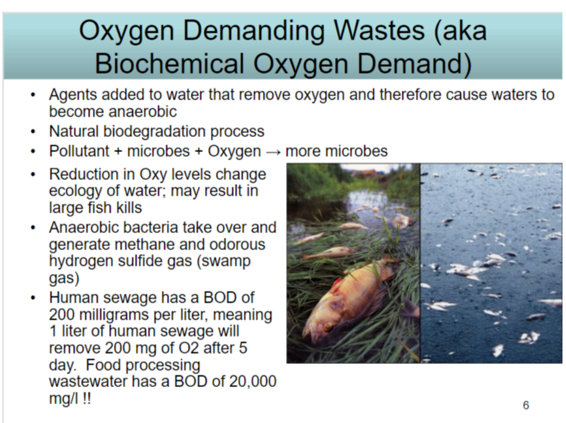


Before

After

We integrated the newly photoshopped image into the Articulate Storyline 360 module and added accessible, readable, and interactive labels instead. This helps simplify imagery to just supportive drawings (Clark, p.227) and other materials that may even serve dual purposes as advance organizers. We then supported this approach of distributing content to distribute other important takeaways elsewhere such as text, video, and narration along with the images in line with the multiple representation principle (Ainsworth, p.464). Now, learners will have more opportunities to engage in a way that will be amenable to a wider variety of learning preferences. We also made sure to provide ample scaffolding in our on-screen instructions to move learners along while giving them the ability to pause at any moment. At the same time, quicker learners will still be able to move through quickly without getting bogged down in content.

Throughout the module, we utilized several different principles of multimedia learning to enhance the content and help to minimize extraneous processing, manage essential processing, and foster generative processing for learners. The multimedia and the coherence principle were mainly used to remove text-heavy slides. For many of the slides in the original PowerPoint, we followed the advice of Mayer and Fiorella and eliminated "words, pictures, and sounds that are not relevant to the instructional goal," (2014, p. 285). Specifically, we developed a script for many of the slides to incorporate an auditory element, used meaningful visual imagery when it was not already provided, and minimized the text on the slide to better minimize extraneous cognitive processing. A great example of this was the slide on Oxygen Demanding Wastes (Biochemical Oxygen Demand). The original slide was incredibly text and script-heavy, so we removed nonessential information from the slide and the script, and split the slide into two parts for the learner. See below for the before and after images.



Before After

The visuals used help to enhance or clarify the content and the text on the "after" slide is used sparingly with bolded words to highlight important information. Mayer and Fiorella address the importance of removing too much extraneous material in multimedia and recommend adding "cues that direct the learner's attention toward the essential material" (2014, p. 285). These cues are based on the signaling principle and again aim to help minimize extraneous processing. Finally, we added an additional slide to spread out the information for the original "before" slide. This slide can be seen in the Articulate Storyline 360 file and uses a helpful animated video we found on biochemical oxygen demand to better explain the complex topic.

In addition to the multimedia principle, we also used the voice principle, the modality principle, the personalization principle, and the embodiment principle to help manage essential processing and foster generative processing for learners. Specifically, through the use of a script and recorded human audio we benefit both learners' essential processing through the modality principle and generative processing through the voice principle. By creating and recording the script, learners will be able to hear a friendly human voice instead of written text or a computer voice. We also made a mindful effort when writing the script to keep the script casual and informal, instead of overly academic and professional, adhering to the personalization principle. The script language was written with the hope that it would help make the learners more comfortable and thus better foster generative processing. Lastly, we used the embodiment principle by adding a college-age student avatar to help guide the learners through the module. See an example below of the college-age female student avatar that was added in several places in the module.

These principles and application of the cognitive load theory and cognitive theory of multimedia learning were instrumental in enhancing the learning material.

Bloom's Taxonomy:

Throughout our design, we also focused on keeping Bloom's Taxonomy in mind despite it being absent from the source material. We created learning objectives based on the cognitive process dimensions highlighted by Krathwohl (2002, p. 215). We have established the following learning objectives for the module:

- **Identify** parts of a pit privy outhouse design
- **Compare** and **connect** historical sewage systems to modern-day sewage systems
- **Classify** different categories of water pollutants
- **Evaluate** potential pollutant threats from modern-day industrial practices
- **Hypothesize** solutions to water pollution

We created these objectives and re-designed the original content to fit a variety of levels of the cumulative hierarchical framework of Bloom's taxonomy. These levels of the hierarchical cognitive process dimensions include remember, understand, apply, analyze, evaluate, and create. As we encouraged the learner to develop knowledge through this hierarchical framework, our goal was to push the learner toward higher levels of knowledge development. Specifically, we wanted to include some learning objectives within the dimensions of analyze and evaluate. We hope to engage higher levels of knowledge building through our reflection prompts as seen by the last two objectives we have added to the module. While the reflection prompts are primarily for the learners and do not offer any grades or direct feedback, we hope that learners will engage with the reflections as a means to practice metacognition and reflect on their lives and the learning done in the course. For the Post Lesson Reflection section near the design's end, we made it a goal to find an engaging way for the learner to relate these new findings to some sort of existing schema. Through a response activity, we gave the learners room to consider their new application of the material. Per best practices, the focus of this activity is less on feedback (was it right, was it wrong) and more on providing the time for learners to connect with the material while it is still in their working memory. For this section, we also aimed to take advantage of the tried and true model of using prompted self-explanations to further stimulate the learner, and hopefully increase retention (Clark, p.232).

Additionally, we engage learners in some of the more rudimentary cognitive process dimensions through engaging knowledge checks, including a drag and drop and a multiple-choice assessment. These knowledge checks are utilized to help students remember and understand important learning content. If students do not correctly complete these assessments, they are given the ability to dive back into the information or try again until they receive the correct answer (*Bloom's Taxonomy: Structuring The Learning Journey*). This agency, while not fully a part of Bloom's Taxonomy, is important as it provides students with the locus of control and stops them from feeling trapped in repeating their mistakes (Martinez, p.167).

Engagement and Accessibility:

Once we had established this research-based structure in Bloom's Taxonomy and considered theories of cognitive load and cognitive theory of multimedia learning, we built out the module which included several engagement elements offered within the Articulate Storyline 360 software. These elements provide a narrative for the learner to follow by allowing them to navigate from slide to slide using clearly labeled buttons. Additionally, we incorporated several click-to-reveal buttons to engage the learner in the content to better feel like they have an active role in the learning process.

While accomplishing our design goals based on important principles of multimedia learning, we also made a point to implement accessibility measures. When choosing a platform to do our redesign, our team felt that Articulate Storyline 360 would help standardize our visuals as well as aid in accessibility. Through built-in functionality, we were able to use both voiceover, narration, and textual subtitles (in the form of a transcript option located in the menu bar in the player) in support of our images. At the same time, the user has control to personalize their experience and choose which methods they would like to use for their information (either reading the transcript or listening to the audio). When focusing on new content creation, we also avoided pieces, such as our Privy diagram, where the original layout had information to simply be displayed in the image where it can get lost in cognitive load concerns or by a student's screen reader.

Conclusion:

Overall, we feel that we were able to transform this content into something more successful through the application of simple design, engagement, and learning theory-based practices and research. These changes will allow for a wider variety of learners to use the tool, and most importantly, take with them its key learning objectives without the reliance on one-on-one attention from an instructor.

References:

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