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ConceptScape: Interactive Concept Maps for E-Learning

In today's world, students are relying on video and other electronic resources as part of their daily curriculum more than they ever have before. This is not only due to advancement in technology that has allowed students and teachers to be more flexible in how they create and consume educational content, but the global pandemic of COVID-19 has forced almost everyone to participate in e-learning in some capacity. According to the United States Census Bureau, 93% of households with school-aged children participated in some form of "distance learning" in 2020 which often included students leveraging pre-made or live videos of their teachers [1]. For younger students, it can be especially difficult to stay focused when watching educational videos and they often don't have the skills to take notes or engage with the videos as they are watching. While being able to link similar concepts is critical to learning, novice learners can have a difficult time doing this without support from instructors. Learners also lose the chance to reflect or identify knowledge gaps when relying solely on video content [2]. ConceptScape is a tool that aims to help students navigate and comprehend lecture videos by generating interactive concept maps using principles of Natural Language Processing.

ConceptScape aims to address the challenges students face with video learning by automatically generating concept maps that the user can interact with while watching a video. This not only helps the user visualize the related concepts from the video but also assists the user in navigating the content. Traditional linear navigation of video is counterintuitive to how students learn and remember information, so using a concept map to navigate the video increases students engagement and comprehension as they are able to associate similar concepts that may be in completely different parts of the video. In order to test these theories about the usefulness of concept maps, the group conducted a study in which participants were randomly assigned one of two videos with a pre-defined concept map and were asked to watch the video and make improvements to the concept map based on what they learned. While most users reported limited prior knowledge of the video topics, their self-evaluated engagement

during the videos was high in both cases. Their self-evaluated understanding after watching one of the two videos was moderately high. Overall, participants reported that seeing the concept map before watching the video wasn't helpful as they did not have enough prior knowledge to be able to interpret the map. However, most participants found the concept map to be helpful while watching the video. Participants reported that the concept map during the video helped them follow instructions in the video, clarify knowledge, be aware of past, current and upcoming topics, and organize their notes. Similarly, many participants reported that reviewing the concept map after watching the video was helpful in reinforcing learner understanding and making it easy to reflect and navigate to parts of the video where they need more clarification. Lastly, participants noted that editing the concept map while watching the video was beneficial in reinforcing the learner's memory and giving the participant the opportunity to digest what they are learning. Based on these findings, it was determined that ConceptScape would generally benefit students who are utilizing lecture videos to learn.

The task of automatically generating a concept map from a video requires complex processing. First, it requires Natural Language Processing and cutting-edge speech recognition to be able to translate the audio of the video to test for processing. In addition to the audio processing, automatically generating a concept map requires machine learning to be conducted on the visual components of the video. This is especially difficult for lecture videos because of the diversity of images such as slides, animation, and handwriting. The complexity of this problem led researchers to explore alternatives that would be less complex but still produce reliable and usable concept maps. The final proposition for ConceptScape is to crowdsource concept maps by providing a framework to workers so they can create high quality maps. Through experiments similar to the one described previously, the ConceptScape researchers were able to evaluate the response of the workers creating the concept maps as well as new students using and improving existing concept maps. Through this exercise, ConceptScape was able to assess the quality of questions and reflections given to workers as they create the

concept maps, as well as gather feedback from new students on usability and accuracy of the crowdsourced concept maps. Overall, ConceptScape-generated concept maps had comparable quality to maps generated by experts in terms of both holistic evaluation and component-level evaluation.

Thus, ConceptScape provides an innovative solution to the ever-present challenge of e-learning for students in the 21st century. ConceptScape aims to address the issues of student comprehension and engagement with lecture videos by providing interactive concepts maps to help the student retain knowledge and easily navigate through concepts presented in the video. While these concept maps could be generated through complete machine learning and Natural Language Processing techniques, ConceptScape determined that crowdsourcing would yield the highest quality maps for other students to use and improve upon. After reviewing this technology, I see that interactive concept maps can help students retain and recall knowledge, engage with virtual content, and navigate virtual content in a non-linear way. For future enhancement or consideration, I would recommend ConceptScape expand their research and experiments to students below the college grade level. This year and into the future, students of all ages are becoming more reliant on technology and hybrid learning beginning as young as 5 years old. I think interactive concept maps have a lot of potential to help mitigate the gap between how young students learn in the classroom compared to how they learn virtually. I would also like to see ConceptScape reconsider using NLP and complex machine learning to automatically generate these concept maps. Artificial Intelligence is progressing every day and would be the key to ensure ConceptScape is available to a wide audience that needs it. While there may still need to be some form of crowdsourcing to get maps to the desired level of quality, automatically generating these concept maps would save time in the initial creation and allow crowdsourcing workers to focus on more niche or complex topics that are harder for AI to model. Overall, ConceptScape is a necessary technology in our current world and the potential for aiding students of all ages with interactive content maps has never been greater.

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Sources

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[2] CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing

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