Comparison of Video Content for Clarity, Usefulness, and Relevance

Mr. Umer Farooq, Texas A&M University

Umer Farooq is a Ph.D. student in the Multidisciplinary Engineering Department at Texas A&M University, with a focus on Engineering Education. Umer is part of the Learning Enhancement and Applications Development Lab (LEAD Lab). Umer contributes to research initiatives centered on educational, instructional, and workforce development in the manufacturing sector. His efforts align with the mission of the Texas A&M University Gulf Coast Center of Excellence (GCCoE), where he collaborates on projects aimed at enhancing learning experiences for students, trainees, and professionals.

Hannah Farias, Texas A&M University

Hannah Farias is a first-year master's student in mechanical engineering at Texas A&M. She is passionate about energy generation, consumption, and reduction, as well as engineering education. In her time with the Gulf Coast Center of Excellence at Texas A&M, she hopes to develop high quality tools, videos, and educational curriculum that will enable students and industrial workers to make changes that will reduce energy waste.

Mr. Digvijaysinh Barad, Texas A&M University
Matt Elliott
Dr. Bryan P. Rasmussen, Texas A&M University

Dr. Bryan Rasmussen is the Leland T. Jordan Professor II of Mechanical Engineering at Texas A&M University. He received his B.S. degree from Utah State University in 2000, followed by M.S. and Ph.D. degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign in 2002 and 2005. His research focuses on intelligent building and industrial energy systems. He is also the director of the Texas A&M Industrial Assessment Center, a US Dept. of Energy program that trains students to conduct energy audits for industrial manufacturing facilities. He is a Fellow of the American Society of Mechanical Engineers (ASME) and a licensed Professional Engineer in the state of Texas.

Dr. Saira Anwar, Texas A&M University

Saira Anwar is an Assistant Professor at the Department of Multidisciplinary Engineering, Texas A and M University, College Station. She received her Ph.D. in Engineering Education from the School of Engineering Education, Purdue University, USA. The Department of Energy, National Science Foundation, and industry sponsors fund her research. Her research potential and the implication of her work are recognized through national and international awards, including the 2023 NSTA/NARST Research Worth Reading award for her publication in the Journal of Research in Science Teaching, 2023 New Faculty Fellow award by IEEE ASEE Frontiers in Education Conference, 2022 Apprentice Faculty Grant award by the ERM Division, ASEE, and 2020 outstanding researcher award by the School of Engineering Education, Purdue University. Dr. Anwar has over 20 years of teaching experience at various national and international universities, including the Texas A and M University - USA, University of Florida - USA, and Forman Christian College University - Pakistan. She also received outstanding teacher awards in 2013 and 2006. Also, she received the "President of Pakistan Merit and Talent Scholarship" for her undergraduate studies.

Comparison of Video Content for Clarity, Usefulness, and Relevance

Abstract

The Gulf Coast Center of Excellence (GCCoE) at a large R1 Southwestern University in the USA has been developing curriculum material to advocate energy efficiency within the industrial sector. This initiative aims to educate the industrial workforce and students on best practices for energy conservation. The training curriculum provides a variety of materials, such as information videos, how-to conduct-a-task videos, assessment calculators, worksheets, and lectures. Also, the curriculum is prepared for various settings such as community colleges, college curricula, training modules for industry practitioners, workshops, and online professional development courses. One major type of curriculum material is information videos, which provide topic's basic understanding. Designed for students and the industrial workforce, these videos must be clear, engaging, useful, and enhance learning. Due to the variation in the participant experience, we created two video versions on the same topic. Version 1 relies on traditional PowerPoint-style slides with text and audio for a more conventional learning experience. Version 2 embeds recorded videos and relevant images to enhance visual comprehension. This study aims to evaluate these two video versions and identify which version serves the basic purposes of clarity, usefulness, and relevance for students. The following research question guides this study: Which video version demonstrates greater clarity, usefulness, and relevance in explaining key energy-saving concepts? The data were collected from 7 participants using a post-survey after each video. The survey consisted of three 5-point Likert scale questions focusing on clarity, usefulness, and material relevance. In this paper, data is analyzed using a multi-method approach. Descriptive statistics were used to summarize the survey responses, and conventional qualitative content analysis was employed to examine participants' feedback, providing deeper insights to support the quantitative findings. This study is part of a larger research project and will enable the GCCoE to develop curriculum material that resonates with the participants. Further, the gained insights will help select the right design choices for future videos. Moreover, the insight will guide in getting feedback for improvements in curriculum material clarity, usefulness, and relevance of material.

Introduction

The high rate of energy consumption in the United States reached approximately 94 quadrillion Btus in 2023 [1]. This underscores the pressing need for effective energy conservation strategies to mitigate the impacts of climate change. The industrial sector, which accounted for approximately 33% of energy consumption in 2020 [2], is a critical area for intervention. Studies have highlighted practical measures, such as reducing unnecessary compressed air usage, which could save significant energy [3], and participating in energy audits, which can achieve an average reduction of 6.4% in energy consumption [4]. However, implementing these strategies requires an informed and aware workforce equipped with the knowledge and tools to identify and act on energy-saving opportunities. This study addresses this need by evaluating two versions of educational videos designed to educate key energy-saving concepts. By identifying which version better supports clarity, usefulness, and relevance, the study aims to contribute to the development of curriculum materials that effectively educate students and the industrial workforce to adopt energy-efficient practices.

Industrial Training and Assessment Centers (ITACs) have historically played a crucial role in training students to conduct industrial energy assessments. There remains a need for broader, scalable educational initiatives to address the persistent energy challenges faced by manufacturers. To bridge this gap, GCCoE was established with the mission to advocate for energy efficiency and equip both students and the industrial workforce with the tools and knowledge to implement energy-saving practices. Unlike ITACs, which focus on site-specific assessments, GCCoE develops comprehensive curriculum materials such as information videos, how-to conduct-a-task videos, assessment calculators, worksheets, lectures, and workshop materials.

GCCoE supports training new ITAC students while also educating members of the industrial workforce on best practices for energy conservation. To achieve this, the Center has developed various educational materials to promote energy efficiency. Among these are two distinct versions of an instructional video on the same topic, designed to convey key energy-saving concepts effectively.

Because videos are often the most widely accessible medium of communication for both industrial workers and students, GCCoE has prioritized the creation of high-quality educational videos. Research on video curriculum and best practices has revealed that the style and organization of videos significantly influence the participants' learning process. Understanding these impacts is essential in the early stages of video curriculum development to ensure the effectiveness of the educational materials.

This paper addresses the critical need to evaluate these two video versions to determine which is more effective in terms of clarity, usefulness, and relevance. The findings will guide the development of future materials, ensuring they resonate with diverse audiences and maximize their impact in promoting energy-efficient practices. The following research question guides this study:
Which video version demonstrates greater clarity, usefulness, and relevance in explaining key energy-saving concepts?

Literature Review

A fundamental concept offered by Mayer's Cognitive Theory of Multimedia Learning suggests that videos with visuals better suit how the brain interprets information [5]. According to Mayer, the combination of visual and auditory channels improves comprehension, especially when it comes to complicated subjects [6]. Video with graphics helps reduce the cognitive load on the learners [5]. Visually presenting complex processes allows learners to process information more efficiently and focus on understanding the content. This occurs because visual representations offload cognitive demands from working memory and enable better integration of new information. Hence, it can hold attention for a longer time. According to a study by Wang and Antonenko, learners who watched videos with images that supported the explanation felt less mentally exhausted [7]. This effect was particularly noticeable in videos that made strategic use of diagrams or animations, which allowed viewers to move through complex material at their own pace without feeling overloaded [8]. However, learners may become overwhelmed by complicated visuals or too many graphics, especially if the visual components are not well matched with the course material. Considering learners' responses to the video, many multimedia components can impact students' learning. Commonly used components include graphics, visual aids, and narration of the material.

For learning through videos, graphics can be static or dynamic [9]. Static graphics include photos, drawings, graphs, and tables, whereas dynamic graphics include video or animation. Sweller's Cognitive Load Theory states that by giving students a temporal dimension and assisting them in visualizing processes that develop over time, dynamic graphics may lessen the cognitive burden in complex subjects [10]. For instance, a study by Mayer and Moreno [11] identified that animations work especially well in disciplines like biology and physics, where they help to visualize phases or changes over time for processes. When it comes to static graphics, students frequently encounter the "split-attention effect," which requires them to switch between a graphic and the text or narrative that goes with it [12]. If the static graphics are complicated and require mental integration, cognitive load may increase. Research indicates that dynamic graphics (aka animations) mitigate this effect by combining the visual and explanation components in real-time, speeding up processing and enhancing understanding. Although dynamic images are usually helpful for complicated subjects, if the animations are overly quick-paced or visually busy, there is a chance that the viewer will experience cognitive overload. To prevent overloading the learner's working memory, it is advised that animations be concise, pertinent, and clear [13].

Visual aids are particularly beneficial for visual learners, according to comparative research, but they might not have as much of an effect on learners who strongly prefer verbal information [14], [15]. Given that different people learn differently, some may benefit more from visual aids than others.

Narration is an essential element of instructional videos, which leads viewers through the material, offers clarifications, and affects their degree of interest. According to a study [16], human vocal characteristics boost perceived social presence, increasing the likelihood that learners will interact and relate to the content. Human voice is more likely to establish a social connection, whereas machine-like voice is more likely to undermine the appearance of a social partnership, according to social agency theory and the cognitive theory of multimedia learning [17]. Therefore, people should learn more profoundly when a human voice is used in the lesson instead of a machine voice. On the other hand, artificial voices might not have the same nuanced emotional expressions as humans, which could lessen the effect of social presence. A study conducted on university students revealed that they preferred voiceovers that sounded more human and that they had no significant negative opinions about AI-generated voices that were more human-like [18]. This suggests that AI-generated voices may be utilized more frequently in explainer videos with new developments.

Prior literature suggests that engagement is a key indicator of a video's performance [19], [20]. Since it indicates that the success of instructional videos frequently depends on how well they draw in and hold viewers' interest [21], [22]. The existing literature highlights that learner engagement with training videos mostly depends on interactivity, video duration, and aesthetic appeal [23], [24]. The best video might vary depending on the topic, learner profile, and context, but short, interactive, and visually appealing videos are generally more engaging [25].

Research Design

This study employs a multi-method approach using both quantitative and qualitative approaches [26]. The quantitative side uses a cross-sectional research design. The cross-sectional approach enables comparing data collected from the same group of students at a single point in time. To complement these findings, conventional qualitative content analysis of participants' open-ended feedback was conducted to provide deeper insights and support the quantitative results.

Site and Participants

The research was conducted at Texas A&M University (a large R1 University in the southwestern region), United States. The data were collected from **7** participants. The participants were recruited via email, and all participation was voluntary. The research was conducted by complying with the requirements of the approved Institutional Review Board procedure [Texas A&M IRB Approval STUDY2024-0446 / MOD00001222].

Design of Video

Both video versions were designed on the topic "Top Five Ways to Save Compressed Air Energy," selected from the compressed air module. Each video was approximately 90 seconds long. While the core content and structure remained identical, the two versions differed in presentation: one utilized static images with a human voiceover, while the other featured actual video footage with an AI-generated voiceover. We generated an AI voiceover from a text script. Figure 1 illustrates screenshots from both videos highlighting the differences in presentation.

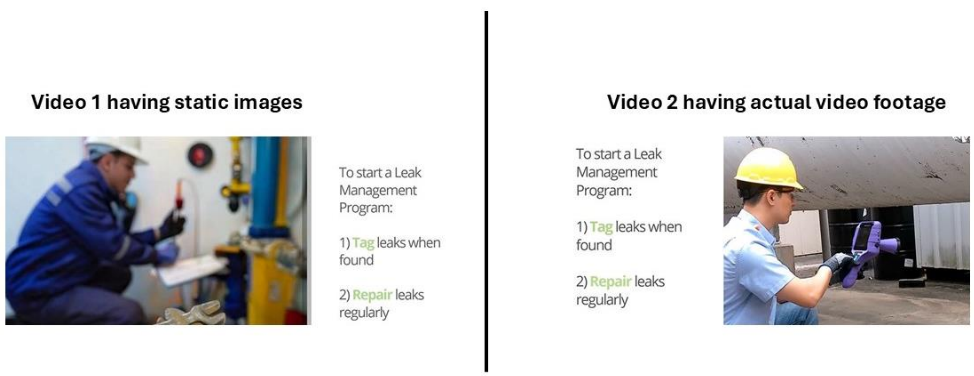

Figure 1: Screenshots highlighting differences between the two video versions' designs.

Measures and Data Collection

After obtaining informed consent, participants viewed the first version of the instructional video on the topic of "Top Five Ways to Save Compressed Air Energy." Immediately after watching, they scanned a QR code and completed a post-survey. The second version of the video, covering the same topic, was then shown, followed by another post-survey specific to that version.

Each post-survey consisted of 5-point Likert scale questions to capture participants' perceptions of the video content. These questions assessed participants' clarity of the material presented, the usefulness of the material, and the relevance of the material in meeting participants' needs. Figure 2 illustrates the sequential data collection process followed for each participant.

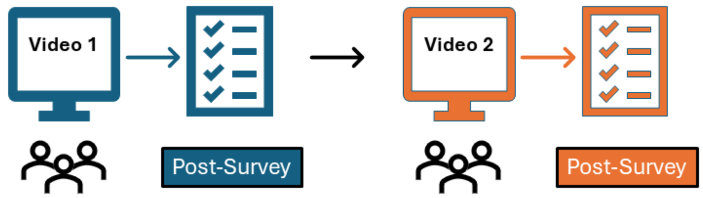

Figure 2: Data Collection

Procedure and Analysis
The analysis involved both quantitative and qualitative methods to evaluate participants' perceptions of the two video versions. Quantitative analysis focused on descriptive statistics to summarize ratings of clarity, usefulness, and relevance for each video, collected using a 5-point Likert scale where 1 indicated "very dissatisfied" and 5 indicated "very satisfied." These ratings were compared across the two video versions to identify trends and differences in participant responses. Python scripts were written to generate descriptive statistics and create visualizations.

For the qualitative data, conventional qualitative content analysis was employed to examine participants' open-ended feedback. This approach was chosen because it allows themes to emerge organically from the data without predefined coding categories. The responses were recorded in rows within an Excel spreadsheet, where codes were assigned to text segments. The coded data were then reviewed and grouped to summarize codes. Excel was further used to save the final summary of the codes for easy organization and future reference.

Results

RQ: Which video version demonstrates greater clarity, usefulness, and relevance in explaining key energy-saving concepts?

We first conducted the quantitative data analysis. The descriptive statistics provided insights into participants' perceptions of the two video versions based on their ratings of clarity, usefulness, and relevance. For clarity, three out of seven participants were "very satisfied" with video 1, while four participants rated it as "satisfied." In contrast, for video 2, three participants were satisfied, and four were very satisfied. These results suggest that both videos were perceived as clear in terms of material, with slight variations favoring Video 2 for its higher number of "very satisfied" ratings. Figure 3 clearly shows the frequencies of participants' ratings on each video.

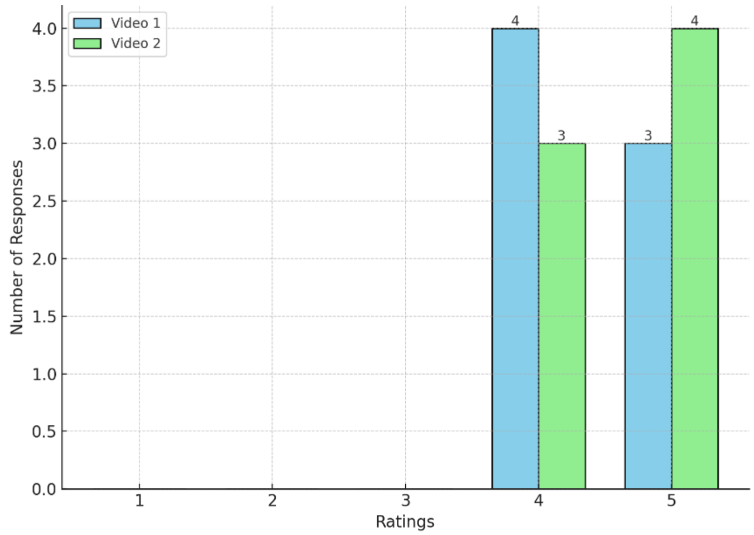

Figure 3: Video 1 vs Video 2 Clarity

Similarly, for usefulness, for Video 1, four out of seven participants rated it as "satisfied," two as "neutral," and one as "dissatisfied," reflecting moderate usefulness overall. In comparison, Video 2 demonstrated a broader distribution, with three participants rating it as "very satisfied," one as "satisfied," two as "neutral," and one as "dissatisfied." These results suggest that while Video 2 was perceived as highly useful by some participants, others had mixed reactions. Figure 4 illustrates the distribution of participants' ratings for the usefulness of both videos.

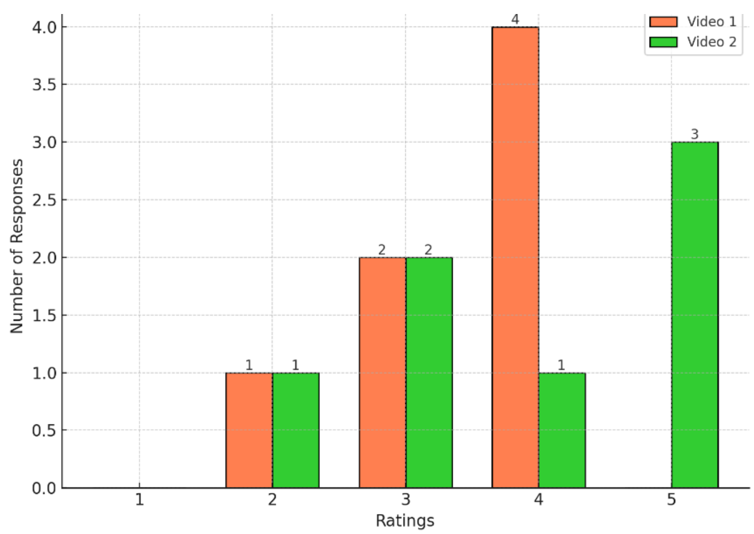

Figure 4: Video 1 vs Video 2 Usefulness

For relevance, Video 1 received two out of seven ratings of "neutral," two ratings of "satisfied," two ratings of "very satisfied," and one rating of "dissatisfied," while Video 2 recorded three ratings of "very satisfied," one rating of "satisfied," two ratings of "neutral," and one rating of "dissatisfied." This indicates that both videos were perceived as relevant, with slightly higher ratings favoring Video 2. These results are depicted in Figure 5.

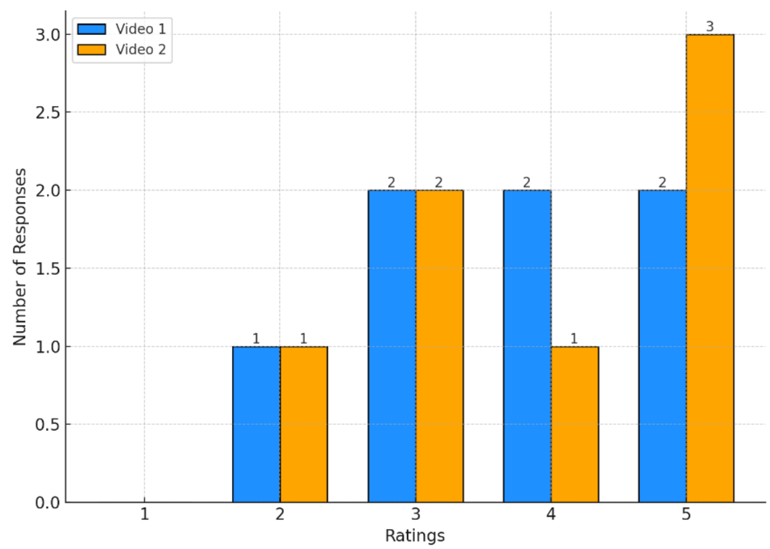

Figure 5: Video 1 vs Video 2 Relevance

Later, we conducted the qualitative content analysis of participants' open-ended feedback, revealing key insights into their perceptions of the two video versions. Analysis highlighted differences in engagement, pacing, presentation style, and the clarity of the instructional material.

For Video 1, participants consistently appreciated its simplicity and clear presentation. For example, a participant mentioned

"Kept it simple and to the point" and *"It's very clear and simple, but it gives very concrete metrics for how to save energy."*

This underscores its straightforward approach. However, some participants noted areas for improvement, such as the desire for additional animations to enhance engagement and reduce gaps between steps, as reflected in feedback like

"I wish there were more animated videos along with the information." and

"The gaps in-between some of the steps can be a little shorter."

Despite these critiques, the video was valued for its uncluttered design and human narration, contributing to its clarity.

For Video 2, participants highlighted its dynamic visual elements and ability to maintain attention. Exemplary feedbacks are:

"Video 2 is more enjoyable to watch. Holds more attention" and

"I liked the video usage showing the instructions mentioned, it is very useful"

These participants' reflections indicate the video's engaging format. However, the pacing was a common concern, with several participants commenting that it moved too quickly, making comprehension challenging. For example, one participant stated, *"The video is rather fast-paced in-between the steps, so maybe a very brief pause can help."*

Additionally, while the AI narration was noted as less user-friendly than the human narration in Video 1, participants appreciated the live demonstrations, as expressed in comments like

"I liked the live demos we could see on the side of the video."

Some inconsistencies between visuals and narration, such as in the final example of compressed air usage, were also noted as points of confusion.

Discussion and Conclusion

This study aimed to evaluate the effectiveness of two video versions in conveying energy-saving concepts to students, focusing on clarity, usefulness, and relevance. Results highlighted that both videos effectively communicated key concepts, but participants' preferences and perceptions varied based on the presentation style. Participants appreciated the clarity and presentation of video 1, but they found live demos of video 2 more engaging, enjoyable, and attention-grabbing.

The results of this study align with existing literature that suggests that dynamic elements can enhance video appeal [13]. A probable explanation of these results could be rooted in Sweller's Cognitive Load Theory, which suggests that dynamic graphics can reduce cognitive load by helping students visualize processes over time [10]. However, it is important to note that participants critiqued the pace and narration of the same video. In this video, as the voiceover was generated through AI narration, not all participants could relate. One probable explanation could be that participants prefer the human aspect more than the machine aspect for both the content and narration. Although the literature supports mixed results on AI-based videos, these results highlight the debate on whether AI-generated video content and narration are equivalent to human elements of live demonstration and voiceover in varying accents.

The study's findings help to serve the purpose of this study, which was to gain initial insights on what works better for GCCoE participants to finalize the videos' future design. With these findings, the informed development of more effective instructional materials for GCCoE can be performed that may cater to the needs of diverse participants.

This study has several limitations that should be addressed in future research. First, the small sample size of 7 participants limits the generalizability of the findings, as the study focused on a specific group of students at a single institution. Future studies could include a larger and more diverse sample, including participants from various professional and educational backgrounds, to enhance the applicability of the results. Second, the study used self-reported data through surveys, which may be subject to response bias. Objective measures like knowledge retention tests or behavioral assessments could help understand the videos' effectiveness. Third, this study focused on "Top Five Ways to Save Compressed Air Energy." Expanding the research to include other topics within the energy efficiency curriculum would help determine whether the findings are consistent across different content areas. Fourth, the video design was limited by graphics and narration choices. Future studies can consider other choices, such as visual aids or language, for comprehensive understanding. Lastly, as this study focused on a one-on-one comparison approach, there was only one human voiceover, limiting the accent choice. As the study progresses towards more videos, voiceover could be presented in varying accents. While the participants preferred the current accent of the narrator, the same may not be true for all human voice-overs in the future.

Future research could also explore additional factors, such as the role of individual learning preferences and technological familiarity, in determining the effectiveness of instructional videos. Moreover, testing other AI-based features, such as personalized narration or interactive content, could offer valuable insights for further improving educational video design.

Acknowledgement

This material is based upon work supported by the Department of Energy under Grant No. (DE-MS0000022). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Department of Energy.

References

[1] U.S. Energy Information Administration, "U.S. energy production exceeded consumption by record amount in 2023," *Today in Energy*, Jun. 26, 2024. [Online]. Available: https://www.eia.gov/todayinenergy/detail.php?id=62407. Accessed: Nov. 15, 2024.

[2] U.S. Department of Energy, "DOE industrial decarbonization roadmap," [Online]. Available: https://www.energy.gov/industrial-technologies/doe-industrial-decarbonization-roadmap. Accessed: Nov. 15, 2024.

[3] A. McKane and A. Hasanbeigi, "Motor systems energy efficiency supply curves: A methodology for assessing the energy efficiency potential of industrial motor systems," *Energy Policy*, vol. 39, no. 10, pp. 6595-6607, 2011. Available: https://doi.org/10.1016/j.enpol.2011.08.004

[4] G. Boyd and E. M. Curtis, "Impact of strategic energy management practices on energy efficiency: Evidence from plant-level data," [Online]. Available: https://www.researchgate.net/profile/Gale-Boyd/publication/353495620_Impact_of_Strategic_Energy_Management_Practices_on_Energy_Efficiency_Evidence_from_Plant-Level_Data/links/61003fc50c2bfa282a0605ab/Impact-of-Strategic-Energy-Management-Practices-on-Energy-Efficiency-Evidence-from-Plant-Level-Data.pdf. Accessed: Nov. 15, 2024.

[5] R. E. Mayer and R. Moreno, "A cognitive theory of multimedia learning: Implications for design principles," *Journal of Educational Psychology*, vol. 91, no. 2, pp. 358–368, 1998.

[6] R. E. Mayer, "Multimedia learning," *Psychology of Learning and Motivation*, vol. 41, pp. 85-139, 2002. Available: https://doi.org/10.1016/S0079-7421(02)80005-6

[7] J. Wang and P. D. Antonenko, "Instructor presence in instructional video: Effects on visual attention, recall, and perceived learning," *Computers in Human Behavior*, vol. 71, pp. 79-89, 2017. Available: https://doi.org/10.1016/j.chb.2017.01.049

[8] N. A. Martin and R. Martin, "Would you watch it? Creating effective and engaging video tutorials," Journal of Library & Information Services in Distance Learning, vol. 9, no. 1–2, pp. 40–56, 2015. Available: https://doi.org/10.1080/1533290X.2014.946345

[9] D. Lewalter, "Cognitive strategies for learning from static and dynamic visuals," Learning and Instruction, vol. 13, no. 2, pp. 177–189, 2003.

[10] J. Sweller, J. J. G. van Merrienboer, and F. G. W. C. Paas, "Cognitive architecture and instructional design," *Educational Psychology Review*, vol. 10, pp. 251-296, 1998. Available: https://doi.org/10.1023/A:1022193728205

[11] R. E. Mayer and R. Moreno, "Nine ways to reduce cognitive load in multimedia learning," *Educational Psychologist*, vol. 38, no. 1, pp. 43-52, 2003. Available: https://doi.org/10.1207/S15326985EP3801_6

[12] P. Ayres and J. Sweller, "The split-attention principle in multimedia learning," in *The Cambridge Handbook of Multimedia Learning*, vol. 2, pp. 135-146, 2005.

[13] B. Tversky, J. B. Morrison, and M. Betrancourt, "Animation: Can it facilitate?" *International Journal of Human-Computer Studies*, vol. 57, no. 4, pp. 247-262, 2002. Available: https://doi.org/10.1006/ijhc.2002.1017

[14] S. Kalyuga, "The Cambridge handbook of multimedia learning: Prior knowledge principle in multimedia learning," in *The Cambridge Handbook of Multimedia Learning*, pp. 325-338, 2005. Available: https://doi.org/10.1017/CBO9780511816819.022

[15] R. E. Mayer and L. J. Massa, "Three facets of visual and verbal learners: Cognitive ability, cognitive style, and learning preference," *Journal of Educational Psychology*, vol. 95, no. 4, pp. 833-846, 2003. Available: https://doi.org/10.1037/0022-0663.95.4.833

[16] C. Callaway and K. Sima'an, "Wired for speech: How voice activates and advances the human-computer relationship," *Computational Linguistics*, vol. 32, no. 3, pp. 451-452, 2006. Available: https://doi.org/10.1162/coli.2006.32.3.451

[17] R. E. Mayer, "Using multimedia for e-learning," *Journal of Computer Assisted Learning*, vol. 33, pp. 403-423, 2017. Available: https://doi.org/10.1111/jcal.12197

[18] W. K. Leong, Y.-Y. Chew, B. Zulkifli, and S. N. Kho, "Perception of university students towards the use of artificial intelligence-generated voice in explainer videos," *SEARCH Journal of Media and Communication Research*, Special Issue: SEARCH 2022 Conference, pp. 77-89, 2023. Available: https://fslmjournals.taylors.edu.my/vol-15-special-issue-search-conference-2022/

[19] S. Anwar, "Impact of educational technology-based learning environment on students' achievement goals, motivational constructs, and engagement," *Proceedings of the 2019 ACM Conference on International Computing Education Research (ICER 2019)*, Toronto, ON, Canada, 2019, pp. 321-322. Available: https://doi.org/10.1145/3291279.3339441.

[20] U. Farooq and S. Anwar, "Work-in-progress: Effect of instructional practices on students' engagement and performance," *Proceedings of the 2024 ASEE Annual Conference & Exposition*, Portland, Oregon, USA, June 2024. Available: https://doi.org/10.18260/1-2--48536.

[21] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: Potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1, pp. 59-109, 2004. Available: https://doi.org/10.3102/00346543074001059

[22] P. J. Guo, J. Kim, and R. Rubin, "How video production affects student engagement: An empirical study of MOOC videos," in *Proceedings of the First ACM Conference on Learning @ Scale Conference*, Atlanta, GA, USA, 2014, pp. 41-50. Available: https://doi.org/10.1145/2556325.2566239

[23] X. F. K. Kok, P. C. Wang, K. Avnit, and M. Shukla, "User engagement with interactive educational videos: Relations with task value, cognitive load, and learning satisfaction,"

International Journal of Instruction, vol. 17, no. 4, pp. 459–482, 2024. Available: https://doi.org/10.29333/iji.2024.17426a.
[24] N. Gerard, N. Athar, J. Nasir, H. M. Abdullah, M. W. Mazhar, and A. Khan, "Impact of digital content-based UDL compliant lesson plan on students learning and engagement," EDULEARN19 Proceedings, pp. 5082–5087, 2019.
[25] F. Amini, N. H. Riche, B. Lee, J. Leboe-McGowan, and P. Irani, "Hooked on data videos: Assessing the effect of animation and pictographs on viewer engagement," in *Proceedings of the 2018 International Conference on Advanced Visual Interfaces*, May 2018, pp. 1–9.
[26] I. V. Alarcón and S. Anwar, "Situating multi-modal approaches in engineering education research," *Journal of Engineering Education*, vol. 111, no. 2, pp. 277–282, 2022. Available: https://onlinelibrary.wiley.com/doi/full/10.1002/jee.20460