(Board 49/Work in Progress): Using Generative AI for Reducing Faculty Workload in Online Engineering Courses

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Abstract

WIP. The demand for high-quality online engineering courses and credentials is surging, driven by the upskilling and reskilling needs of industry partners and engineers with 8-10 years of experience. Creating accessible, top-tier online courses requires producing exceptional videos, transcripts, and content segmented appropriately for optimal student learning [1]. Beyond lecture preparation, faculty are often tasked with creating well-designed slides and assessments to engage students and measure learning. Despite the support of instructional designers in many institutions, this multifaceted process presents a significant challenge for faculty, who are often concurrently engaged in research, service duties, and mentoring activities [2], [3].

To support instructional designers and faculty in this endeavor, we have leveraged the APIs of OpenAI tools to create Transcriptto, a Python program that contains clever algorithms that aid in the crucial steps in lecture preparation, allowing instructional designers and faculty to have a better starting point when starting the development of an online course. Transcriptto utilizes a straightforward yet robust workflow, incorporating openly available technologies such as Pymovie, FFmpeg, OpenAI's Whisper, and ChatGPT. It transforms video lectures into polished text, supporting various input types, including audio files, and pre-existing scripts. The tool enhances clarity, removes redundancy, student interventions, semester-specific details, and provides a user-friendly configuration file for easy customization without requiring programming knowledge. The resulting content is optimized for information processing and fine-tuned via the OpenAI API, yielding not just a polished transcription that may be used to record a streamlined lecture more efficiently, but a multifaceted educational suite that generates outlines for slides, quizzes, assignments, and discussion questions. All learning materials are based on the content being taught.

Preliminary test usage of Transcriptto indicates faculty are enthusiastic about options for enhancing existing lecture materials and creating an optimized experience for their online course. We estimate this process will contribute to cutting the time it takes to write a script for studio sessions, and faculty will also appreciate the efficient creation of high-quality additional learning materials to evaluate students and maintain engagement. To assess the efficacy of Transcriptto, we employ a modified schema after Merriam [4], conducting a survey and focus groups with faculty users who provided their content as input for the program to process. Our aim is to gather in-depth insights, experiences, strengths, weaknesses, and suggestions related to the tool, actively facilitating discussions, and analyzing qualitative data to draw conclusions about its efficacy. The tool's adaptability, driven by ongoing feedback from faculty, instructional designers, and other experts in the field, ensures its alignment with real-world educational needs.

Keywords: AI, Instructional Design, Online Transition, Online Education, e-learning, OpenAI, Python, Time Saving Strategies for Faculty, Lecture Capture, Repurposing Video Lectures.

Introduction

The landscape of higher education, particularly in engineering, is indeed undergoing a significant transformation, with a marked increase in the demand for online engineering education. This surge is driven by professionals seeking career advancement in a rapidly evolving technical landscape and the need for upskilling and reskilling among experienced engineers. However, the creation of top-tier online courses presents considerable challenges, especially for faculty who must balance research, service duties, mentoring, and teaching responsibilities.

The creation of high-quality videos, transcripts, and appropriately segmented content is crucial for optimizing student learning [5]. Research has shown the effectiveness of educational videos varies across disciplines, with online educational videos being more effective in scientific disciplines compared to humanities, as per students' preferences [6].While there are many studies that compare face to face delivery to video capture we could not find any that directly compare lecture capture to purposely scripted online videos, some have found the use of preproduction and scripting in particular, may offer advantages in terms of enhancing student engagement and learning outcomes in online classes [7]. Furthermore, it is important to consider the discipline-specific preferences and the quality of the video content to ensure its effectiveness in improving student learning experiences.

The process of designing for online learning is critical to support faculty effectively and efficiently with transferring their instruction online, especially when many institutions face the challenge of supporting a large number of inexperienced faculty with transferring instructions [8]. In addressing these challenges and trends, we sought a scalable solution to assist designers and faculty in efficiently developing well-structured online lectures. Consequently, we explored the use of generative AI tools and Python scripting to streamline key steps in lecture preparation. This approach aims to shift the focus of faculty from the logistics of content creation to their primary role in teaching.

Why Transcriptto?

The development of Transcriptto was motivated by the necessity to address the specific needs of faculty who were transitioning from traditional face-to-face teaching to online formats. This change highlighted the inadequacy of conventional classroom materials, particularly lecture slides, for online teaching that primarily relies on voice-over PowerPoint presentations. This gap necessitated a solution that would adapt these materials to engage students effectively in an online setting.

Our team initially began by manually transcribing lectures and using ChatGPT to draft preliminary outlines. This method proved efficient in organizing content and led to the enhancement of the original lecture materials. This enhancement involved the generation of quizzes, discussion prompts, and other interactive elements, thereby not only saving time but also enriching the overall learning experience.

Transcriptto was designed to automate this process and to offer streamlined, polished text formats that are easily customizable. Its ability to create various learning materials, including slides, quizzes, and assignments, is particularly suited to meet the evolving requirements of online engineering education. It is important to note that Transcriptto is not used to generate the

core lecture content, which remains the faculty's prerogative; instead, it is employed to refine and expand upon the original content provided by the faculty, be it in the form of video lectures, audio recordings, or transcripts.

The ongoing research surrounding Transcriptto aims to evaluate its effectiveness in easing the transition to online teaching, particularly in reducing faculty workload and enhancing the quality of online course materials. This research is expected to provide valuable insights for further development of Transcriptto and to contribute to the broader field of online education, potentially establishing Transcriptto as a crucial tool that enables educators to concentrate more on teaching and less on the technical aspects of course development.

Literature Review

Educators in engineering are balancing the demands of research with teaching responsibilities. They face challenges in curriculum development, ensuring alignment with evolving accreditation goals and industry trends, particularly in rapidly advancing areas like IoT and cybersecurity. Administrative duties and student engagement are other significant concerns as educators strive to make learning interactive and engaging in large, often lecture-style, classes.

However, there are some barriers to transitioning from face-to-face to online teaching as it requires intentional planning and preparation, more than needed in a traditional face-to-face course [9]. Novice faculty may not have enough experience with teaching, the subject matter, students, and institutional knowledge to design high-quality online courses [10]. Furthermore, being a good teacher in a face-to-face environment does not automatically guarantee effective online teaching [11].

The transition from traditional face-to-face teaching to online course design, particularly in engineering education, presents significant challenges for faculty. This struggle is exacerbated when faculty have multiple roles or assignments, such as conducting research. Faculty members are not inherently content producers or instructional designers, and the shift to online teaching demands a different skill set and approach to course design. The urgency of the transition to online teaching during the COVID-19 pandemic has often overshadowed the pursuit of quality online learning, leading to a focus on emergency instruction rather than thoughtful course design [12]. Additionally, the time demands of developing an innovative online course are substantial, and faculty may not have the necessary expertise in educational technology to effectively design and deliver online courses [13]. Furthermore, the design of an online learning environment is inherently challenging, and faculty may struggle to make online learning authentic, especially in engineering education [14].

In this context, AI tools that assist faculty in shaping their content and course design would be highly beneficial. These tools could alleviate the burden on faculty members and instructional designers, enabling them to create high-quality online courses more efficiently and with scalability. The pandemic has catalyzed a significant shift to online and blended teaching, where emerging technologies, including AI, are being applied to enhance students' learning outcomes [15]. Therefore, the integration of AI tools in course design and content shaping could

significantly support faculty in overcoming the challenges associated with transitioning to online teaching, particularly in the context of engineering education.

Development Phases of Transcriptto

The development of Transcriptto is going through a stepwise four-phase incremental development process. Specific features are being developed for each phase, and faculty feedback data are analyzed and integrated into the development of each phase. Figure 1 provides an overview of the phased development, including the iterative cycle of Phase 1, where continuous improvement should occur until the application's core functionality is deemed to provide consistent successful results. Afterward, the next phases will occur sequentially. These contain some of the main improvements suggested by faculty during this study. It's worth noting that this study is specific to the first iteration of Phase 1.

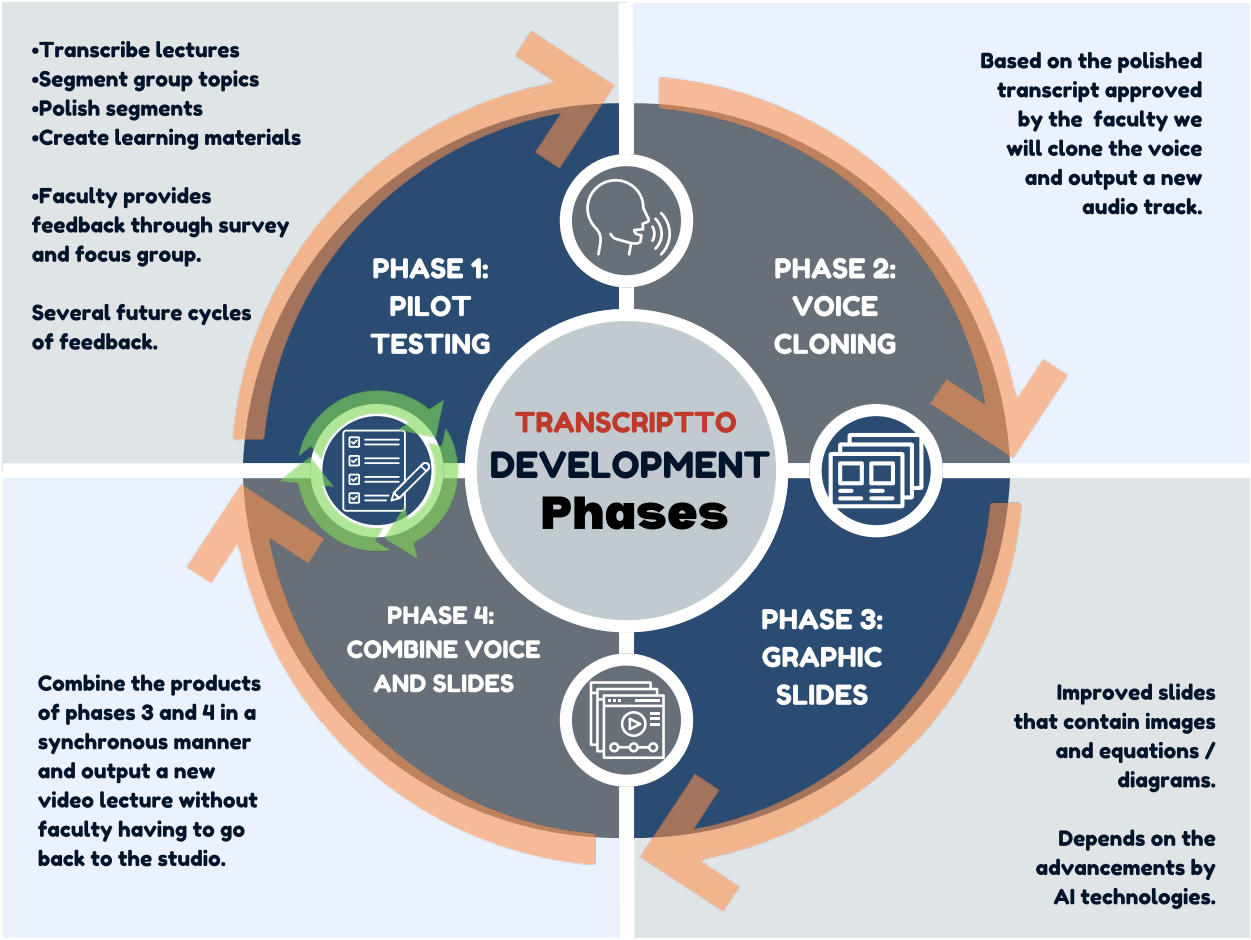

Figure 1. Development phases of the application.

Purpose of Study and Research Questions:

The primary objective of this research is to evaluate the effectiveness of Transcriptto in facilitating the transition of university faculty to online teaching, focusing on reducing the workload associated with preparing online course materials. Data collection follows a mixed methods approach that combines a quantitative survey and focus group interviews. Surveys,

conducted through Qualtrics, capture faculty's initial reactions to Transcriptto, focusing on aspects like transcription accuracy, content polishing, and the relevance of generated quizzes and discussion questions. The focus group interviews aim to provide deeper feedback on faculty experiences with Transcriptto and aim to tease out specific advantages, disadvantages, and features that need to be added to the tool.

Specifically, the study aims to assess the following aspects from the faculty's perspective:

Topical Segmentation:

- Determine if Transcriptto segments lecture content into coherent topics successfully.

Polishing:

- Evaluate if Transcriptto's ability to enhance the clarity of lectures is perceived as successful.

Learning Asset Generation:

- Assess if the usefulness of learning materials generated by Transcriptto, such as quizzes, discussion questions, assignments, instructional objectives, and slide outlines.

Perception of Time Saving:

- Determine whether using Transcriptto's output as a starting point for studio-based lectures reduces the time required to create these videos.

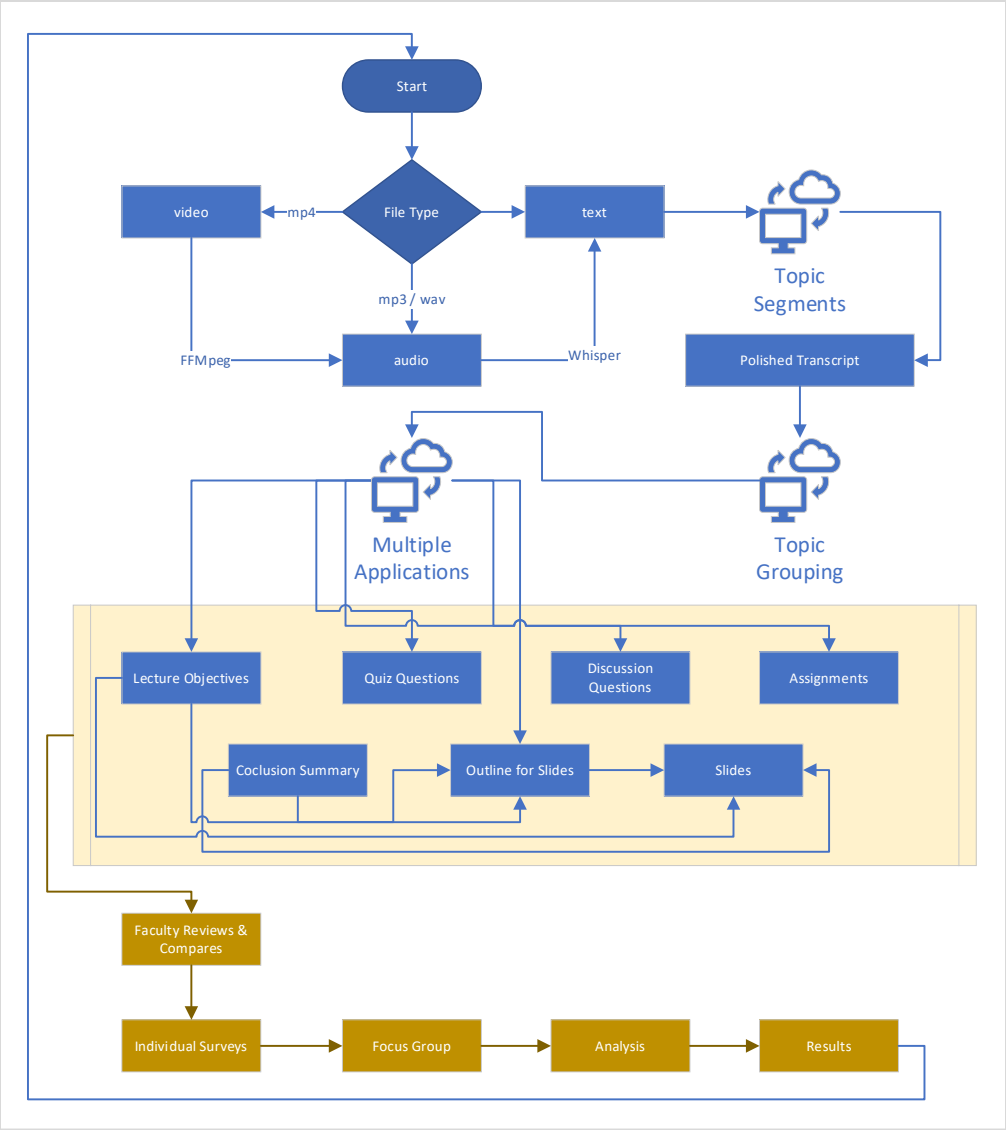

Figure 2. An integrated overview of the application processing workflow with the data collection process.

Figure 2 provides an integrated overview of the application processing workflow, how it interacts with Open AI's API, and the data collection process of Phase 1 represented in this paper. The study thus aims to provide comprehensive insights into the practical utility of Transcriptto in the context of modern online engineering education, contributing to the understanding of how generative AI tools can support effective and efficient course development and, at the same time, reduce faculty workload. These insights will allow further improvement of the application and future studies on its improvements.

Methods

Participants

The participants in this survey and the focus group are five faculty members at Texas A&M University from three different departments (Electrical Engineering, Industrial Engineering and Mechanical Engineering. When faculty came from the same department, they came from different engineering disciplines. Each faculty member has extensive experience in online course development, teaching, and delivery.

The faculty members came from the Departments of Mechanical Engineering, Industrial Engineering, and Electrical Engineering. The survey aimed to capture the faculty's perceptions of Transcriptto's functionality in segmenting lectures, polishing content, and creating useful academic materials. Faculty then pondered how these new elements would reduce their workload when creating a fully online predesigned course.

Measures

An online survey was created in Qualtrics and administered to the faculty who provided regular 50-minute video lectures that were processed by Transcriptto, which outputs a new polished transcript together with a variety of learning materials that faculty can use to design and record their online course. The instrument focused on two aspects of Transcriptto: (1) the quality of the output from the tool and (2) the usefulness of the tool's output together with the notion of time-saving. The initial feedback indicated that the faculty was satisfied with the output quality and its usefulness, including topic segmentation, and polishing of the resulting segmented lectures, quizzes, discussion questions, and assignments.

In addition to the online survey, an hour-long focus group was conducted virtually with all the faculty participating in a discussion about the usefulness of the tool, their perceived gaps in the output and performance, and their recommendations for future iterations.

Data Analysis

The first descriptive statistical analysis was applied for frequency data such as counting the number of faculty who indicated that the tool produced polished content very well. We also similarly counted the number of faculty who indicated a particular learning material as being useful. Due to the small population size, no statistical measures were performed beyond the basics. The open-ended responses were analyzed to identify specific faculty feedback and triangulated with the qualitative data from the focus groups.

The focus group was conducted online and faculty responses to specific prompts were tabulated and used for developing the secondary probing questions. In addition, the entire focus group session was recorded and transcribed with permission of the participating faculty, who had also accepted the terms of the informed consent documented on the IRB STUDY2024-0157, “Evaluating Transcriptto's Impact on Faculty Workload in Online Engineering Education.” The transcript was analyzed using a professional version of ChatGPT 4.0 to ensure that these data were not mixed with the training model and to ensure privacy. The AI tool was prompted to uncover specific themes, which were corroborated by the tabulated answers from the focus groups.

Quantitative Analysis of Survey Data

Figures 3 and 4 provide an illustrative snapshot of the faculty response to the quality of the output and their perception of the usefulness of the products of Transcriptto. The analysis of their responses for each category is described below.

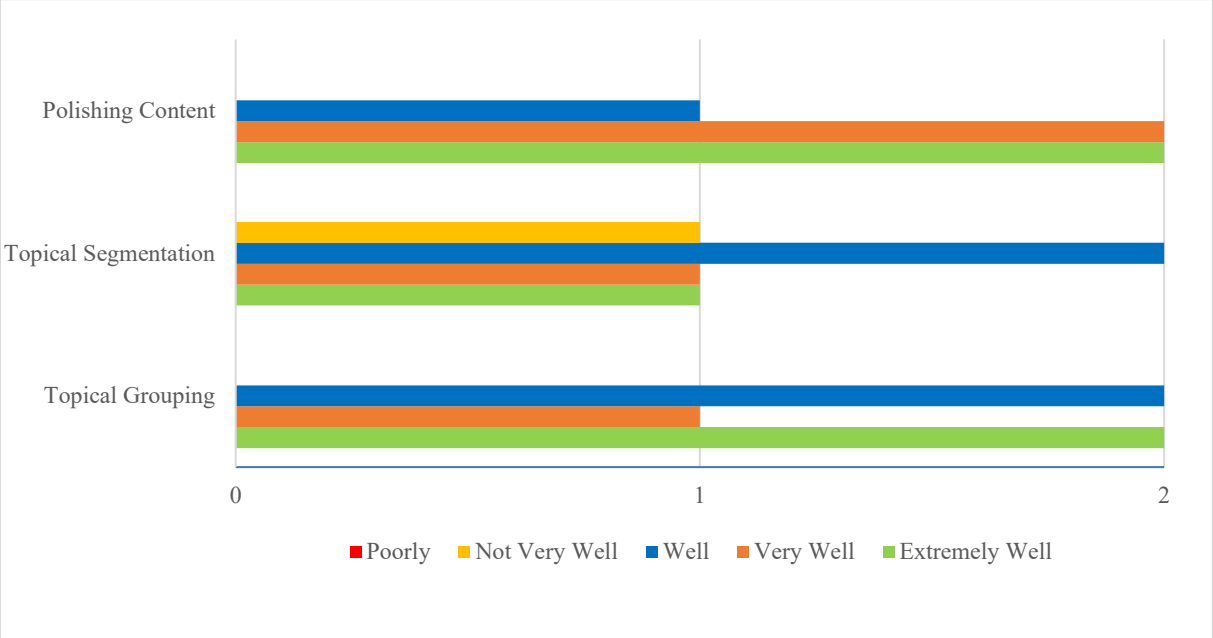

Figure 3. Faculty's highest rated functions regarding Transcriptto's capabilities.

(a) Breakdown of Lectures into Appropriate Segments

The responses indicate a generally positive reception towards Transcriptto's ability to segment lectures appropriately. Most of the participants rated the tool as segmenting "Very Well" or "Extremely Well," suggesting effectiveness in its primary function of structuring content conducive to online learning environments.

(b) Quality of Polished Lecture Segments

After polishing, the quality of the lecture segments was favorably received, with again a majority of respondents rating it as "Very Well" or "Extremely Well." This reflects an elevated level of satisfaction with the AI's ability to streamline and refine lecture content, removing unnecessary elements such as pauses and distractions. However, a small group of the participants rated this aspect as "Well," suggesting some room for improvement in content refinement.

(c) Utility of Final Segmented Lecture Product

We noticed a wide variation in the responses to the question of the utility of the final segmented lecture which was one of the products of Transcriptto. One participant rated the product as not very useful, but a majority of the respondents did find the product to the somewhat useful to very useful. The focus group data were used to determine the specific reasons why these ratings were so varied.

(d) Quiz and Assignment Recommendations

Responses to Transcriptto's quiz and assignment recommendations showed mixed evaluations. 4 out of the 5 participants found the quiz recommendations at least "Somewhat Useful," but one of them found them "Not Very Useful." This pattern was similar for assignment suggestions, indicating a need for further refinement to align more closely with faculty needs.

(e) Learning Objectives

All respondents agreed that the learning objectives developed by Transcriptto were at least "Somewhat Useful," with unanimous approval across this metric. This uniform response underscores the tool's capability to provide foundational support in curriculum development.

(f) Overall Time-Saving Potential

Most participants acknowledged the overall time-saving potential of using Transcriptto, with a majority affirming that the tool helped save time when preparing online course content to varying degrees. However, one participant "Somewhat Disagreed," suggesting that the tool does not significantly reduce workload for some users, potentially due to the need for additional content verification and adaptation.

Qualitative Analysis of the Focus Group

In our analysis of the focus group transcripts, several key themes emerged regarding the perceptions and experiences of faculty members using Transcriptto for online course content development.

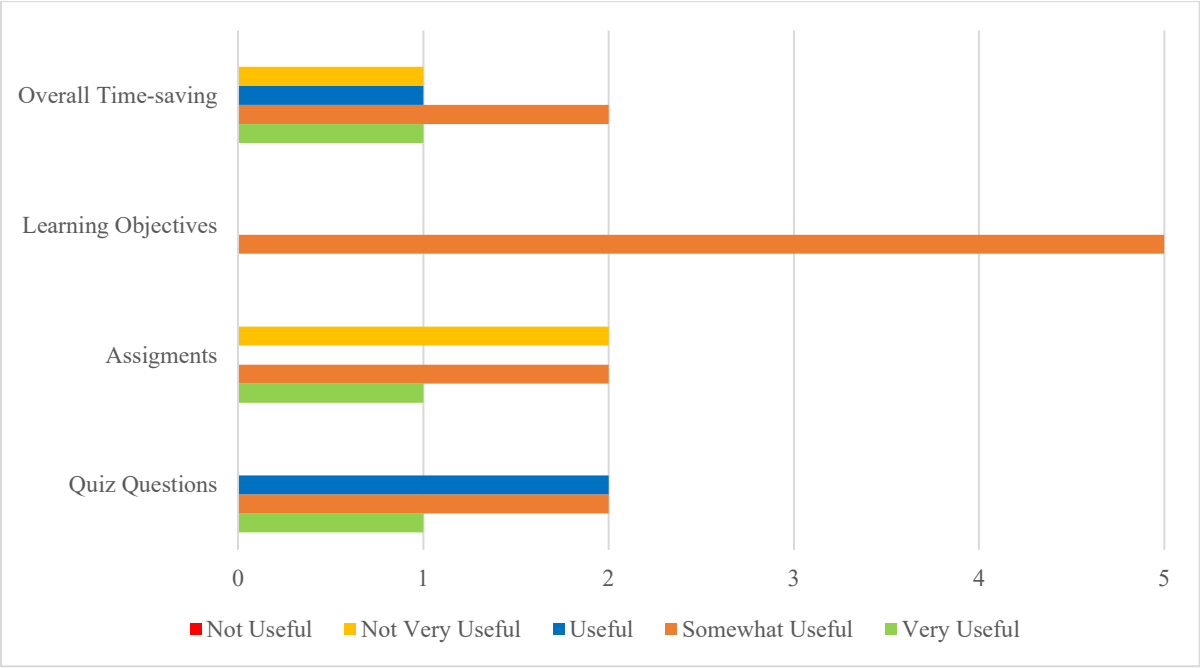

Figure 4. Faculty usefulness perceptions about the Learning Materials produced by Transcriptto.

(g) Effectiveness of Transcription and Polishing

Quality of Transcription: Participants noted that the transcription was quite accurate, around 90-95%, according to one faculty member, suggesting a high level of initial accuracy.

Polishing: While the transcript polishing was generally appreciated, there was a consensus that it still required faculty review to ensure accuracy and contextual appropriateness, particularly in specialized subject areas.

(h) Utility in Academic Settings
Time-saving: Most participants agreed that Transcriptto significantly saved time, providing a better starting point for creating online content.

Content Segmentation: Faculty found the software helpful in breaking down lectures into manageable segments, which is crucial for online learning formats.

(i) Areas for Improvement
Subject Matter Nuances: The software sometimes fails to capture the nuances of specific disciplines, leading to inaccuracies in the polished content, such as confusing "continuous and discrete data".

Special Content Types: Handling equations and specialized content like illustrations was pointed out as lacking, which is critical in subjects like engineering and sciences.

(j) Suggestions for Enhancement
Enhanced Customization: Suggestions included better integration of graphical content and customization options to better align with the faculty's existing materials.

Dynamic Updates: Participants expressed a desire for the software to incorporate dynamic updates based on the latest academic resources and textbooks.

(k) Overall Satisfaction and Future Expectations
There was a general sentiment of satisfaction with the foundational capabilities of Transcriptto, acknowledging its role in easing the transition to online education. Expectations for future versions include more robust AI capabilities to handle diverse academic needs, adding more sophisticated handling of complex subjects, and integration of visual aids. Participants expressed interest in enhancements such as graphics and illustrations for the slides, the option for the system to suggest adding updated content reflecting recent developments, and the implementation of voice cloning for not having to record videos over but have them refresh using new information and their cloned voice.

Challenges and Limitations:

We acknowledge our sample size is too small to represent a wide variety of lecturers and to have statistical significance. While this mixed methods approach is instrumental for in-depth qualitative analysis, it also introduces constraints regarding the generalizability of our findings due to the acknowledged sample size limitation. However, we find value in this initial stage as a step towards a broader college-wide, university-wide, and system-wide study in the future.

Discussion

Transcriptto, a tool designed to segment lecture content and enhance educational materials, underwent rigorous evaluation through surveys and focus group discussions involving faculty members from three different departments. The tool's ability to segment lecture content into coherent topics was scrutinized for its impact on online course usability and pedagogical efficacy.

Survey results revealed a strong approval rate for Transcriptto's segmentation capabilities, with participants acknowledging its proficiency in identifying and delineating lecture topics. However, a few participants of respondents rated the tool's performance as merely "Well," indicating room for algorithmic refinement to better capture complex academic discourse transitions.

In addition to survey data, focus group discussions with faculty members highlighted Transcriptto's utility in breaking down lectures into manageable segments. Participants consistently praised the tool's transcription accuracy, which typically ranged between 90% to 95%. Despite these strengths, there was a consensus among faculty members on the importance of a subsequent review to ensure segmented content's contextual and educational integrity, especially in specialized subject areas where precision is paramount.

Transcriptto's content polishing features, aimed at enhancing the clarity of lecture materials, were assessed through survey responses and focus group insights. Most respondents rated the tool's ability to refine lecture content as "Very Well" or "Extremely Well." However, a few noted that there was room for improvement, especially in processing nuanced academic content. The faculty emphasized the need for future developments to advance the tool's contextual processing abilities to preserve the complexity of academic discourse effectively.

Faculty feedback on the generation of learning materials by Transcriptto, including quizzes, discussion questions, assignments, instructional objectives, and slide outlines, provided insights into the effectiveness of these materials in online learning environments.

Quizzes and assignments generated by Transcriptto received a mixed response, with 4 out of 5 participants acknowledging them as "Somewhat Useful." However, one participant indicated that these tools were "Not Very Useful," suggesting a need to align generated content more closely with specific pedagogical needs.

Discussion questions and instructional objectives were uniformly rated as "Somewhat Useful," indicating that Transcriptto effectively identified key themes from lectures. Nonetheless, there was room for improvement to prompt deeper critical thinking and student engagement.

Feedback on slide outlines highlighted the need for enhancements to improve depth and engagement. Faculty members noted that while slide outlines helped structure lecture content, they often lacked sufficient depth and interactivity, potentially hindering student engagement.

In summary, Transcriptto's performance in segmenting lecture content and refining educational materials received positive feedback from faculty members. The tool's transcription accuracy was a key strength, but ongoing opportunities exist to refine the algorithm and enhance its

contextual processing abilities. Future developments should prioritize aligning generated learning materials more closely with specific pedagogical needs and improving the depth and interactivity of slide outlines to optimize online course design and delivery.

Conclusion

The integration of Transcriptto into the online engineering education process has been met with generally positive feedback, highlighting its utility in segmenting lectures into well-defined topics, which is crucial for the online format. However, the data also points to significant areas where improvements are necessary. The tool's performance varies across different academic specializations, particularly in handling specialized content such as equations and visual aids such as diagrams essential to the field of engineering. There is a consistent call for enhancing the tool's ability to accurately process such visual content, understand it, and improve the relevance and precision of the generated visual academic materials, such as the slides.

Moreover, while the generated learning materials—quizzes, assignments, and instructional objectives—are recognized for their utility, they show variability in meeting the diverse requirements of higher education courses. The feedback makes it clear that there is a need for greater customization and sophisticated integration of dynamic, discipline-specific content, which would not only align more closely with faculty needs but also enhance student engagement and depth of learning.

Regarding efficiency, most faculty members have noted time-saving benefits when using Transcriptto's outputs as a foundation for creating studio-based lectures. These benefits primarily stem from the structured and enhanced nature of the pre-recorded materials. However, the degree to which time savings are realized varies notably by discipline, with less pronounced benefits in fields requiring intensive use of specialized content. This variability highlights the need for ongoing enhancements to the tool's capabilities, including better customization options and improved handling of complex academic materials.

In conclusion, while Transcriptto demonstrates significant strengths in facilitating the transition to online education, it also exhibits substantial areas for improvement. Addressing these concerns will be critical in minimizing the need for extensive faculty intervention and maximizing the educational effectiveness of the platform. The future development of Transcriptto should focus on refining its algorithms to better accommodate the nuances of specialized academic content and to adapt to the dynamic nature of educational settings. By doing so, Transcriptto can more effectively meet the evolving demands of higher education and offer more universally positive outcomes across diverse academic disciplines.

Future Work Denoted for Phases 2, 3, 4

As outlined in Figure 1, the iterative work of Phase 1 will continue until Transcriptto can provide consistent successful results on its core functionalities. After that loop is closed, we will move to the next phases. We intend to document how each cycle improves the overall core functionality of the application through testing with more faculty members from varied engineering disciplines.

Phase 2: Voice Cloning

This phase will use voice cloning technology to create a model of the faculty's voice with their express permission and use this to narrate the polished and segmented new lectures, which would have to be proofed before by instructional designers and faculty members. As Transcriptto's development advances, less manipulation is estimated to be necessary. The output of this phase would be the narrated audio track of the resulting lecture. This capability will be particularly helpful when the faculty determines that an update or correction of the lecture is needed. Thus, instead of the faculty having to go to the studio to record the changes, these can be output by making a few modifications to the transcript and rendered again using Transcriptto's engine.

Phase 3: Improved Graphic Slides

Engineering disciplines rely highly on visual aids such as diagrams to illustrate concepts and designs. Furthermore, faculty often show equations and diagrams during lectures to enhance understanding and facilitate learning. Transcriptto, unfortunately, uses solely text-based technology, which most likely does not effectively capture or convey the visual aspects of equations and diagrams. This limitation can hinder the learning experience for engineering students, as they may struggle to fully grasp the concepts presented without a visual representation. Therefore, finding new ways to incorporate visual recognition technology as AI advances that can accurately interpret and analyze equations and diagrams is essential.

Phase 4: Synchronous Combination of Cloned Voice with Graphic Slides

As AI advances we hope to employ tools that would allow us to perform intelligent image recognition and be able to synchronize it with the output of the cloned voice track produced in the previous phases. This would require careful calibration of new algorithms created within Transcriptto and other AI APIs that would allow us to perform that complex functionality.

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