Thesis

Designing and Evaluating LLM-Generated Short-Form Educational Videos

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Abstract

The rise of generative Artificial Intelligence (AI) and the growing popularity of short-form videos have opened new possibilities for delivering educational content in engaging and efficient ways. This thesis explores the intersection of these trends through the design and evaluation of ReelsEd, a web-based system that automatically generates short-form educational videos or "reels" from long-form lecture content using large language models (LLMs), while preserving the pedagogical intent of the original material.

The motivation for this work stems from the increasing demand for microlearning formats, particularly among younger learners who favor concise, visually-driven content on platforms like TikTok and Instagram Reels. Despite the promise of AI in educational media generation, there remains limited understanding of how such content affects learning outcomes, user engagement, and trust in AI-generated material.

To address these gaps, ReelsEd was developed as a modular client-server system capable of segmenting educational videos, summarizing key moments using GPT-4, and presenting them in a structured short-form format. A controlled user study with university students was conducted to evaluate the impact of LLM-generated reels compared to traditional long-form videos. The study measured performance, cognitive load, user experience, and trust.

Results demonstrated that learners using ReelsEd achieved higher quiz scores, completed tasks more efficiently, and reported greater perceived competence without an increase in cognitive load. Moreover, participants expressed strong trust in the system, particularly valuing its clarity, accessibility, and modularity.

This thesis contributes both a novel AI-assisted system for educational video summarization and empirical insights into the role of LLMs in microlearning environments. Findings suggest that generative AI can enhance learning experiences when thoughtfully integrated into educational tools, especially when prioritizing user trust, usability, and pedagogical alignment.

Content

Chapter 1

Introduction

1.1 Thesis overview

This thesis explores the intersection of generative Artificial Intelligence (AI) and microlearning by focusing on the automated creation of short-form educational videos using Large Language Models (LLMs). With the growing demand for engaging and accessible learning formats especially among younger audiences short-form video has emerged as a powerful medium for delivering structured educational content. The recent development of tools like ReelsEd, a system that leverages LLMs to generate concise learning reels from long-form lecture videos, represents a novel opportunity to reshape how students consume and interact with learning materials.

The idea for this project emerged from the recognition that while short-form video is widely consumed in informal settings (e.g., TikTok, Instagram Reels), its potential for structured, AI-generated educational use remains underexplored. This thesis presents the design and evaluation of ReelsEd, a web-based system that automatically summarizes and segments lecture content from long-form educational videos using GPT-4, generating personalized and accessible microlearning experiences. A companion mobile application was also developed to support cross-platform use.

To evaluate the educational impact of LLM-generated short-form videos, a between-subjects user study was conducted with 62 university students.

Participants were assigned to either a control group that watched long-form instructional videos or an experimental group that interacted with the AI-generated reels. The study assessed learning effectiveness, user engagement, perceived learning efficacy, and trust in AI-generated content. Results showed that learners using the ReelsEd system demonstrated significantly higher quiz scores, faster task completion, and greater perceived competence without experiencing increased cognitive load.

This thesis contributes to Human-Computer Interaction (HCI) and educational technology by offering empirical insights into how generative AI can enhance microlearning. It also explores the pedagogical trade-offs and trust dynamics involved in replacing or augmenting traditional instructional content with AI-generated media. By combining technical development with user-centered evaluation, the work lays the groundwork for future applications of LLMs in personalized education at scale.

1.2 Problem Statement

Traditional educational formats, particularly long-form lecture videos often fail to meet the expectations and habits of modern learners. With the rise of short-form content on platforms like TikTok and Instagram Reels, students have become increasingly accustomed to fast-paced, visually engaging, and bite-sized media. However, despite the widespread popularity of these formats in entertainment, their potential for structured, academic learning remains largely untapped.

This disconnect between how learners consume content and how educational material is delivered creates a major challenge in online and blended learning environments. Students frequently disengage from lengthy videos, even when the content is relevant or well-structured. Hence, there is an opportunity to make learning more accessible, digestible, and motivating by rethinking how educational content is packaged and delivered.

At the same time, the rise of generative AI and particularly LLMs like GPT-4 offered a powerful solution. These models are capable of summarizing, segmenting, and generating new content with minimal human input. Yet, most applications of LLMs in education focus on static tasks such as summarizing text or answering questions, and rarely take advantage of their potential to produce full, multimedia learning experiences.

Also there is a lack of empirical understanding around how learners perceive AI-generated content. There are open questions around trust, engagement, and learning outcomes when educational materials are created by machines rather than instructors. Given these gaps, it was necessary to study whether learners find AI-generated short-form content effective, and how it compares to traditional long-form videos in terms of perceived quality, usefulness, and cognitive effort.

To address these gaps, ReelsEd was developed, a system that automatically generates structured, short-form educational reels from long-form lecture videos using LLMs. The system was designed to investigate whether AI-generated microlearning can improve educational effectiveness while aligning more closely with learners' media habits. The goal was not only to create a functional tool, but also to evaluate how students experience and trust this new form of instruction and whether it can meaningfully enhance their learning.

1.3 Generative AI and Large Language Models

Generative AI, and more specifically LLMs have rapidly transformed the way content is created and consumed across various domains, including education. These models are capable of understanding context, summarizing information, and generating human-like responses, making them powerful tools for producing personalized and adaptive learning materials. In this thesis, LLMs are used to automate the generation of educational video reels, offering a scalable and efficient solution for microlearning. Their integration aims to explore not only the technical possibilities of automated content creation, but also the impact of AI-generated materials on student engagement, learning outcomes, and trust.

Generative AI and microlearning have been explored across various domains within education, including higher education learning environments [1][4][10][11][12], teacher professional development [3][15], social media-enhanced learning [1][2][5][9], AI-supported tutoring and feedback systems [6][7][8], and technical training such as programming and database education [4][16]. These applications form the foundation of this thesis and highlight the relevance of using LLMs for the automated creation of short-form educational content.

1.4 Motivation

The motivation for this thesis arises from the growing disconnect between how students consume content in their daily lives and how educational material is traditionally delivered. In a world increasingly dominated by short-form video content particularly on platforms like TikTok and Instagram Reels there is an opportunity to explore whether this format can be harnessed not just for entertainment, but also for meaningful and effective education.

A central focus of this work is how generative AI particularly LLMs can be used to automatically produce short, engaging, and educationally valuable video content. Recent advances in LLMs offer significant potential to scale the creation of microlearning materials; however, this potential remains largely unexplored in structured academic settings. This gap presents a compelling reason to investigate how these technologies can work together to enhance accessibility, efficiency, and learner engagement.

Another key motivation for this work was the need to reduce the cognitive and time burden on students who are often overwhelmed by long-form instructional videos. The goal was to explore a system capable of delivering concise learning moments without compromising educational quality. ReelsEd was developed to automatically transform long lecture recordings into digestible educational reels supporting not only learner comprehension and trust, but also assisting instructors by streamlining the creation of engaging, accessible content.

This thesis is motivated by the desire to bridge modern media habits with academic instruction, to test the pedagogical effectiveness of AI-generated content, and to contribute to the growing field of AI-supported learning. Ultimately, my goal is to enhance the way learners interact with educational materials by making learning more accessible, adaptive, and aligned with the way people actually consume content today.

1.5 Scope of thesis

The main goal of this thesis is to develop and evaluate a system that uses LLMs to automatically generate short-form educational videos from long-form academic lectures. The core objective is to enhance the learning experience by delivering microlearning content that aligns with modern content consumption habits, without compromising educational effectiveness.

The project focuses primarily on the development of ReelsEd, a web-based system that integrates GPT-4 to segment, summarize, and transform lecture videos into concise educational reels. A companion mobile application was also created to support cross-platform access, but the emphasis of the work remained on the backend logic and the generative AI pipeline. The system includes features such as reel generation, editing capabilities, instructor-based reel assignment to students, and user-based rating for each reel to support feedback and refinement.

In addition to the system design and implementation, a major part of the thesis is dedicated to evaluating how learners interact with and respond to AI-generated educational content. A user study was conducted to compare the learning outcomes, engagement levels, and perceived trust between students using the ReelsEd system and those viewing traditional lecture videos. The findings suggest that AI-generated short-form content can have a positive effect on learning performance and user experience.

This thesis does not attempt to replace traditional educational models, but rather to explore how generative AI can supplement them through accessible, efficient, and adaptive microlearning content.

Chapter 2

Background Theory

2.1 Introduction

This chapter explores the current landscape of microlearning in digital education and examines the role of generative AI particularly Large LLMs in shaping new educational content formats. It will begin by reviewing the concept of microlearning, its pedagogical foundations, and how short-form content is increasingly delivered through social media platforms. Then, it will provide an overview of generative AI in higher education, highlighting how LLMs are being adopted for content creation and instructional support. Finally, this chapter will focus on learner interaction with AI-generated educational content, including factors such as user trust, engagement, and perceived effectiveness. Ethical and pedagogical implications will also be discussed, offering a critical perspective on the challenges and opportunities of integrating AI into modern learning environments.

2.2 Microlearning in Digital Education

2.2.1 Evolution of Microlearning and Its Pedagogical Value

Microlearning has rapidly emerged as a contemporary instructional approach, designed to meet the evolving needs of learners in digital and blended environments. At its core, microlearning breaks educational content into small, focused units, often lasting only a few minutes. This concise structure allows learners to engage with materials flexibly and at their own pace, a model well suited to the demands of modern education [15].

The COVID-19 pandemic accelerated the adoption of digital learning tools, revealing significant limitations in traditional professional development methods, which often rely on lengthy and generalized sessions disconnected from immediate teaching contexts [15]. In contrast, microlearning offers targeted, on-demand content that supports just-in-time learning. This shift has been especially critical for equipping educators with skills to navigate emerging technologies like generative AI and virtual learning platforms [3].

In higher education, microlearning is not only reshaping professional development but is also being applied effectively in student learning. For example, platforms such as TikTok have demonstrated potential as microlearning environments, fostering increased engagement, curiosity, and collaborative learning among students through short-form video content [1]. These digital formats reflect students' existing media habits and contribute to higher acceptance of educational content delivered in this way.

Pedagogically, microlearning aligns with active learning principles, supports autonomous study, and reduces cognitive overload by focusing on one specific objective at a time [3]. It also allows for modular, personalized instruction that is essential for learners and teachers working across varied educational settings. While the practice itself dates back decades, its integration with current technologies has redefined its value in the classroom and beyond [15].

In summary, the evolution of microlearning reflects a broader transformation in education, where flexibility, relevance, and accessibility are prioritized. As both a pedagogical method and a delivery strategy, microlearning is proving to be a powerful tool in supporting lifelong learning and educational resilience

2.2.2 Microlearning Through Social Media Platforms

The integration of microlearning with social media has created new possibilities for delivering educational content in ways that align closely with learners' digital habits and attention spans. Platforms like TikTok, Instagram Reels, YouTube Shorts, and Twitter have become informal microlearning spaces where short-form content is used to deliver concise, engaging educational messages [2]. These platforms are particularly appealing due to their accessibility, visual format, and ability to rapidly reach wide audiences, especially among Generation Z.

Studies have shown that the use of social media in education enhances learner engagement, improves knowledge retention, and supports the development of collaborative learning environments. In particular, microlearning via platforms like TikTok has proven to be effective in higher education settings such as nursing programs, where students reported high levels of satisfaction with short video-based content that supplemented traditional coursework [1]. The familiarity of these platforms contributes to positive reception, as students interact with tools they already use in their daily lives, allowing for a more seamless integration of learning into everyday routines.

From a pedagogical standpoint, social media supports personalized, just-in-time learning that aligns with the principles of microlearning, including brevity, relevance, and immediacy. Videos lasting from 15 seconds to 2 minutes deliver focused educational snippets that cater to the learner's needs in the moment, whether for concept reinforcement, skill practice, or creative exploration [2]. Educators also benefit from these platforms by using them to expand their professional networks, share resources, and present instructional content in new, engaging formats [9].

Instagram Reels, for instance, has influenced how Generation Z consumes educational and lifestyle content [5]. Short videos appeal to their preference for instant gratification and multitasking, making long-form media less attractive. The participatory nature of these platforms, through likes, comments, and content creation, further fosters a sense of agency and motivation among users [5]. This interactive model transforms learners from passive viewers to active contributors, which can enhance engagement and promote deeper understanding of the material.

However, while these platforms offer exciting new pathways for learning, challenges remain. Concerns over content depth, digital literacy, and potential for distraction must be addressed to ensure that microlearning via social media maintains educational value [2]. Despite these concerns, the current evidence strongly supports the view that social media, when used thoughtfully, is a powerful vehicle for delivering microlearning content at scale [2].

2.2.3 Benefits and Limitations of Short-Form Content in Education

Short-form content, such as that used in microlearning, offers distinct advantages for modern education by delivering information in concise, focused formats that align with learners' cognitive capacities and digital habits. This content is often structured into 1–10 minute modules using video, infographics, or text and can be accessed on-demand across various platforms. These features make microlearning an appealing strategy for both formal and informal educational settings [2].

One of the key benefits of short-form content is its ability to increase learner engagement and satisfaction. Studies show that bite-sized learning materials reduce cognitive overload, improve content retention, and provide learners with a sense of autonomy [3]. These outcomes are particularly evident when short-form content is integrated into online or blended learning environments, where learners can control the pace and timing of their study sessions. In a recent case study involving AI-enabled microlearning in a database programming course, students reported that short, focused lessons allowed them to grasp key programming concepts more easily, and they appreciated the immediacy of AI-generated feedback for simple tasks [16].

Furthermore, short-form educational content has proven effective in boosting digital competence and motivation among both students and educators. In professional development contexts, short-form modules help teachers quickly adapt to new technologies or pedagogical strategies without the time commitment of traditional workshops or semester-long training [3]. These microlearning sessions can be revisited multiple times and are often designed to be practical, solution-oriented, and closely tied to real-world classroom applications.

Despite its advantages, short-form content is not without limitations. One challenge lies in the depth and complexity of information that can be conveyed in such a brief format [16]. While effective for foundational knowledge and skill-building, short-form modules may not be well-suited for teaching nuanced concepts or fostering deep critical thinking. For instance, in the AI-enabled microlearning study, students expressed concerns about the inconsistency and occasional inaccuracy of chatbot-generated explanations when handling more complex queries [16]. These issues highlight the need for hybrid approaches that combine short-form modules with more in-depth instructional methods and human oversight.

Additionally, the integration of AI tools into short-form content presents its own set of challenges. While AI can personalize learning and provide real-time support, concerns persist about over-reliance on automated systems and their potential to limit learner independence or accuracy in more technical domains [16]. Designers of microlearning environments must therefore carefully balance automation with pedagogical rigor to ensure reliability and relevance.

In conclusion, while short-form educational content offers significant benefits, particularly in flexibility, engagement, and just-in-time learning, it should be employed thoughtfully. Its limitations in depth and consistency call for complementary methods and ongoing refinement, especially as AI tools become increasingly integrated into learning systems.

2.3 Generative AI in Higher Education

2.3.1 The Rise of Large Language Models for Content Creation

Large Language Models (LLMs), such as GPT-3, GPT-4, Claude, and PaLM, have fundamentally transformed content creation in education, offering unprecedented capabilities in generating personalized, adaptive, and context-aware learning materials. These models, built on transformer architectures and trained on vast textual datasets, are now widely integrated into educational workflows to produce summaries, quizzes, examples, dialogues, and explanations with minimal human input [10].

The integration of LLMs in microlearning has enabled educators to rapidly generate concise, tailored micro-content short videos, flashcards, or explanatory text segments based on student needs and course objectives. These models adapt to varying levels of learner proficiency and preferences, offering a scalable solution for differentiated instruction [4]. For instance, by analyzing learner profiles, LLMs can personalize instructional materials and support diverse learning paths, improving engagement and retention. This marks a significant shift from static, one-size-fits-all instructional design to more responsive and interactive educational systems.

Another major strength of LLMs lies in their ability to support educators by automating labor-intensive tasks. Instructors increasingly rely on tools like ChatGPT to draft syllabi, formulate assessment questions, and explain complex concepts, thereby freeing up time for more strategic teaching tasks [11]. In this way, LLMs are becoming indispensable digital assistants in modern pedagogical practice.

However, the rapid adoption of LLMs also brings critical challenges. Concerns around accuracy, hallucinated content, and biases remain prevalent, especially when models are used to generate assessments or instructional explanations without sufficient oversight [10]. Moreover, there is an ongoing debate in higher education around how these tools affect student learning behaviors, with some suggesting they may discourage critical thinking or reduce writing practice when over-relied upon [11].

Despite these concerns, there is a growing consensus that the rise of LLMs is not just a passing trend but a defining moment in the evolution of digital education. Their potential to revolutionize content creation by making it faster, more personalized, and more inclusive has sparked optimism among educators and researchers alike. When used responsibly, these tools can support pedagogical innovation and expand access to high-quality educational experiences.

2.3.2 Generative AI Tools in Teaching and Learning Contexts

Generative AI (GenAI) tools, particularly Large Language Models like ChatGPT, have significantly reshaped the landscape of teaching and learning. These tools offer new possibilities for creating personalized content, supporting student engagement, and optimizing instructional efficiency. In higher education, GenAI has rapidly evolved from a novel technological feature to a widely adopted pedagogical aid, transforming how educators design lessons, conduct assessments, and interact with learners [12].

One of the most notable impacts of GenAI in the classroom is its role in enhancing personalized and student-centered learning. Tools like ChatGPT can tailor explanations, generate formative assessment questions, and offer real-time feedback, making learning more interactive and responsive [7]. This capability aligns with constructivist and inquiry-based pedagogies, where students benefit from adaptive guidance and multiple ways of engaging with content. Educators have reported using these tools to assist in the development of teaching materials, draft syllabi, and even simulate tutoring sessions [13].

Moreover, GenAI tools serve as valuable supports in fostering inclusion and accessibility. For instance, students from linguistically diverse or neurodivergent backgrounds have been observed to benefit from AI-generated content that adapts to their pace and preferred modality of learning [7]. This has led to increasing optimism about GenAI's potential to democratize access to quality education, especially in institutions seeking to reduce inequities in learning outcomes.

Despite their advantages, the use of GenAI in educational settings also introduces challenges that must be managed carefully. Concerns regarding academic integrity, over-reliance on AI for assignments, and the ethical implications of data usage are common among educators [12]. Many universities are grappling with questions around how to guide students in using these tools responsibly, leading to the development of AI use policies and the integration of AI literacy into digital education training programs.

Educators themselves face a learning curve in adopting GenAI effectively. A recent study indicated that while many teaching staff are experimenting with generative AI, few feel adequately supported or trained to use these tools to their full potential [12]. The lack of standardized guidelines and institutional resources often results in inconsistent application across departments and courses. Furthermore, technical limitations of current AI models, including hallucinated outputs and inherent biases, highlight the need for human oversight and critical evaluation when integrating AI-generated content into instruction [13].

In summary, generative AI tools are rapidly becoming integral to contemporary teaching and learning practices. Their benefits, ranging from personalization and increased efficiency to inclusivity, are balanced by ethical, technical, and pedagogical challenges that demand thoughtful implementation. As higher education institutions move toward more AI-integrated curricula, continuous professional development and policy-making will be essential to ensure these tools support, rather than disrupt, effective teaching and learning.

2.3.3 Institutional Perspectives and Policy Implications

The rapid emergence of generative AI in higher education has prompted institutions to respond with varying strategies, ranging from cautious regulation to full integration [14]. Initially, many universities reacted to tools like ChatGPT by restricting their use, citing concerns about academic integrity and potential misuse. However, over time, a shift has occurred toward embracing generative AI as a valuable educational resource, prompting the development of formal policies, teaching guidelines, and curriculum frameworks [14].

A comprehensive study of over 100 R1-level universities in the U.S. revealed that most institutions now encourage the responsible use of generative AI, offering sample syllabus language, classroom activities, and even prompt engineering exercises to help integrate AI tools into teaching [14]. Approximately 63% of these institutions supported AI use in the classroom, while half provided detailed curriculum suggestions and examples of how instructors might leverage AI tools for assignments, discussions, and creative exploration.

Despite growing support, institutional policies reveal tension between innovation and responsibility. While many institutions provide guidance on lesson planning and personalized student support, a significant number also caution against over-reliance on AI detection tools, noting their unreliability. Instead, emphasis has shifted toward designing assessments that naturally discourage AI misuse, such as scaffolded assignments, reflection-based tasks, and critical thinking prompts that AI models struggle to complete effectively [14].

Ethical concerns are also central to institutional policymaking. More than half of the universities in the study addressed issues of privacy, data security, and digital equity. Some institutions provided specific warnings about inputting sensitive information into AI tools due to potential data breaches or third-party tracking, raising questions about compliance with laws like FERPA [14]. Furthermore, about 52% of institutions acknowledged the importance of considering diversity, equity, and inclusion (DEI) in the design of AI-related curricula, particularly to avoid amplifying existing biases or disadvantaging certain student populations.

Institutional policies also reflect the broader need to prepare students for an AI-integrated workforce. Many policies advocate teaching AI literacy alongside ethical and technical skills, including when and how to use AI effectively. This includes training on limitations such as AI hallucinations, the importance of fact-checking, and understanding the consequences of automated decision-making [14].

In summary, institutional perspectives on generative AI reveal a dual focus: enabling educators and students to use AI tools productively, while ensuring responsible, ethical, and privacy-conscious practices. As higher education continues to adapt to the evolving technological landscape, policy frameworks will play a critical role in balancing innovation with accountability.

2.4 Learner Interaction with AI-Generated Content

2.4.1 Human vs. AI Teaching Preferences and Student Trust

As generative AI becomes increasingly embedded in educational systems, a critical question emerges: do students prefer to be taught by humans or AI, and how does trust influence this preference? Recent studies show that while AI teaching assistants (AI TAs) offer clear advantages in terms of speed, availability, and consistency, human educators are still often perceived as more trustworthy, emotionally intelligent, and pedagogically relatable [6].

Peng and Wan [6] investigated this tension by analyzing student preferences between AI and human TAs through a model grounded in preference theory, trust theory, and the stimulus-organism-response (SOR) framework. They found that student preferences are significantly influenced by perceived differences in trust dimensions, specifically ability, benevolence, and integrity. For instance, students often favored human TAs in complex communication scenarios, where human flexibility, empathy, and contextual understanding provided a greater sense of psychological safety. Conversely, AI TAs were appreciated for their quick response times and consistent availability, especially for straightforward or repetitive questions. Students with higher social anxiety also tended to prefer AI TAs due to reduced fear of judgment in virtual interactions.

The dimension of trust plays a central role in mediating these preferences. AI TAs excelled in integrity-related trust factors, responding promptly and fulfilling tasks without human variability, but lagged behind in areas where benevolence and adaptive communication were essential [6]. This supports a growing consensus that while AI tools can complement instruction, students do not yet fully equate them with the interpersonal depth offered by human educators.

Parallel research by Netland et al. [17] reinforces these findings in the context of AI- versus human-generated teaching videos. In an experimental study, students rated their learning experience as slightly higher after watching human-made videos, citing factors such as relatability, emotional nuance, and perceived authenticity. However, when it came to actual learning outcomes, measured via standardized assessments, there was no statistically significant difference between human- and AI-taught content. This suggests that while trust and preference may sway the subjective learning experience, objective learning gains can still be achieved through AI-generated instruction.

In summary, student preferences are shaped not just by content delivery but by affective and relational dimensions of teaching. Trust, especially in the form of benevolence and psychological comfort, remains a key differentiator between human and AI instructors. As AI tools continue to evolve, bridging the trust gap will be essential in designing systems that learners not only use, but also believe in.

2.4.2 User Experience, Engagement, and Learning Outcomes

The integration of generative AI into microlearning environments has introduced new layers of interaction between learners and educational technologies. Rather than serving solely as content delivery tools, AI systems are increasingly shaping how students experience and engage with learning materials [8]. As these systems evolve, attention has shifted toward evaluating their impact not just on academic performance, but also on learners' perceptions, motivation, and sense of control throughout the learning process.

A growing body of evidence suggests that generative AI can significantly enhance the personalization of content, which in turn fosters higher engagement and better learning outcomes. Boumalek et al. [4] emphasize that AI-generated microlearning materials, such as short videos, summaries, and practice tasks, create more flexible and adaptive educational experiences. By tailoring content to learners' individual needs, preferences, and knowledge gaps, these systems reduce cognitive overload and improve retention. AI also facilitates just-in-time learning, allowing students to receive immediate, relevant content and feedback at the moment it is needed most.

Sankaranarayanan and Mithun's study [16] provides empirical insight into this effect within a second-year database programming course. Students reported that the AI-based chatbot helped simplify complex concepts and deliver prompt feedback on SQL syntax and queries. Although the accuracy and consistency of the AI's responses varied, sometimes leading to confusion or incorrect guidance, students still valued the chatbot's ability to support real-time clarification and conceptual reinforcement. Approximately 83% of students rated the AI tutor as "somewhat helpful" or better, indicating generally positive perceptions, especially for introductory topics. However, limitations such as technical errors and unclear explanations in more advanced scenarios suggest the need for human oversight and iterative tool improvement.

Brusilovsky [8] adds a crucial layer to this discussion by exploring the balance between learner control and AI automation. He argues that human-AI collaboration, particularly through open learner models and transparent recommendation systems, can improve both engagement and trust. When learners are given control over aspects of content sequencing or visibility into how AI decisions are made, they tend to report higher satisfaction and are more likely to engage actively with the material. These findings highlight the value of integrating explainability and interactivity into AI-enhanced microlearning systems.

Taken together, these insights underscore the importance of designing AI-supported learning environments that are not only technically sound but also learner-centric. Engagement and outcomes are maximized when students feel that the system is responsive, transparent, and aligned with their learning goals. As AI continues to evolve, future iterations of educational technology must prioritize user experience as a central component of instructional design.

2.4.3 Ethical and Pedagogical Challenges in AI-Assisted Learning

While generative AI has introduced significant opportunities in education, from content creation and personalization to efficiency and accessibility, it also presents critical ethical and pedagogical challenges that institutions and educators must confront. These challenges revolve around user agency, bias, transparency, data privacy, and the evolving role of the teacher in AI-integrated learning environments.

One of the core concerns is the erosion of learner control and autonomy. As Brusilovsky [8] argues, many AI-driven educational systems rely on opaque algorithms that make decisions about what students should see, learn, or do next, often without offering the learner meaningful input or oversight. This lack of transparency risks disempowering students and promoting passive consumption over critical engagement. To address this, human-AI collaboration models that prioritize open learner models and adaptive navigation support have been proposed. These approaches aim to strike a balance between automated personalization and student agency by involving learners in reviewing and editing their AI-generated learning paths.

From a pedagogical perspective, there is growing concern that over-reliance on generative AI may dilute essential cognitive processes such as deep reflection, synthesis, and critical thinking. Jensen et al. [11] note that AI-generated content, while convenient, may undermine the formative value of learning activities, especially in writing, by decoupling thought from expression. If students begin outsourcing too much of their cognitive effort to AI tools, it could compromise their ability to construct knowledge independently and critically. This raises fundamental questions about the long-term impact of AI on student learning habits and educational outcomes.

Ethical risks are further compounded by issues of data privacy and algorithmic bias. Mittal et al. [9] highlight the importance of responsible AI deployment, especially in safeguarding sensitive student information. Many generative AI systems operate as third-party services with proprietary models, often lacking transparency in how data is used or stored. There is also evidence that these systems can reinforce existing social or cultural biases, particularly if they are trained on datasets lacking diversity. These limitations demand stricter regulatory frameworks and more robust ethical standards for AI in education.

Additionally, the teacher’s role in AI-assisted learning is being redefined. Rather than being replaced, educators are expected to serve as mediators, helping students navigate and critically assess AI outputs. This demands new competencies in AI literacy, digital ethics, and instructional design. However, as [11] points out, many faculty members still feel underprepared to manage this transition, highlighting an urgent need for professional development initiatives that equip educators with the skills to integrate AI in pedagogically sound and ethically responsible ways.

In conclusion, while the integration of AI into education holds transformative potential, it also raises fundamental ethical and pedagogical questions. Effective deployment will require thoughtful design, clear policy frameworks, and a commitment to preserving the values of autonomy, transparency, and inclusivity in learning environments.

Chapter 3
Tools, Technologies and Architecture

3.1 Introduction

This chapter will present the various technologies and tools used to create the ReelsEd interface. In addition, an explanation of the system architecture will be provided.

3.2 Technologies and Tools Used

For the design and implementation of the system(s), the following tools and devices were used:

1. ***Python*** is a versatile and widely-used programming language known for its simplicity and readability. It supports seamless integration with various Application Programming Interfaces (APIs), making it highly suitable for backend and automation tasks. In this project, Python was used to develop essential components of the application.
2. ***Visual Studio Code*** is a lightweight and versatile source-code editor widely favored for simplifying the programming process. It supports numerous languages through extensions and offers powerful features like debugging and version control. This was the primary editor used for developing the application.
3. ***Django*** is a high-level web framework that was written in Python, that helps developers to achieve rapid development. It was developed in 2005. It makes it much easier for developers to build complex, database-driven websites. It was used for the back-end

part of the thesis.

4. ***PostgreSQL*** is a powerful and advanced open-source relational database system known for its reliability and robust features. It is well-suited for handling complex queries and large-scale applications. In this thesis, PostgreSQL was used as the primary database for the backend.
5. ***Docker*** is a platform designed to simplify the deployment and management of applications using containerization. It allows developers to package applications and their dependencies into containers, ensuring consistency across different environments. In this thesis, Docker was used to streamline the backend deployment and improve portability.
6. ***NGINX*** is a high-performance web server and reverse proxy used to handle incoming requests and manage load balancing. It efficiently serves static files and forwards API calls to backend services. In this thesis, NGINX was deployed in front of the Django application to ensure smooth and optimized request handling.
7. ***Expo CLI*** is a set of tools and services that simplify the development, building, and deployment of React Native applications. It provides an optimized workflow and useful libraries out of the box. In this project, Expo CLI was used to streamline the development process of the mobile app and facilitate rapid testing and deployment.
8. ***The OpenAI API*** provides powerful language models, including GPT-4, for various AI-driven tasks such as natural language processing and generation. In this thesis, the OpenAI API was integrated into the backend to analyze video transcripts and generate summaries and titles for educational reels.
9. ***yt-dlp*** is an open-source command-line tool for downloading videos from YouTube and other platforms. It supports a wide range of formats and offers advanced configuration options. In this project, yt-dlp was used to download educational videos from YouTube for

processing and reel generation.

10. ***YouTube Transcript API*** is a Python library that simplifies the extraction of video transcripts from YouTube videos. It allows easy access to caption data for further processing. In this thesis, it was used to retrieve transcripts from educational videos, which were then analyzed by the AI system.
11. ***MoviePy*** is a Python library designed for video editing tasks such as cutting, concatenation, and adding effects. It provides a simple interface to automate video processing. In this project, MoviePy was used to trim videos and generate short-form reels automatically based on AI-selected timestamps.

3.3 System Architecture

The system adopts a 3-tier architecture based on the client-server model, which divides responsibilities across distinct layers: the presentation tier (user interface), the application tier (backend logic), and the data tier (data storage). This modular design is widely favored as it allows each tier to operate independently, making the system easier to develop, maintain, and scale. For this project, the 3-tier model was selected to support flexibility and future expansion, since updates or improvements to one tier do not directly affect the others. An overview of architecture is presented in Figure 1.

Each tier is responsible for specific tasks, described in detail below:

1. **Presentation tier:** This layer represents the front-end clients, including both the web-based and mobile applications. It interacts with the backend by sending API requests and rendering the received data into user-friendly formats. For example, generated video reels and summaries are displayed to instructors and students through intuitive interfaces, supporting easy access and interaction.
2. **Application layer:** The backend logic resides here, managed primarily by a Django web server with NGINX handling incoming API traffic. This tier processes client requests, manages authentication, handles AI interactions through OpenAI's GPT-4 API, and extracts video transcripts from YouTube. Data fetched or processed in this tier is structured and returned in JSON format, ensuring seamless communication with the front-end clients.
3. **Data tier:** This layer is responsible for secure and efficient data management. PostgreSQL is used as the relational database to store user data, video information, and AI-generated summaries. The application tier communicates directly with the database, performing queries and updates as required, and passing the results back to the clients when needed.

The use of this architecture offers several benefits beyond modular development. It enables scalability, as each tier can be scaled independently to handle increased demand. Additionally, isolating each component improves reliability and simplifies debugging and maintenance. Furthermore, Docker containerization ensures consistent environments across different stages of deployment, enhancing portability and reducing potential integration issues.

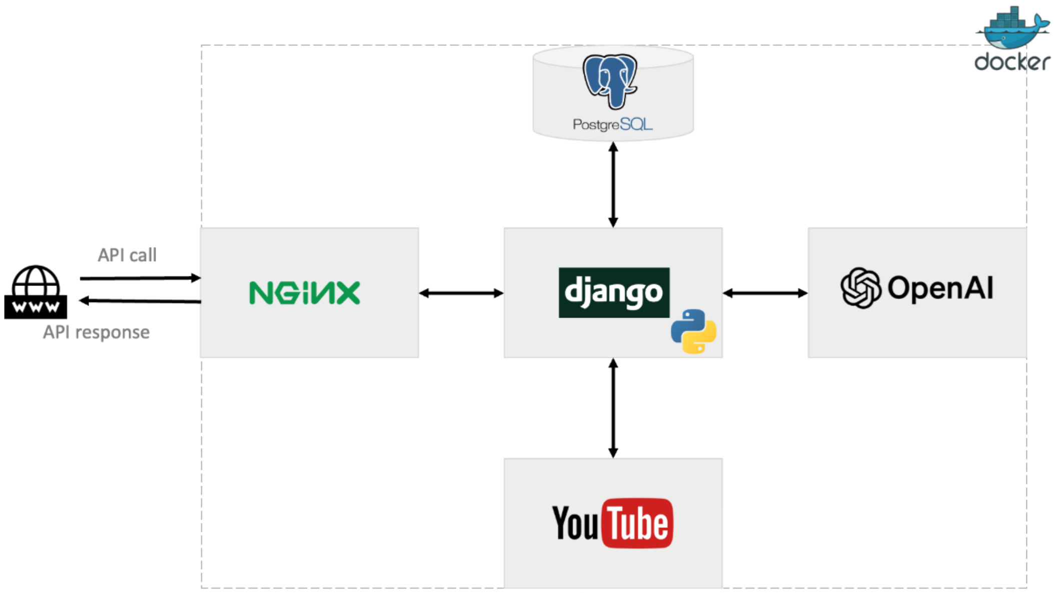


Figure 1 – System’s Architecture

Chapter 4

Design and implementation

4.1 Introduction

This chapter provides an overview of the developed system. It covers both frontend and backend components, including the instructor and student dashboards. Key functionalities such as uploading videos, generating and editing short reels, and assigning them to students are discussed. The mobile application is also explained, along with the system architecture and database used to support and manage the content.

4.2 Database Architecture

The software that the database is running on is PostgreSQL, an advanced open-source relational database system widely used in production environments. It offers robust performance, scalability, and support for complex queries, making it suitable for both development and deployment stages of web applications. PostgreSQL is highly reliable and adheres to SQL standards, while also providing powerful extensions and features such as full-text search, JSON support, and concurrency handling. In this project, PostgreSQL was used to ensure better management of relational data, especially as the system needed to support multiple users, video content, and dynamically generated reels. It integrates seamlessly with Django and is ideal for systems that are expected to grow beyond the limitations of lightweight solutions like SQLite.

The database architecture is described in the following section. Before that, two points regarding naming conventions are clarified:

1. As shown in Figure 2 the prefix before the underscore in table names refers to the Django app to which the model belongs. For example, in the table name *web_app_customuser*, *web_app* refers to the application name, and *customuser* is the actual table storing user-related data.
2. The fields ending with _id indicate that they store foreign key references. In this specific table, the field customuser_id refers to the primary key of the user table, while the field video_id corresponds to the primary key of the video table. These fields are used to create associations between users and the videos assigned to them, effectively linking which videos are accessible to each user.

4.2.1 Tables

As shown in Figure 3 it stores the information for all users registered on the platform. The primary key of the table is the id field. It includes essential authentication and profile details such as username, password, email, and the user's first_name and last_name.

Additionally, it contains several boolean flags used for user permissions and activity status:

- is_superuser indicates whether the user has all permissions without explicitly assigning them.
- is_staff is used to determine if the user can access the administrative interface.
- is_active controls whether the user account is considered active.

Timestamps such as last_login and date_joined help track user activity and account creation. Finally, the role field, a varchar, distinguishes between different types of users (e.g., student, instructor), allowing role-based access and behavior within the system.

1. As shown in Figure 4, the table stores information about each short video segment (reel) created from a full video. Each reel has a unique id, a start_time and end_time (in seconds), and a label which gives a short title or description of the reel's content.

   The file_path field stores the location of the video file, and created_at saves the date and time when the reel was generated. The video_id is a foreign key linking each reel to the full video it came from. There's also an average_rating to show how users rated the reel, and a summary field where a brief description can be stored.

2. As shown in Figure 5, the table stores information about full videos uploaded to

the system. Each video has a unique id, a video_id (used for identifying the video, usually a YouTube ID), and a title that describes the content.

The url holds the source link of the video, and the file_path shows where the downloaded or processed video file is saved.

The created_at column keeps track of when the video was added, and the user_id is a foreign key linking the video to the instructor who uploaded it. duration shows the total length of the video in seconds, and status can be used to track if the video is processed, pending, or has another state.

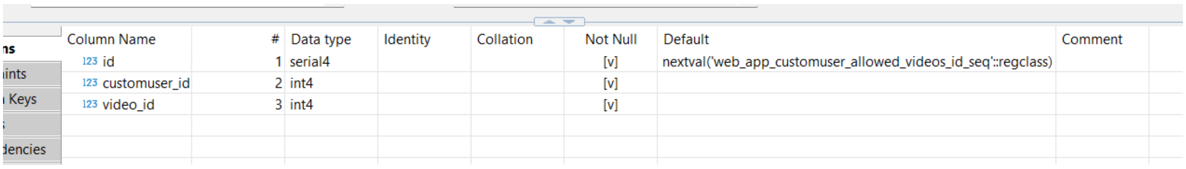


Figure 2 – Table ID Example

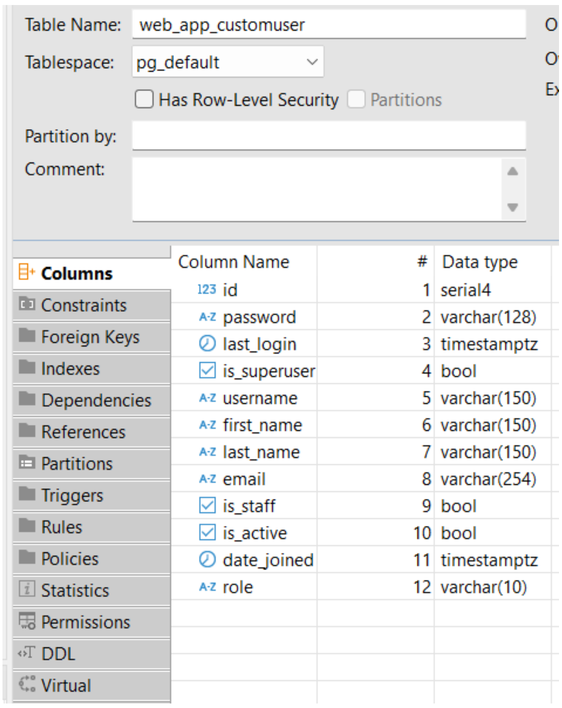


Figure 3 – Table web_app_customuser

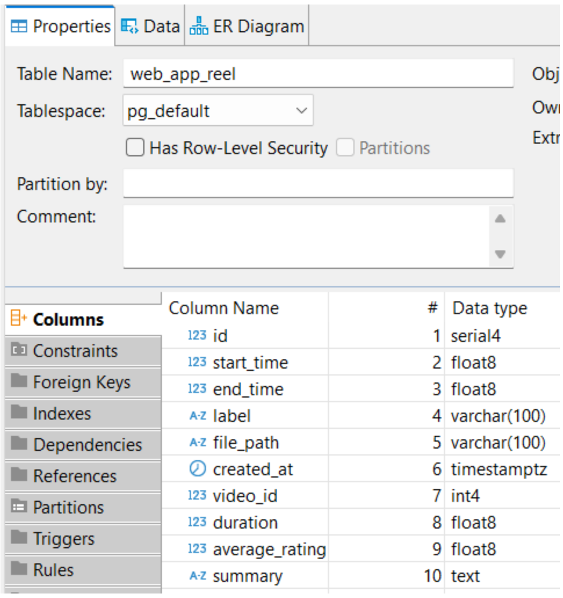


Figure 4 – Table web_app_reel

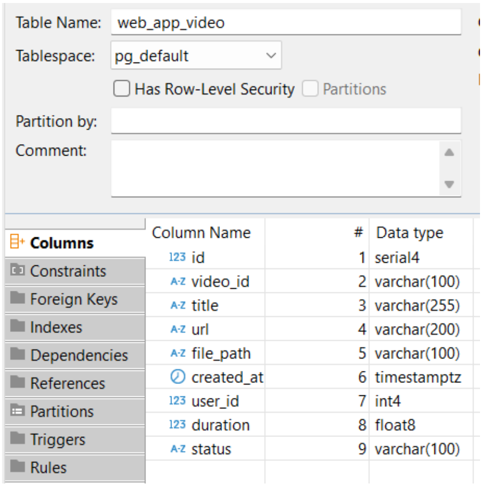
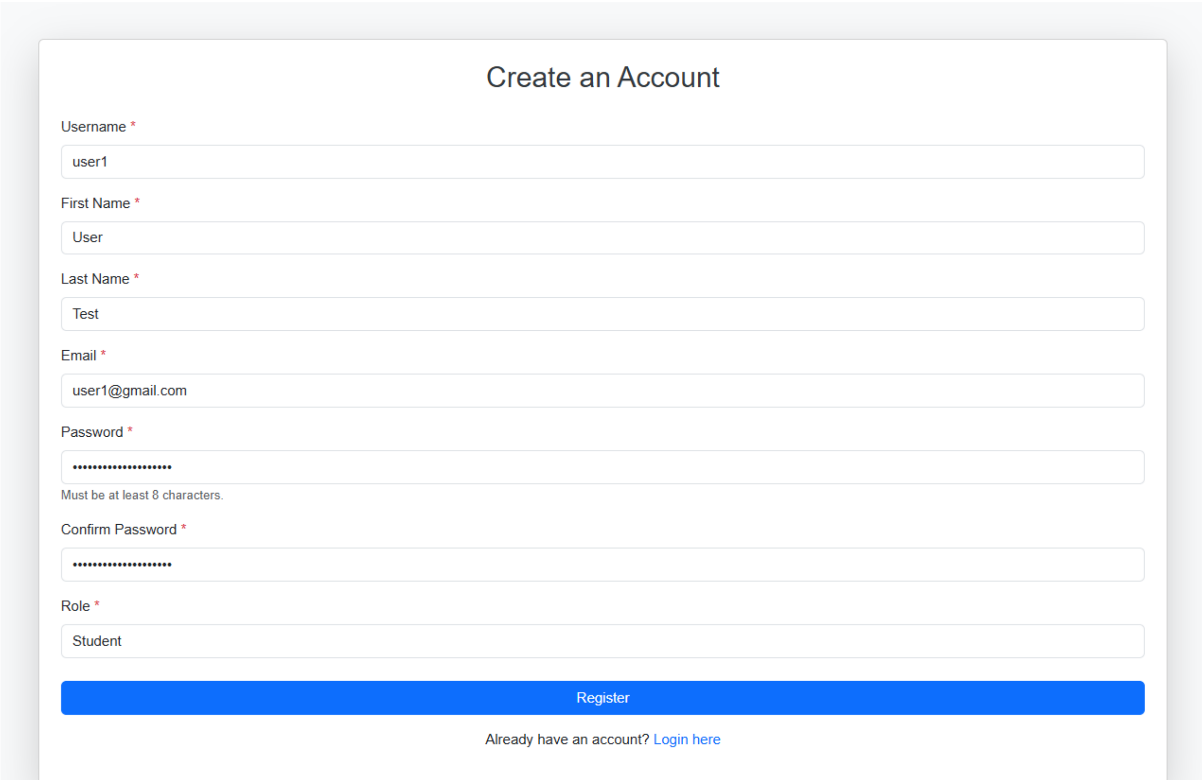


Figure 5 – Table web_app_video

4.3 Web Application

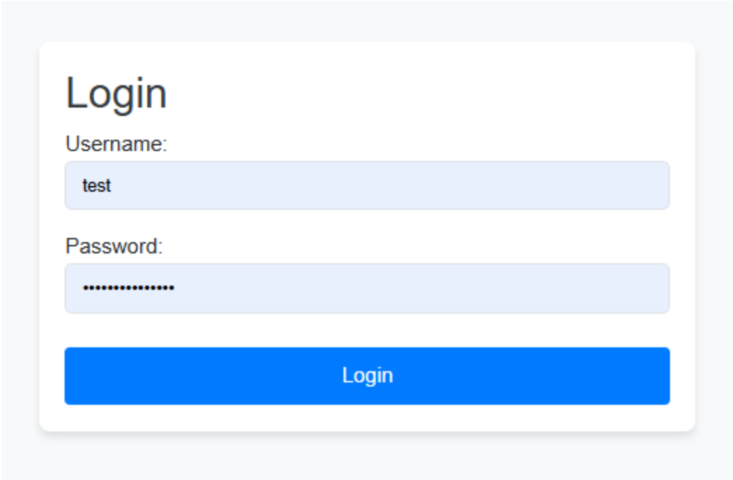
4.3.1 Register

The registration screen allows users to create an account by filling in basic details such as name, email, password, and role. It includes a password confirmation field and a dropdown to choose the user's role. There is a button to complete the registration and a link for users who already have an account to log in



4.3.2 Login

The login screen allows users to access their account by entering their username and password. The interface is minimal and user-friendly, featuring two input fields and a clear "Login" button.

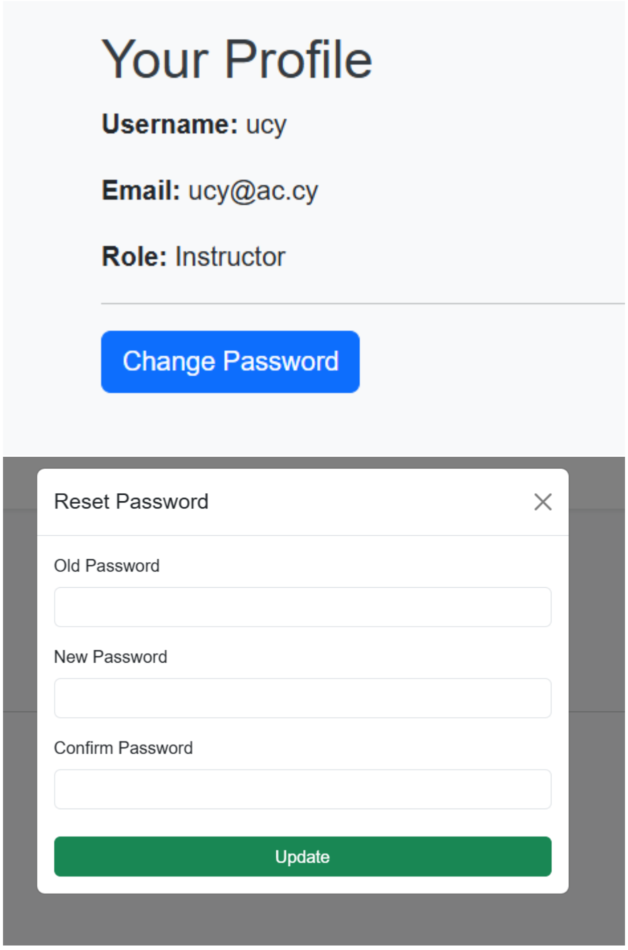


4.3.3 Menu

The navigation menu provides quick access to the main features of the system. It includes a back button, the system title (Educational Reels Generator), which also serves as a link to the index page, and links to the instructor dashboard, user profile, and a logout button.

4.3.4 Profile

The profile screen displays the user's basic account information, including username, email, and role. It also provides a button for changing the password. When clicked, a modal window appears allowing the user to securely update their password by entering their old password and confirming the new one.

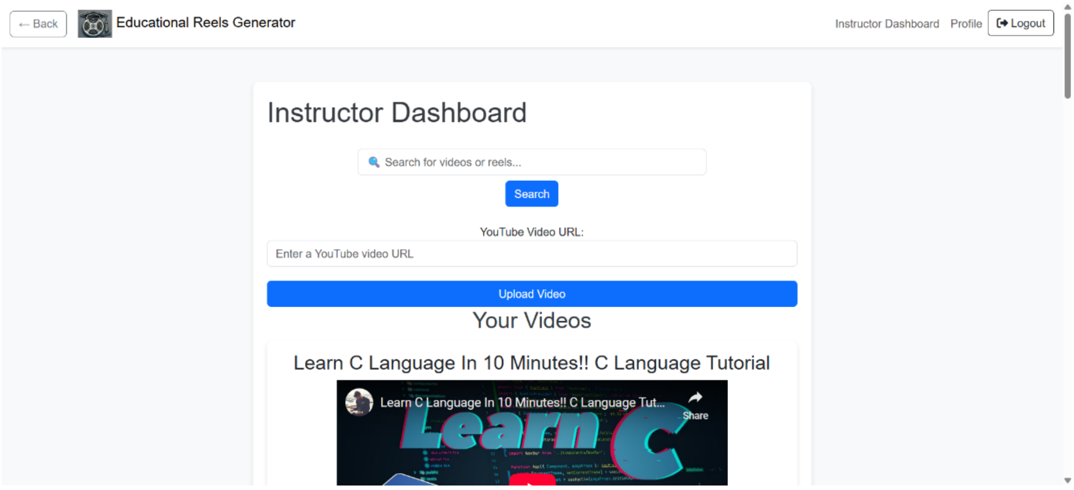

Your Profile
Username: ucy
Email: ucy@ac.cy
Role: Instructor
Change Password
Reset Password
Old Password
New Password
Confirm Password
Update

4.3.5 Instructor Dashboard

This is the Instructor Dashboard, where educators can manage their educational content and interact with the core features of the ReelsEd system. Instructors can upload videos by pasting a YouTube URL into the provided input field. Once uploaded, videos appear in a list under "Your Videos," each displayed with a preview and title.

For each uploaded video, instructors have several options:

- View Reels: Allows them to watch the AI-generated short segments of the video.
- Generate Reels: Triggers the system's summarization pipeline to create educational reels from the full video.
- Edit Reels: Opens the editing interface where instructors can adjust or refine the generated reels.
- Assign to Students: Enables the instructor to distribute the content to their students.
- Delete Video: Removes the video and its associated content from the platform.



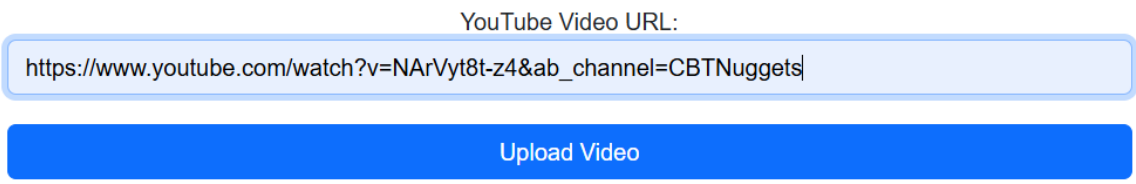

Learn C Language In 10 Minutes!! C Language Tutorial
Learn C Language In 10 Minutes!! C Language Tut...
Share
Learn C
Language
In 10 Minutes
Watch on YouTube
View Reels
Generate Reels
Edit Reels
Assign to Students
Delete Video

4.3.6 Upload Video

Instructors can upload videos to the system by simply pasting a YouTube video URL into the designated input field and clicking the Upload Video button. This action initiates the download process using the open-source command-line tool yt-dlp, a popular utility built for extracting and downloading videos from YouTube and other video-sharing platforms.

Once the URL is submitted, yt-dlp is triggered on the backend to:

- Retrieve the video content from the specified YouTube link.
- Download the video in a suitable format (e.g., MP4).
- Store the video temporarily on the server.
- Register the video within the system's database for further processing (e.g., transcript generation, reel segmentation).



4.3.7 Generate Reels

Instructors can generate short educational reels from uploaded videos through the Generate Reels interface. This feature allows them to specify the number of reels and the duration for each. A progress indicator guides users through the process, which includes downloading the video, analyzing its content using OpenAI, and creating the reels.

Technically, the system follows several automated steps:

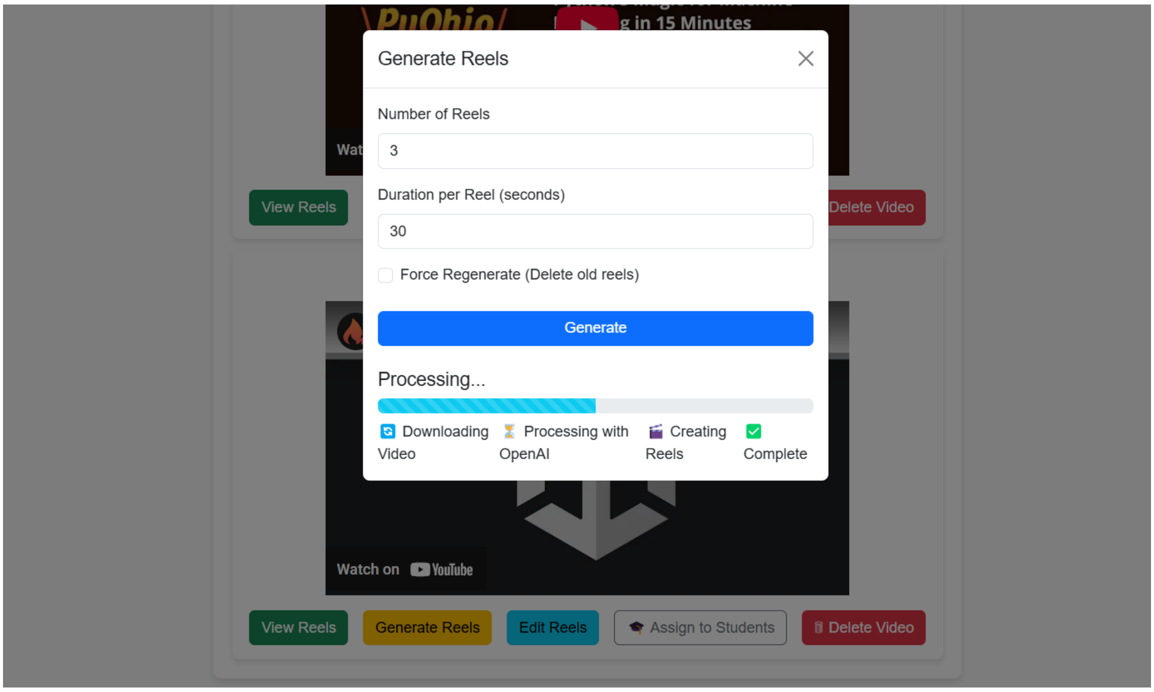
- Video Download: The original video is downloaded using yt-dlp and passed to the processing pipeline.

- Transcript Analysis: A transcript of the video is generated (if not already available), which is then processed to extract meaningful content segments.

- Key Moment Extraction with GPT-4: Using the OpenAI API, the full transcript is analyzed to identify the most important key moments. The function extract_key_moments_with_labels sends the transcript and the target number of reels to GPT-4, which returns time-stamped segments in JSON format, each including a start_time, end_time, and text.

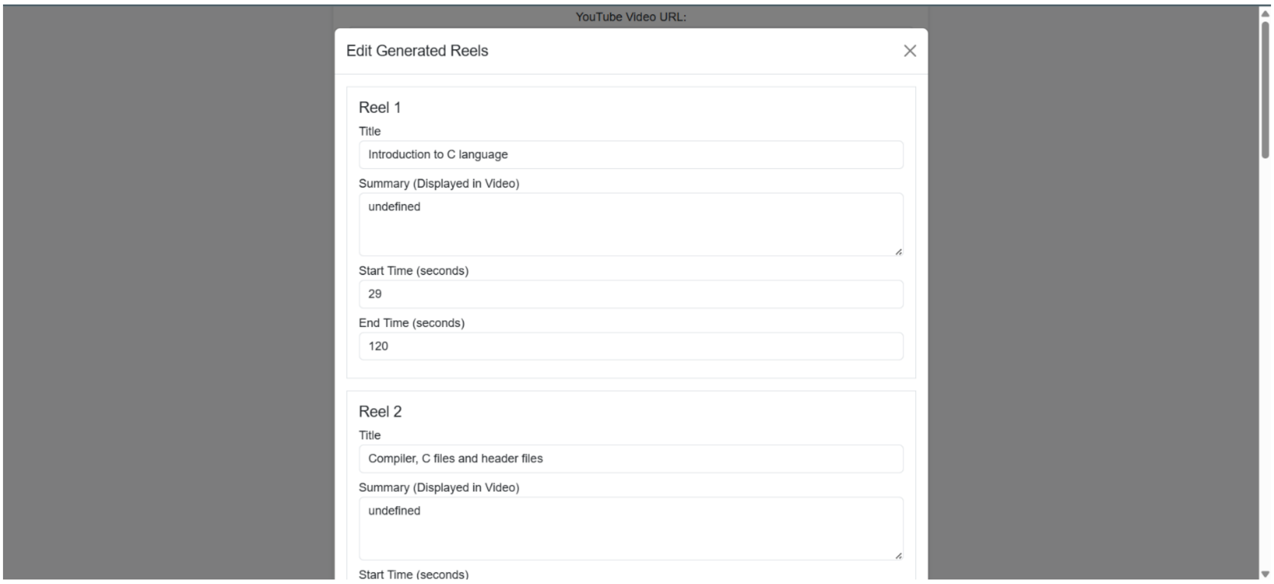
- Label Generation: Each extracted moment is summarized again via OpenAI to generate a short, meaningful title for the reel (e.g., "Data Preprocessing" or "Loop Basics").

- Reel Creation with VideoFileClip: The moviepy.editor.VideoFileClip tool is used to clip the original video into multiple segments, corresponding to the key time intervals provided by the model. These clips are then saved and registered as educational reels.


Generate Reels
Number of Reels
3
Duration per Reel (seconds)
30
Force Regenerate (Delete old reels)
Generate
Processing...
Downloading Video
Processing with OpenAI
Creating Reels
Complete
View Reels
Delete Video
Watch on YouTube
View Reels
Generate Reels
Edit Reels
Assign to Students
Delete Video

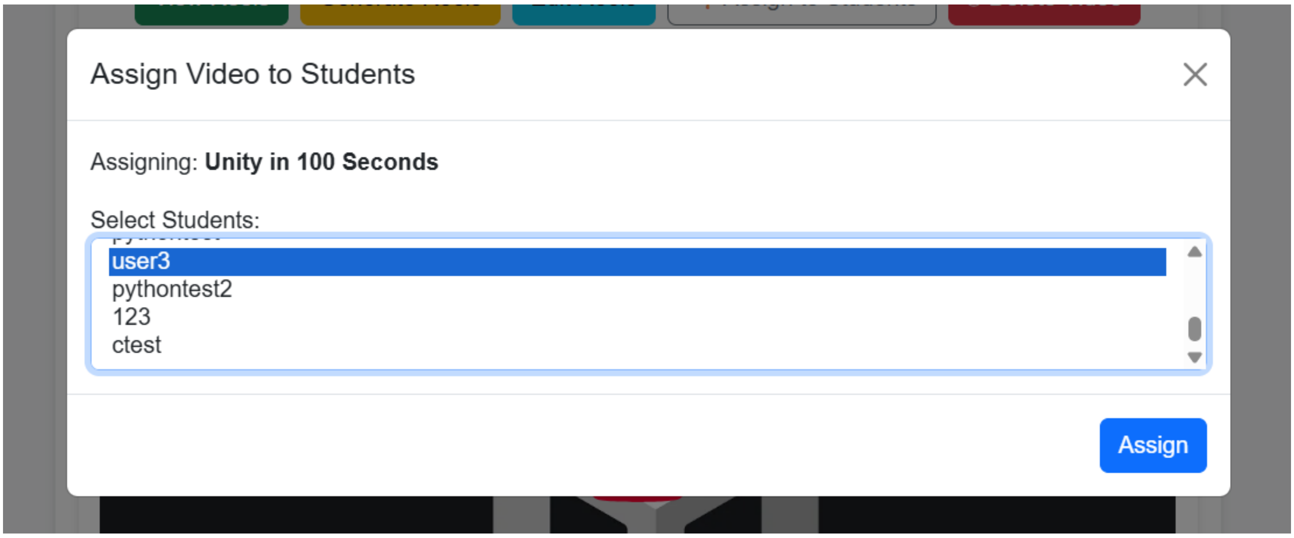
4.3.8 Edit Reels

For each reel, instructors can modify the title, provide a short summary to be displayed during playback, and adjust the start and end time (in seconds) if necessary.



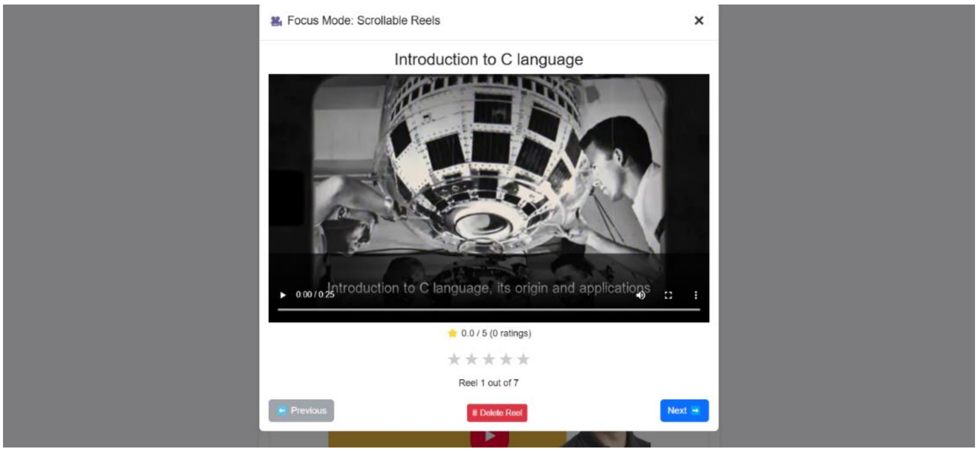
4.3.9 Assign Video to Students

The Assign to Students feature allows instructors to select specific students from a list and assign a video (and its associated reels) directly to them. Once assigned, students gain access to the selected material through their accounts.



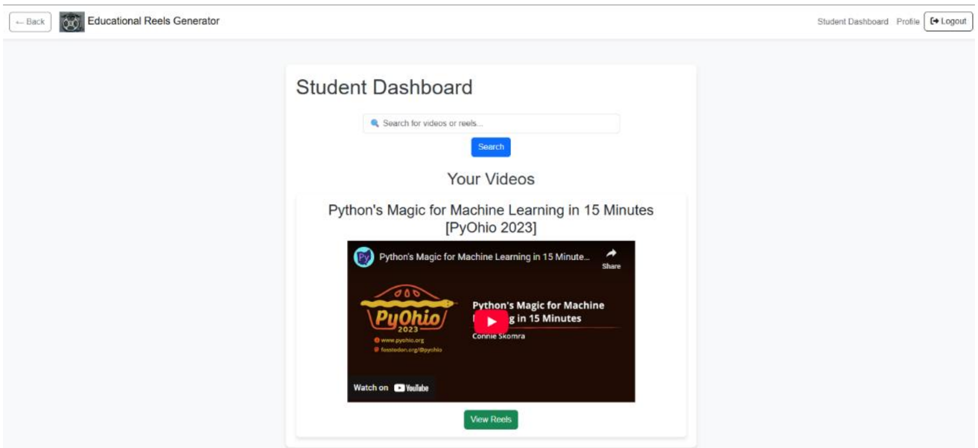
4.3.10 View Reels

The View Reels feature allows students to watch AI-generated educational video segments in a focused, scrollable interface inspired by platforms like TikTok. Reels are presented one at a time, enabling users to navigate easily using "Previous" and "Next" buttons. Students can also rate each reel based on its usefulness, helping improve content quality over time. While students can interact with and rate the reels, only instructors have the ability to delete them.



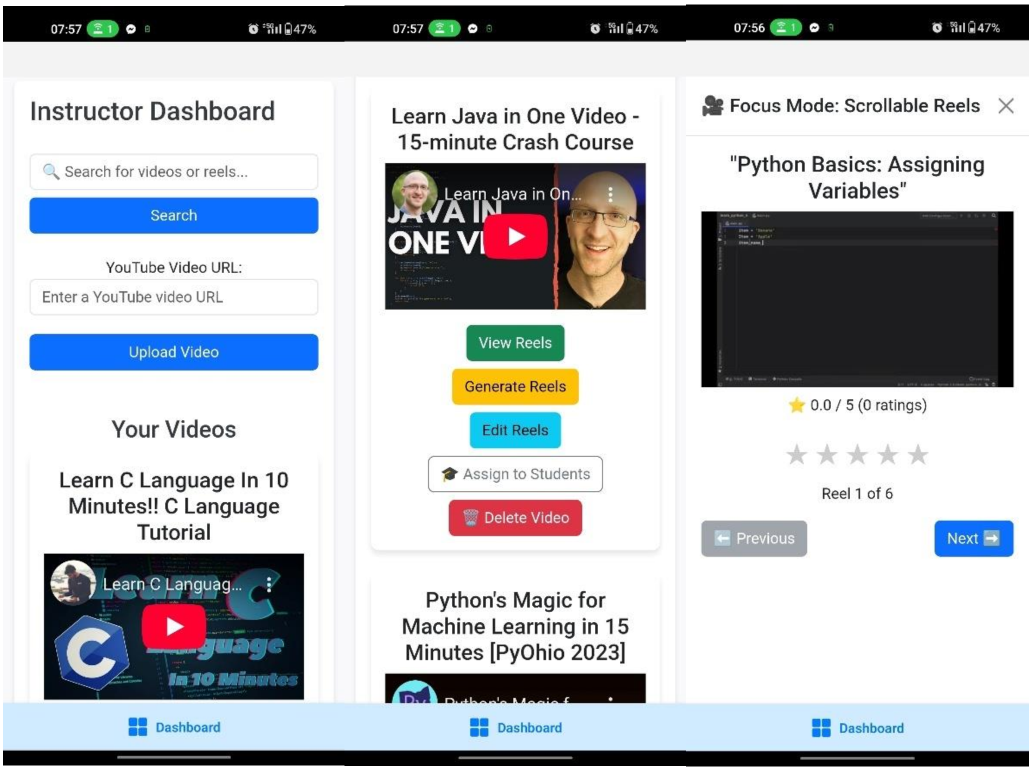
4.3.11 Student Dashboard

The Student Dashboard offers a simplified version of the instructor interface. It displays a list of videos assigned to the student, each accompanied by a thumbnail and a "View Reels" button. While students can search through their content and watch the AI-generated reels, they do not have access to upload videos, generate or edit reels, or assign content.



4.4 Mobile App

The mobile version of the system offers the same features as the web platform and was developed to complement it by meeting the needs of users who prefer learning on their phones or tablets. With short-form educational content being naturally suited to mobile consumption, a dedicated app ensures a more seamless and intuitive experience. It allows learners to engage with the material in a familiar environment, similar to how they already interact with everyday media. The goal was to make the platform more accessible and convenient, especially for students who may not always be using a desktop or laptop device.



Chapter 5

Evaluation

5.1 Introduction

This section includes excerpts adapted from a research paper I co-authored, submitted to CHIGreece 2025, the 3rd International Conference of the ACM Greek SIGCHI Chapter.

Generative AI, particularly LLMs, has introduced new possibilities in education by enabling scalable and personalized content creation. In parallel, short-form video has emerged as a dominant format for online media consumption, especially among younger audiences. However, the use of LLMs to automatically generate educational short-form video content remains relatively unexplored. This thesis investigates the intersection of these two emerging areas by presenting ReelsEd, a system that uses GPT-4 to convert long-form academic lectures into concise, engaging educational reels.

To examine how users perceive and interact with this novel form of AI-generated content, we conducted a user evaluation focusing on aspects such as learning effectiveness, user engagement, and perceived trust. Participants were divided into two groups, with one engaging with the ReelsEd system and the other with traditional long-form video content. The goal of this evaluation was to understand how learners respond to automated microlearning experiences powered by generative AI.

This research is motivated by the growing interest in using AI technologies to enhance learning, engagement, and accessibility in educational environments. Previous studies have examined the use of short-form videos in higher education to promote informal learning and social media-based microlearning [1][2][5][9], as well as the role of LLMs in supporting educational tasks such as tutoring, summarization, and feedback [7][10][11]. Other work has emphasized the benefits of microlearning in supporting retention, engagement, and learner autonomy in both student and teacher development contexts [3][15]. However, few studies have combined these areas to evaluate the effectiveness of fully AI-generated short-form video content in structured academic learning. By integrating LLMs into the microlearning pipeline, this research explores a new approach to delivering educational content that is both scalable and aligned with contemporary learning behaviors.

5.2 Study

A study was conducted with 62 participants, aged between 18 and 26 years old, all of whom were undergraduate or postgraduate university students. Participation was entirely voluntary, and participants were free to withdraw at any time. The study followed the university's research ethics guidelines, ensuring anonymity, privacy, and data confidentiality. Each participant provided informed consent by signing a consent form prior to participation.

The study used a between-subjects design, with participants randomly assigned to one of two groups. The experimental group (31 participants) interacted with the ReelsEd system, which presented short-form educational reels automatically generated using GPT-4. The control group (31 participants) viewed the original long-form versions of the same instructional videos.

Four publicly available videos were selected across different introductory topics:

1. Python: https://www.youtube.com/watch?v=FWjsdhR3z3c
2. C: https://www.youtube.com/watch?v=zTnp0c41XnQ
3. Java: https://www.youtube.com/watch?v=drQ8kEciAyY&t=72s
4. Machine Learning: https://www.youtube.com/watch?v=2_rYvaOjesQ

These videos were chosen based on three criteria: i) similar duration (10–15 minutes) to control for cognitive load, ii) structured verbal narration suitable for transcript-based summarization by LLMs, and iii) open licensing for academic use. In the long-form condition, the videos were shown in full without interruption. In the AI-Generated (ReelsEd) condition, the same videos were segmented into 5–6 key moments (approximately 30–60 seconds each) identified by the system's LLM-based summarization pipeline.

To reduce bias and enhance validity, we recruited students from a diverse set of academic backgrounds, including disciplines in Computer and Data

Sciences, Engineering, Natural Sciences, Mathematics, Social Sciences, and Business. To account for varying levels of prior experience, non-Computer Science students were assigned to one of the introductory programming topics (i.e., a, b, or c) to ensure accessibility, while Computer Science students were assigned to the more advanced Machine Learning topic (d) to match their prior knowledge and provide an appropriate level of challenge.

The study followed these steps:

i. Participants were informed that their data would be used anonymously for research purposes and signed a consent form.
ii. They were introduced to the study's objective and received instructions on how to interact with either the long-form or ReelsEd interface.
iii. Participants viewed the content assigned to their group.
iv. After viewing, they completed a 5–7 question multiple-choice quiz assessing their understanding of the material.
v. Finally, participants filled out a questionnaire evaluating their overall experience, including measures of engagement, cognitive load, perceived learning effectiveness, and, specifically for the ReelsEd group, trust in AI-generated content.

Each session lasted approximately 15 to 20 minutes depending on the condition. This setup allowed for a direct comparison of educational outcomes and user perception between AI-generated short-form content and conventional video-based instruction.

5.3 Results

User experience was assessed using standardized measures of pragmatic and hedonic quality. The overall user experience rating for the control group (No-LLM) was 1.810, with a pragmatic quality score of 2.024 and a hedonic quality score of 1.597. The experimental group (LLM) reported a slightly higher overall experience rating of 1.923, with pragmatic quality rated at 2.339 and hedonic quality at 1.508. These results suggest a modest improvement in perceived usability and task-related interaction quality when using the LLM-generated short-form video system.

Learning effectiveness was evaluated through three key metrics: quiz scores, quiz completion time, and the number of video revisits.

Quiz Scores:

Participants in the LLM group scored significantly higher than those in the control group. The LLM group achieved a mean quiz score of M = 93.85%, SD = 7.89, while the control group scored M = 79.72%, SD = 16.98. A Mann-Whitney U test confirmed the statistical significance of this difference (U = 736.50, p = 0.0001), indicating that the AI-generated microlearning format enhanced learners' comprehension and retention, as illustrated in Figure 6.

Quiz Completion Time:

Students using the ReelsEd system completed their quizzes significantly faster than those in the control group. The LLM group had a mean quiz completion time of M = 328.77 seconds (approx. 5:28), SD = 104.26, compared to M = 446.23 seconds (approx. 7:26), SD = 132.87 in the No-LLM group. This difference was also statistically significant (U = 219.00, p = 0.0002), as presented in the middle panel of Figure 6, suggesting increased efficiency in processing and recalling information.

Number of Video Revisits:

Participants in the LLM group revisited the videos less frequently (M = 2.90, SD = 1.58) than those in the No-LLM group (M = 3.52, SD = 1.98). However, this difference was not statistically significant (U = 402.50, p = 0.2679), as shown in the right panel of Figure 6, indicating that the LLM-assisted format did not reduce the need to revisit content in a meaningful way.

Overall, the results suggest that the LLM-assisted microlearning approach significantly improved both performance and time efficiency without increasing reliance on repeated video viewing. These benefits appear to be driven by the instructional quality of the generated reels, not merely by additional exposure.

The user questionnaire also captured perceived competence, learning effectiveness, engagement, and cognitive load.

Participants in the LLM group rated themselves higher in terms of perceived competence, reporting greater skill, confidence, and satisfaction in their performance. These differences were statistically significant across multiple items, as presented in Table 1 under the dimension of perceived competence.

Cognitive load was assessed using the NASA Task Load Index. While no significant differences were found between the two groups, the LLM group reported slightly lower levels of mental demand, effort, and frustration—suggesting that the short-form video format may offer a more cognitively comfortable experience.

In terms of perceived learning effectiveness, users in the experimental group rated the short-form format as more helpful in retaining key concepts, staying focused, and being able to explain the topic to others. All related questions showed statistically significant differences favoring the LLM group.

Participants also expressed a preference for the AI-assisted format for future learning. They reported higher engagement, appreciated the modular breakdown of content, and found the learning experience more approachable compared to traditional lecture formats.

To support the quantitative findings, qualitative feedback was collected through two open-ended questions.

Q1: "What did you find most helpful in how the content was delivered?"

Participants in the LLM group frequently praised the short-form format for its clarity, conciseness, and navigability. Responses highlighted how the structure of reels made content easier to process and revisit. Users described the experience as "more memorable," "focused on key points," and "free of unnecessary details." Many appreciated the ability to move between segments easily, citing a more intuitive and engaging learning experience.

In contrast, the control group acknowledged the coherence of the full-length videos but reported difficulty in locating specific information. Some found the video too long or not well-paced, and engagement was noted as a challenge. Representative comments included requests for better structure and clearer introductions.

Q2: "Was anything missing that would have helped you learn better?"

While LLM group participants generally viewed the format positively, suggestions for improvement included better navigation tools (e.g., a reel gallery or grid layout), subtitles, and note-friendly features such as transcripts or summaries. These comments focused on enhancing usability rather than altering the content.

Meanwhile, the control group expressed a desire for shorter videos, clearer structure, and modular content. Feedback emphasized that long videos felt overwhelming and made it hard to isolate information needed for the quiz.

Collectively, these insights underscore the pedagogical advantages of microlearning through AI-generated short-form content—particularly in terms of accessibility, retention, and learner autonomy.

Trust in the ReelsEd system was assessed exclusively within the LLM group using a series of trust-related questionnaire items.

Participants reported high trust levels with positively framed statements such as:

- "I can trust the system" (**M = 6.03**, *SD* = 0.91)
- "The system is dependable" (**M = 5.90**, *SD* = 1.30)
- "The system is reliable" (**M = 5.81**, *SD* = 1.08)
- "The system has integrity" (**M = 5.68**, *SD* = 1.14)

They also strongly agreed with statements indicating the accuracy (**M = 6.32**, *SD* = 0.79) and trustworthiness (**M = 6.29**, *SD* = 0.78) of the reels and showed confidence in using the system for future learning (**M = 5.90**, *SD* = 0.98).

Negatively framed items revealed low levels of concern, with low agreement on statements like "The system is deceptive" (**M = 2.29**, *SD* = 1.46) or "I am suspicious of the system's intent" (**M = 2.16**, *SD* = 1.77).

While trust was generally high, participants showed moderate scores on items assessing skepticism (**M = 3.13**, *SD* = 2.19) and familiarity (**M = 5.35**, *SD* =

1.40), suggesting that further exposure and system transparency could strengthen user confidence even further.

Dimension	Question	No-LLM vs. LLM Group ($\mu \pm \sigma$)	Test Statistic
Perceived Competence	**I think I am pretty good at this activity.**	5.32 ± 1.35 vs. **6.03 ± 0.84**	U = 624.50, **p = 0.0357**
	I think I did pretty well at this activity, compared to other students.	5.16 ± 1.49 vs. 5.87 ± 0.99	U = 610.00, p = 0.0615
	After working at this activity for a while, I felt pretty competent.	5.29 ± 1.40 vs. **5.97 ± 1.11**	U = 626.50, **p = 0.0336**
	I am satisfied with my performance at this task.	5.42 ± 1.46 vs. **6.52 ± 0.68**	U = 714.00, **p = 0.0005**
	I was pretty skilled at this activity.	5.03 ± 1.54 vs. **6.10 ± 0.87**	U = 690.00, **p = 0.0023**
	This was an activity that I couldn't do very well.	3.87 ± 1.73 vs. 3.71 ± 2.13	U = 453.00, p = 0.7007
Task Load Index	How mentally demanding was the task?	4.10 ± 1.51 vs. 3.71 ± 1.75	U = 426.50, p=0.4426
	How physically demanding was the task?	1.68 ± 1.11 vs. 1.58 ± 0.89	U = 488.50, p=0.9013
	How hurried or rushed was the pace of the task?	3.52 ± 1.39 vs. 3.26 ± 1.34	U = 449.00, p=0.6467
	How successful were you in accomplishing what you were asked to do?	3.39 ± 1.91 vs. 2.81 ± 2.33	U = 376.00, p=0.1325
	How hard did you have to work to accomplish your level of performance?	4.29 ± 1.66 vs. 3.58 ± 1.78	U = 366.00, p=0.1028
	How insecure, discouraged, irritated, stressed, and annoyed were you?	2.81 ± 1.74 vs. 1.97 ± 1.28	U = 356.00, p=0.0677
Perceived Learning Effectiveness	**I was able to understand the topic well through these videos.**	4.71 ± 1.46 vs. **6.29 ± 0.92**	U = 857.50, **p=0.0000**
	The short-form video format helped me retain key information.	4.81 ± 1.55 vs. **6.29 ± 1.22**	U = 805.00, **p=0.0000**
	This format helped me focus better than traditional video lectures.	4.97 ± 1.79 vs. **6.03 ± 1.38**	U = 697.00, **p=0.0099**
	I feel more confident explaining this topic to others now.	4.74 ± 1.80 vs. **5.65 ± 1.18**	U = 661.00, **p=0.0419**
Perceived Learning Experience	**The videos helped me remember key points better than a full lecture.**	4.81 ± 1.49 vs. **6.19 ± 1.11**	U = 732.50, **p=0.0002**
	The format helped break down the topic into manageable parts.	4.45 ± 1.65 vs. **6.45 ± 0.81**	U = 818.00, **p=0.0000**
	I would prefer to learn future topics using this format.	4.26 ± 2.02 vs. **5.87 ± 1.12**	U = 706.50, **p=0.0011**
	This format made it easier to revisit important concepts.	4.00 ± 2.03 vs. **6.55 ± 0.77**	U = 843.50, **p=0.0000**
	I felt more engaged with this format compared to traditional lectures.	4.13 ± 2.08 vs. **6.06 ± 1.46**	U = 739.00, **p=0.0002**

Table 1. Perceived learning efficacy measures across two groups (No-LLM vs. LLM) and four dimensions: perceived competence, task load, perceived learning effectiveness, and perceived learning experience. The Dimension column reflects the conceptual categories assessed through questionnaire items. Values represent μ and σ, with statistically significant results presented in bold.

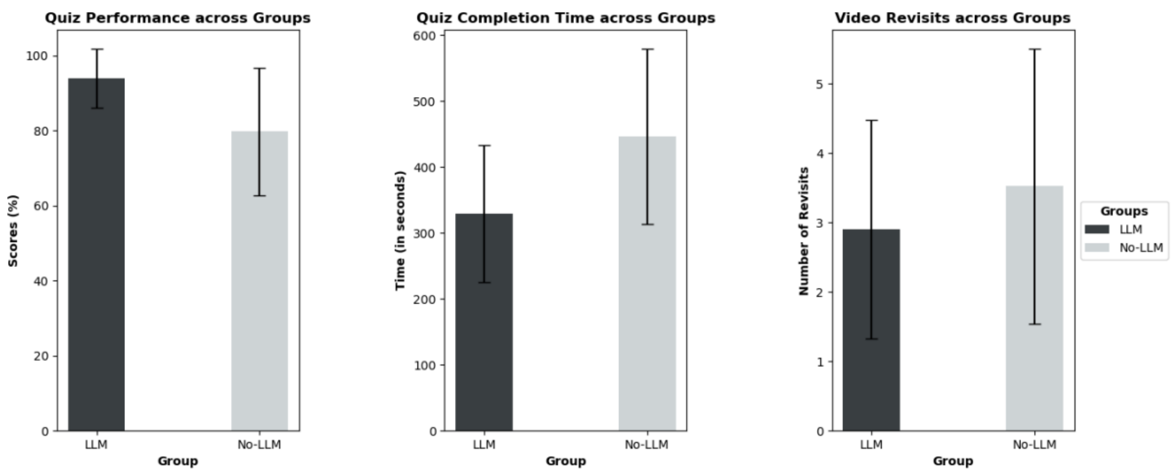


Figure 6. Comparison of learning effectiveness metrics between the LLM-generated short-form video group and the traditional long-form video group. The LLM group

achieved higher quiz scores (left), completed the quiz in less time (middle), and had fewer video revisits (right), although the difference in revisits was not statistically significant. Error bars represent standard deviation.

Chapter 6

Conclusions and Future Work

6.1 Conclusions

In conclusion, this thesis presents the design, development, and evaluation of ReelsEd, a generative AI-powered system for creating short-form educational videos from long-form lecture content. By integrating LLMs into an automated microlearning workflow, this work explores how emerging AI technologies can support more accessible, modular, and engaging learning experiences.

The findings from the user study demonstrate that learners who interacted with the LLM-generated short-form content outperformed those using traditional long-form videos in both comprehension and efficiency. Participants also reported higher satisfaction, improved perceived learning effectiveness, and strong levels of trust in the AI-generated materials. These results suggest that LLM-assisted microlearning can be both pedagogically effective and well-received by students.

Rather than aiming to replace traditional instruction, this work positions generative AI as a valuable augmentation tool that can complement existing educational practices. By aligning content delivery with learners' media habits while maintaining instructional quality, ReelsEd contributes to the evolution of human-centered, AI-enhanced learning environments.

6.2 Limitations

Despite the promising results and positive user feedback from the ReelsEd system, several limitations must be acknowledged:

1. Participant Scope: The study involved a limited number of participants from a single academic institution, which may affect the generalizability of the findings. The sample lacked geographic, linguistic, and disciplinary diversity, which are important factors when assessing educational technologies.
2. Short-Term Study Design: The evaluation was conducted in a single-session format, without exploring the long-term effects of repeated use. As a result, the findings do not offer insight into long-term knowledge retention or sustained engagement.
3. Mobile App Limitations: While the system supports both web and mobile platforms, the mobile application is currently less polished in terms of interface responsiveness and usability. Improvements are needed to ensure a consistent and smooth cross-platform user experience.
4. Editing Functionality: The reel editing feature in ReelsEd is still in early development. In its current state, it lacks robust editing controls, making it difficult for instructors to manually refine the automatically generated content.
5. Interface Shortcomings: Qualitative feedback highlighted missing features such as subtitles, note-taking tools, and a gallery-based navigation system. These omissions limited accessibility and made it harder for users to revisit or organize key content.

6.3 Future Work

This thesis demonstrated the feasibility and impact of using LLMs to generate short-form educational videos for microlearning. The study provided early evidence that such content can be effective, engaging, and well-received by learners. However, future research and development can further expand and refine these contributions.

Future work should focus on conducting studies with more diverse participant groups to examine how cultural, linguistic, and disciplinary backgrounds influence the reception and effectiveness of LLM-generated educational content. Additionally, longitudinal studies are needed to evaluate how the short-form format affects long-term retention, deeper learning, and continued user engagement over time.

Several technical improvements to ReelsEd are also planned. Enhancing the mobile app experience, refining the reel editing workflow, and adding support for subtitles, note-taking, and reel gallery navigation are high priorities. These upgrades aim to improve usability and adapt the system to a wider range of learner needs and preferences.

More broadly, future iterations of ReelsEd will explore greater personalization, learner control, and feedback mechanisms. As AI-generated content becomes more prevalent in education, there is growing value in designing systems that are not only efficient, but also transparent, trustworthy, and centered around the learner's goals and agency. Exploring how trust evolves with repeated exposure and how adaptive design can respond to user behavior are critical next steps in advancing AI-assisted microlearning.

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Appendix: Code Snippets

A-1: YouTube Video Download and Metadata Extraction

```
def download_youtube_video(url, video):
    """
    Download YouTube video, extract title, and store correct filename in the database.
    """
    videos_dir = os.path.join(settings.MEDIA_ROOT, "videos")
    os.makedirs(videos_dir, exist_ok=True)
    output_template = os.path.join(videos_dir, f"{video.video_id}.%(ext)s")

    title_command = ['yt-dlp', '--get-title', url]
    try:
        video_title = subprocess.check_output(title_command, text=True).strip()
        print(f"Extracted Title: {video_title}")

        video.title = video_title
        video.save()
```

A-2: Extracting Key Moments from Transcript Segments

```
def
extract_key_moments_with_labels(transcript_segments,
num_reels):
    """
    Extract key moments using OpenAI, generate short
labels,
    and return structured data including start_time,
end_time, text, and label.
    """
    full_text = "\n".join([entry["text"] for entry in
transcript_segments])


    try:
        # Request key moments from OpenAI dynamically
based on `num_reels`
        response = openai.chat.completions.create(
            model="gpt-4",
            messages=[
                {"role": "system", "content": "You are
a helpful assistant that only responds with JSON
format."},
                {"role": "user", "content": (
                    f"Please return the best
{num_reels} key moments in JSON format, "
                    "with each moment containing
'start_time', 'end_time', and 'text'. "
                    "Ensure 'start_time' and
'end_time'. "
                    "MAKE SURE TO RESPOND ONLY IN JSON
```

```
FORMAT."
                )},
                {"role": "user", "content": full_text}
            ],
            max_tokens=500,
            temperature=0.5
        )
```

A-3: Generating Labels for Extracted Moments

```
for moment in key_moments_data:
    # Convert start_time and end_time from "HH:MM:SS" to seconds
    moment["start_time"] = sum(int(x) * 60 ** i for i, x in enumerate(reversed(moment["start_time"].split(":"))))
    moment["end_time"] = sum(int(x) * 60 ** i for i, x in enumerate(reversed(moment["end_time"].split(":"))))


    # Generate a short label for the moment using OpenAI
    label_request = (
        f"Summarize the following key moment into a short title of 3-5 words:\n"
        "Do not change the start_time and end_time, only summarize the text!!!\n"
        f"\"{moment['text']}\""
    )
    label_response = openai.chat.completions.create(
        model="gpt-4",
        messages=[
            {"role": "system", "content": "You are a helpful assistant that creates concise titles."},
            {"role": "user", "content": label_request}
        ],
        max_tokens=20,
        temperature=0.5
    )
```

```
    moment["label"] =
label_response.choices[0].message.content.strip()
```