AI-Assisted Educational Framework for Floodplain Manager Certification: Enhancing Vocational Education and Training Through Personalized Learning

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Abstract

Floodplain management is critical for mitigating flood risks and safeguarding communities. The FloodPlain Manager (FPM) certification is essential for professionals in this field, but current preparation methods often fall short in providing comprehensive, accessible, and engaging study resources. This research introduces a novel AI-assisted educational tool designed specifically for FPM certification preparation and training process. Leveraging advanced natural language processing and machine learning techniques, this tool offers personalized learning experiences, interactive question-and-answer sessions, and real-time feedback to aspiring floodplain managers. The system architecture integrates certification-specific content through a sophisticated document parsing process, ensuring relevance and accuracy. Evaluation of the tool was conducted through two primary methods including text similarity analysis to assess the correctness of generated answers and a survey with university staff to gather feedback on the tool's effectiveness. Results indicate a high level of accuracy in response generation and positive feedback from educators, highlighting the tool's potential to enhance vocational training for FPM certification. This study underscores the transformative role of AI in professional education and suggests future directions for expanding the tool's capabilities and application to other certifications.

Keywords: Artificial Intelligence (AI), Educational Technology, Personalized Learning, Vocational Training, Adaptive Learning, Professional Certification

1. Introduction

Floodplain management is crucial for mitigating the adverse impacts of flooding, which is the most financially and physically destructive natural hazard in the United States (Tyler et al., 2023; Yildirim et al., 2022). Floodplain Managers (FPMs) play a pivotal role in this process by overseeing the planning, mitigation, preparation, and response to flood hazards within their communities. Their responsibilities include integrating weather and climate information into decision-making to prepare for extreme precipitation events, which are becoming more common due to climate change (VanBuskirk et al., 2023; Alabbad et al., 2023). FPMs rely on a combination of flood forecasts for short-term decisions (Sit et al., 2021) and other factors such as budgets and political influence for long-term planning, with social networks and prior experience also playing significant roles (VanBuskirk et al., 2023).

The effectiveness of FPMs can vary based on their location, experience, and training, with urban and rural settings presenting different challenges and strengths (Siebeneck et al., 2022). Despite technological advances in flood control measures, floods continue to cause significant damage, necessitating both structural and non-structural management methods (Bardhan, 2022; Cikmaz et al., 2023). Additionally, floods generate massive quantities of debris and waste, adding further burdens on environmental, economic, and administrative systems, highlighting the need for a comprehensive debris management system (Al-Jubouri et al., 2022). FPMs are essential in enhancing community resilience to floods, and their role requires continuous adaptation and improvement based on past experiences and evolving challenges (Bardhan, 2022).

The significance of incorporating AI-driven tools in vocational education and training (VET) has been explored in fields such as environmental sciences, demonstrating improvements in engagement and learning through the use of AI and natural language processing (Sajja et al., 2024a). Similarly, integrating AI into hackathon-style learning has shown promise in enhancing educational outcomes by merging theoretical knowledge with practical problem-solving applications (Sajja et al., 2024b).

The FPM certification is a professional credential for the Certified Floodplain Manager (CFM) roles that signifies expertise in floodplain management, a critical field focused on mitigating flood risks and enhancing community resilience. The certification typically requires a combination of education, experience, and passing a comprehensive exam that covers various aspects of floodplain management, including understanding flood hazards, regulatory standards, and best practices for flood mitigation and response. The significance of this certification in professional development is multifaceted. It equips individuals with the knowledge and skills necessary to effectively manage flood risks, which is crucial given the increasing frequency and severity of flooding events due to climate change and other factors (Siebeneck et al., 2022; Rugendyke & Vanclay, 2023; Li and Demir, 2022).

Certified Floodplain Managers (CFPMs) play a pivotal role in local communities by making informed decisions on flood mitigation, preparation, and response, thereby reducing the financial and physical destruction caused by floods (Tyler et al., 2023). Additionally, the certification

enhances the credibility and professional standing of floodplain managers, enabling them to better communicate flood risk (Baydaroglu et al., 2023) and apply scientific knowledge in their work, which is often hindered by communication barriers between scientists and managers (Bouska et al., 2016).

The certification also underscores the importance of continuous training and education, as ongoing professional development is essential for staying updated with the latest floodplain management strategies and technologies (Siebeneck et al., 2022). Moreover, CFPMs contribute to the development and implementation of effective debris and solid waste management systems (Bayar et al., 2009), which are crucial for minimizing the environmental and economic impacts of floods (Al-Jubouri et al., 2022). The FloodPlain Manager certification is a vital component of professional development in this field, fostering a well-prepared and knowledgeable workforce capable of addressing the complex challenges posed by flood hazards.

Preparing for Floodplain Manager certification exams involves understanding a range of complex topics and overcoming several challenges. One of the primary methods includes comprehensive training programs that cover the technical aspects of floodplain management, such as hydrologic and hydraulic requirements, levee certification, and the National Flood Insurance Program (NFIP) regulations (Bellini, 2010).

However, the complexity of flood modeling, which involves highly uncertain and non-linear processes (Li et al., 2023), poses a significant challenge due to the lack of recorded data and the need for physically interpretive solutions (Tegos et al., 2023). Additionally, the interaction network among various actors in flood risk management is intricate, making it difficult for risk managers to fully grasp the interconnections necessary for effective decision-making (Giordano et al., 2016). Local floodplain administrators (FPAs) also face challenges based on their location, experience, and previous training, which can affect their perceived ability to manage flood risks effectively (Siebeneck et al., 2022).

The need for robust and resilient solutions that can perform well under uncertain future conditions further complicates the preparation process (Jonkman & Dawson, 2012). To address these challenges, it is recommended that training programs be tailored to enhance the understanding of these complex networks and provide practical, scenario-based learning to improve the resilience and effectiveness of floodplain managers. This holistic approach can help candidates better prepare for certification exams by equipping them with the necessary knowledge and skills to manage flood risks comprehensively.

The primary aim of this study is to develop an innovative educational tool designed specifically for aspiring FPMs preparing for certification exams. Given the critical importance of effective floodplain management and the increasing complexity of flood risks, there is a clear need for enhanced training methods that can provide comprehensive, up-to-date, and practical knowledge. This tool aims to bridge the gap between traditional study methods and the dynamic requirements of professional certification, leveraging advanced technologies to deliver an effective learning experience. The specific objectives of this study are to provide a thorough description of the FPM educational tool, including its design, functionality, and integration of

state and federal resources; to demonstrate the tool's effectiveness in aiding certification exam preparation through rigorous testing and user feedback; and to discuss how this tool can be integrated into existing professional development programs to enhance the overall preparedness of aspiring floodplain managers.

2. Related Work

Recent educational programs for floodplain management are incorporating innovative and interactive methods increasingly to enhance understanding and resilience among various stakeholders. One such approach is game-based learning, which has been shown to effectively teach students and stakeholders about the complexities of flooding and improve flood resilience by simulating real-world scenarios and decision-making processes (Bogdan & Cottar, 2022; Alabbad et al., 2024). In Makassar, Indonesia, a virtual reality-based educational game has been developed to educate the public on flood disaster management, making the learning process engaging and effective (Sermet and Demir, 2022). This system has received positive feedback, with a significant majority of users finding it very useful (Paliling et al., 2022).

Additionally, Geographic Information System (GIS) viewers, such as those offered by the National Flood Zone Mapping System (NFZMS) and PATRICOVA in Spain, are being used in educational settings to help students understand the social and territorial aspects of flooding. These tools enable students to analyze and compare different flood-prone areas, thereby enhancing their geographical and environmental awareness (Olcina et al., 2022). Furthermore, participatory workshops and community-based approaches, as seen in the Kalloni river basin in Greece, involve local stakeholders in the decision-making process for implementing Nature-Based Solutions (NBS) for flood risk mitigation. This method not only educates the community but also ensures that the solutions are sustainable and widely accepted (Koutsovili et al., 2023).

Despite these advancements, the global impact of floods remains significant, with millions affected and substantial economic losses reported annually (Samuel et al., 2024). This underscores the need for continued innovation and widespread adoption of educational tools and methods to better manage flood risks and enhance community resilience (Jain et al., 2022). The integration of technology in vocational and professional training is pivotal for modernizing educational processes and enhancing the competencies of future specialists. The four technological approaches in vocational education, particularly in fields like agronomy, emphasize the formation of technological competence, which combines theoretical knowledge with practical skills to optimize the educational process and achieve planned outcomes (Onipko et al., 2022).

Digitalization plays a crucial role in this transformation, necessitating the provision of modern digital tools and environments in vocational institutions to foster digital competence among both educators and students (Osadcha et al., 2023). The use of information technology not only personalizes and technologizes the learning process but also promotes the development of cognitive and creative abilities, enabling distance learning and continuous education (Gedzik, 2022). These advancements in technology and digitalization are essential for equipping

vocational and professional training programs with the tools needed to produce highly qualified and adaptable professionals in a rapidly evolving educational and industrial landscape.

Artificial Intelligence (AI) is increasingly being integrated into chatbots (Sermet and Demir, 2021) and educational tools, significantly impacting learning outcomes by enhancing the teaching and learning experience (Kadiyala et al., 2024). AI-driven educational tools offer numerous benefits, such as improving the accuracy and efficiency of assessments, generating personalized feedback, and enabling teachers to tailor their teaching strategies to meet individual student needs (Owan et al., 2023). These tools can transform education by providing personalized learning experiences, adaptive testing capabilities, and intelligent tutoring systems, which can lead to improved student engagement and address educational inequalities (Rizvi, 2023).

AI applications in education, such as natural language processing (NLP) and large language models (LLMs) like GPT-4, facilitate educational support, constructive feedback, tailored curricula, and personalized career guidance, ultimately leading to better educational outcomes (Alqahtani et al., 2023). Additionally, with the use of NLP and LLMs, new tools are being designed to measure student engagement and learning progression (Sajja et al., 2023a). AI tools can help answer students' queries on course logistical questions, curriculum-related questions as well (Sajja et al., 2023b). However, the integration of AI in education also presents challenges, including ethical concerns, algorithmic biases, and the risk of reduced human interaction in classrooms due to automation (Rizvi, 2023).

Despite these challenges, the potential benefits of AI in education are significant, including reduced planning time for teachers and improved assessment methods, which can lead to more effective teaching and learning processes (Ayala-Pazmiño, 2022). The successful implementation of AI in education requires careful consideration of these ethical concerns and effective integration into existing educational systems (Rizvi, 2023). Additionally, ongoing empirical research is essential to fully understand the impact of AI on education and to prepare students for a future where AI plays a leading role (Ayala-Pazmiño, 2022). As educators continue to explore AI's pedagogical advantages, it is crucial to develop AI-enabled platforms that can be effectively scaled and integrated into higher education to maximize their potential benefits (Sajja et al., 2024c).

Despite the progress in educational technologies and AI-driven tools, significant gaps exist in the resources available for preparing for the FPM certification. Currently, there are no dedicated AI-powered tools designed specifically to aid in the preparation for the FPM certification exam. This certification is critical, as it ensures that professionals are equipped to handle the increasing challenges posed by climate change and frequent flooding events. The exam itself is comprehensive and challenging, covering a wide range of topics from regulatory standards to flood mitigation strategies. Given the importance of the FPM role in protecting communities and managing flood risks, there is an urgent need to develop specialized educational tools that can improve the preparation process for this certification. Such tools would not only enhance the

learning experience for aspiring FPMs but also ensure that they are better prepared to tackle the complexities of floodplain management, ultimately contributing to more resilient communities.

3. Methodology

We are presenting an AI-assisted virtual tutor to assist in vocational training and certification for FPM certification. This AI-enhanced tool helps aspiring FPMs with their certification exam by providing a suite of tools designed to enhance their study experience. The tools include personalized flashcards, automated quiz generation, notes generation, and a chatbot for answering any certification-related questions. To support these features, the platform integrates data from various resources, including Association of State Floodplain Managers (ASFPM) course materials, state-level FPM resources, policy and regulatory data, and research tools.

These resources are processed using advanced AI technologies, such as NLP, text embeddings, and text similarity algorithms, to ensure that learners receive accurate, contextually relevant content. The platform's intelligent system enables real-time knowledge retrieval and dynamic learning. Figure 1 illustrates the data resources, intelligent systems, and key features that empower users to have an interactive and personalized learning experience. It further shows how the system processes various data sources and integrates features like personalized flashcards, adaptive quizzes, interactive learning modules, and real-time analytics to support aspiring floodplain managers.

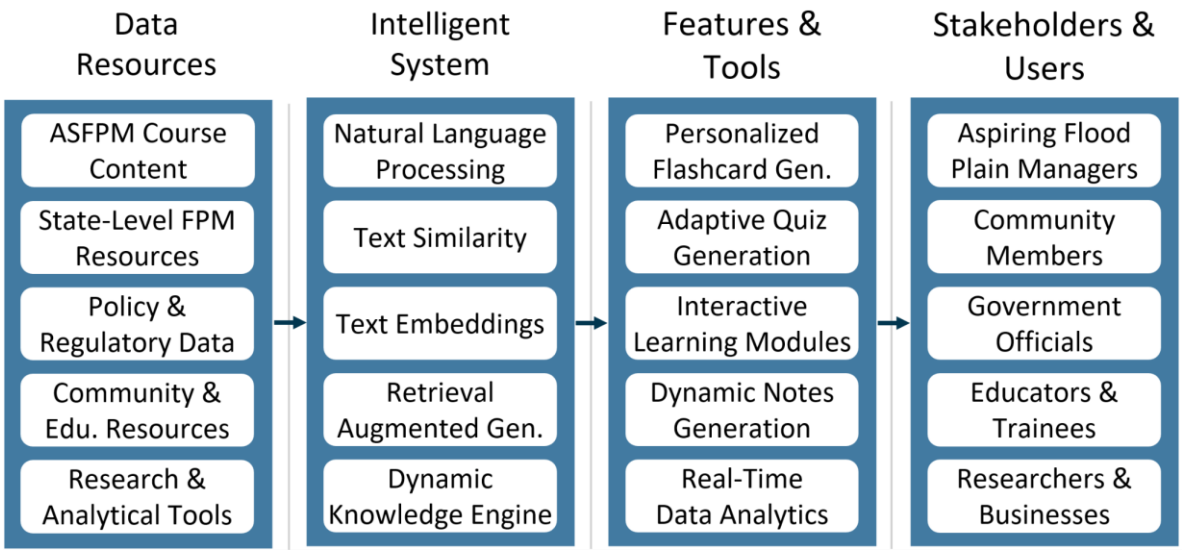

Figure 1: Overview of data resources, intelligent system, features, and stakeholders in the FPM educational tool

3.1. Scope and Purpose

The FPM educational framework is designed to provide prospective floodplain managers with the resources and guidance necessary to effectively prepare for their certification exams. As climate change continues to increase the frequency and intensity of floods, it is more important

than ever to have skilled professionals managing flood risks and enhancing community resilience (Vanucchi, 2021; Peck et al., 2022). Certified FPMs play a crucial role in this process, ensuring that flood mitigation strategies are implemented to protect communities and infrastructure. To help aspiring FPMs access essential study materials and ensure thorough exam preparation, we have developed an AI-powered platform equipped with several advanced features. These tools create a personalized, interactive learning environment tailored to the needs of each user:

a) **Personalized Flashcard Generation**: Custom flashcards to reinforce critical concepts and regulations, ensuring users retain key information.
b) **Adaptive Quiz Generation**: Dynamic quizzes that adjust based on the user's progress and areas needing improvement, simulating real exam conditions.
c) **Interactive Learning Modules**: Engaging modules that break down complex floodplain management topics into digestible lessons, enhancing understanding.
d) **Dynamic Notes Generation**: Automatic summarization of important course materials, helping users efficiently review and organize their studies.
e) **Real-Time Data Analytics**: Continuous tracking and analysis of the user's performance, offering personalized insights and recommendations to improve exam readiness.

These features work together to provide a comprehensive, AI-enhanced study experience. By offering personalized tools like adaptive quizzes, real-time data analytics, and dynamic note generation, the FPM educational tool ensures that users have all the support they need to effectively prepare for certification. This tool aims to improve access to tailored study resources and streamline the exam preparation process, helping future floodplain managers develop the necessary skills and knowledge to successfully pass their certification exams and manage the growing challenges posed by climate change (VanBuskirk & McPherson, 2023).

3.2. FPM Certification Exam Overview

The Certified Floodplain Manager (CFM) Exam, administered by the ASFPM, is designed to evaluate the knowledge and competencies required for effective floodplain management. The role of floodplain managers is to promote the responsible use of floodplains, mitigate flood risks, and protect communities. The NFIP serves as the foundation for the industry, but floodplain management extends beyond the scope of NFIP regulations. In consultation with industry professionals, ASFPM has developed the Floodplain Management Body of Knowledge, which outlines a broad range of topics that certified floodplain managers should master. The CFM exam consists of 120 multiple-choice questions and must be completed within a 3-hour time limit. The exam is a closed-book format, designed to assess a candidate’s knowledge across seven core areas of floodplain management, with the topic categories and approximate percentage distributions as described in Table 1.

3.3. Natural Language Inference

Recent advancements in LLMs have significantly transformed NLP tasks, particularly in areas such as text generation, question answering, and conversation modeling. These models are

trained on extensive datasets, allowing them to generate highly coherent, human-like text. Prominent LLMs, such as GPT-3 (Brown et al., 2020), and RoBERTa (Liu et al., 2019), have been widely adopted across various applications for their ability to understand and generate language in meaningful ways. For the presented FPM educational tool, we employed ChatGPT-4o-latest, a dynamically updated model that continuously evolves to the current version of GPT-4o (OpenAI., 2024a) in ChatGPT.

Table 1: Distribution of Topics and Question Breakdown for the CFM Certification Exam

Topic Category	**Percentage of Questions**	**Approximate Number of Questions**
Floodplain Mapping	20 – 25%	24 – 30
NFIP Regulatory Standards	20 – 25%	24 – 30
Regulatory Administrative Procedures	15 – 20%	18 – 24
Flood Insurance	10 – 15%	12 – 18
Flood Hazard Mitigation	10 – 15%	12 – 18
Natural and Beneficial Functions	10 – 15%	12 – 18
Overall Context of Floodplain Management	5 – 10%	6 – 12

This model has been selected due to its advanced natural language inference (NLI) capabilities and adaptability for tasks like automated quiz generation, flashcard creation, and chatbot-driven queries. The model's continuously updated nature ensures access to the latest enhancements and features, making it a robust tool for both research and practical educational applications. ChatGPT-4o-latest excels in understanding complex instructions and generating accurate, contextually appropriate responses. Its ability to perform few-shot learning allows it to handle domain-specific tasks—such as FPM exam preparation—with minimal training examples. This feature is crucial in adapting the model to specialized content, ensuring a high level of relevance and accuracy in its output.

For the implementation of our tool, we leveraged the model’s ability to provide efficient and accurate real-time responses for tasks such as quiz question generation, text completions, and interactive flashcard sessions. The dynamic and continuously updated model ensures that the tool remains current and effective in its interactions, providing learners with timely and accurate information. By integrating ChatGPT-4o-latest into the FPM educational tool, we have developed a sophisticated system capable of addressing diverse learning needs through a combination of real-time NLP capabilities, domain-specific fine-tuning, and interactive support. This approach enhances the overall learning experience, assisting aspiring FPMs with their certification exam preparation.

Text Embeddings: Text embeddings are numerical representations of text that allow machine learning models to understand and quantify the relationships between different pieces of content. These embeddings enable models to measure the similarity between texts, making them invaluable for tasks such as search, clustering, recommendations, anomaly detection, and

classification. Embeddings convert concepts within natural language or code into a sequence of numbers, allowing algorithms to process and understand the relationships between different pieces of content. They are used in various applications like knowledge retrieval in chatbots and retrieval-augmented generation (RAG) tools.

In our study, we utilized text-embedding-3-large (OpenAI, 2024b), a highly capable embedding model with an output dimension of 3,072, to handle both English and non-English tasks. Once the course content or knowledge base is transformed into embeddings, we employ cosine similarity to assess the similarity between documents, which powers our retrieval-augmented generation method. Cosine similarity measures the angle between two vectors, with a cosine value of 1 representing complete similarity (alignment at 0 degrees) and values less than 1 indicating lesser similarity as the angle increases (Gunawan et al., 2018).

This process essentially conducts a dot product operation between the vectors, helping to quantify how closely aligned or "similar" the word embeddings are. Our search algorithm uses cosine similarity to prioritize vectors with higher similarity scores, selecting the top 5 most relevant documents. These documents then serve as the context for answering questions, generating quizzes, flashcards, notes, and other study materials. By employing this approach, the system ensures that the generated content is contextually accurate, closely aligned with the knowledge base, and highly relevant to the user's query.

3.4. Data Sources

The FPM educational tool utilizes a range of authoritative data sources to support the preparation of aspiring professionals for the CFM exam. These data sources provide the foundation for the development of quizzes, flashcards, notes, and interactive learning modules, offering a comprehensive and multi-level approach to exam preparation. For the national-level certification course content, the tool incorporates material from the NFIP 101 course, developed by the ASFPM. This course is a technical resource designed to provide foundational knowledge to floodplain management professionals and serves as an informative study aid for candidates preparing for the CFM exam. While the NFIP 101 course does not encompass all the knowledge required to pass the exam, it covers essential topics such as floodplain mapping, NFIP regulatory standards, flood hazard mitigation, and disaster response—areas critical to the certification exam.

The course includes over 23 hours of instructional content, which is composed of self-assessments, in-depth presentations, and specialized units. By processing this content, the AI-powered educational tool tailors personalized quizzes and flashcards, focusing on areas that are particularly relevant for the exam. In addition to the national-level resources, state-specific data were collected from individual state websites, each of which provides localized regulations, policies, and guidelines crucial to floodplain managers operating in their respective jurisdictions. The integration of this state-level information ensures that the tool offers detailed insights into both federal and local requirements. Given that states may have unique approaches to flood mitigation, land-use planning, and regulatory compliance, this localized content is essential for providing a comprehensive understanding of floodplain management practices.

By combining national-level resources from ASFPM with state-level data, the FPM educational tool delivers a robust and well-rounded knowledge base. This integrated approach not only ensures that aspiring FPMs are well-prepared for the certification exam but also equips them with the knowledge necessary to apply these principles in practical, real-world settings across diverse regulatory landscapes. The extracted content from these diverse resources is processed and structured by the AI system, which breaks it down into manageable sections to generate adaptive quizzes, dynamic notes, and flashcards. This system ensures that users are directed toward the most relevant information, fostering a deeper understanding of the subject matter and improving their readiness for the certification exam.

3.5. Case Study Design

To evaluate the effectiveness of the FPM educational tool, we designed a case study using two datasets: open-ended and multiple-choice questions. These datasets were derived from various sources to simulate the types of questions encountered in real exam preparation and to test the tool's ability to generate accurate and relevant responses.

Open-Ended Questions: We collected a dataset of 145 open-ended questions from multiple certified floodplain management exam preparation resources, including tools like Quizlet. These questions were compiled from user-generated flashcards, which are commonly used by exam candidates to improve information retention. The questions and their corresponding answers were used to form a testing dataset to evaluate the accuracy of our tool in responding to open-ended queries. Table 2 shows the breakdown of the open-ended questions by category.

The methodology for evaluating the tool's performance on open-ended questions involved comparing the tool-generated answers to the correct answers from the dataset using cosine similarity as a similarity metric. We conducted both manual and automated evaluations to assess the accuracy of the tool. Initially, we performed a manual review where the tool's responses were directly compared with the correct answers. This manual evaluation achieved an accuracy of 91.03%, providing a baseline for further assessment.

Table 2: Categorization of open-ended questions testing dataset

Category	**# of Questions**	**% of Questions**
Floodplain Mapping	35	24.1%
NFIP Regulatory Standards	30	20.7%
Regulatory Administrative Procedures	20	13.8%
Flood Insurance	18	12.4%
Flood Hazard Mitigation	15	10.3%
Natural and Beneficial Functions	12	8.3%
Overall Context of Floodplain Management	15	10.3%
Total	**145**	**100%**

To automate the process and ensure consistency, we applied different cosine similarity thresholds. A similarity percentage threshold of 81% was selected as the most suitable cutoff for automation, based on experiments comparing various thresholds. If the tool's answer scored above 81% cosine similarity with the actual answer, it was marked as correct; otherwise, it was considered incorrect. This threshold was chosen because it most closely approximated the results of the manual review.

Multiple-Choice Questions: In addition to open-ended questions, we gathered 67 multiple-choice questions from the NFIP 101 course, which is a key component of floodplain management training (Table 3). The NFIP 101 course provides a sample exam with nine questions in each section. Although this course serves as an excellent foundation for understanding the NFIP, it is noted that it does not fully prepare candidates for the CFM exam. Nevertheless, the multiple-choice questions provided by the course offer a relevant dataset for testing the tool's capability in handling structured exam-style queries. For the multiple-choice questions, we assessed the tool's accuracy by comparing its selected answers to the correct options provided in the dataset. A correct answer from the tool was marked as accurate, while an incorrect selection was noted as a failure. This provided a straightforward method of evaluating the tool's performance on structured question types, which closely mirror the format of many certification exams.

Table 3: Categorization of multiple-choice questions testing dataset

Category	**# of Questions**	**% of Questions**
Floodplain Mapping	13	19.4%
NFIP Regulatory Standards	12	17.9%
Regulatory Administrative Procedures	11	16.4%
Flood Insurance	9	13.4%
Flood Hazard Mitigation	6	9.0%
Natural and Beneficial Functions	1	1.49%
Overall Context of Floodplain Management	15	22.4%
Total	**67**	**100%**

Evaluation Process: The case study involved submitting the collected open-ended and multiple-choice questions to the FPM educational tool and storing the generated answers. For open-ended questions, the tool's performance was evaluated based on the similarity percentage between the generated and actual answers, with a threshold of 81% used to determine correctness. For multiple-choice questions, the tool's performance was judged by whether it selected the correct options.

4. Results and Discussions

4.1. User Interface

The FPM educational tool is designed to provide a user-friendly, intuitive interface that enhances the learning experience. The tool's interface seamlessly integrates its core features, including personalized flashcards, adaptive quizzes, interactive learning modules, and dynamic notes generation. Each of these elements is crafted to ensure users can easily navigate and engage with the content while preparing for their certification exam. The flashcard generation feature shown in Figure 2 allows users to review key concepts and regulations through custom flashcards. These flashcards are generated based on the user's progress and focus on reinforcing critical areas that require further attention. The interface provides a clear layout where users can easily flip between questions and answers, helping to enhance information retention.

The quiz generation feature shown in Figure 3 dynamically creates quizzes that adjust based on the user's performance. Users can access quizzes that reflect the structure of the CFM exam, categorized by core topics such as floodplain mapping and NFIP regulatory standards. The quizzes provide immediate feedback, allowing users to track their progress and identify areas for improvement. The interactive learning module shown in Figure 4 is powered by an AI-driven chatbot, designed to provide real-time responses to user queries. Users can ask questions related to floodplain management, regulations, or specific exam topics, and the chatbot offers detailed, contextually relevant answers. This interactive element enhances engagement and ensures that users have access to immediate support while studying.

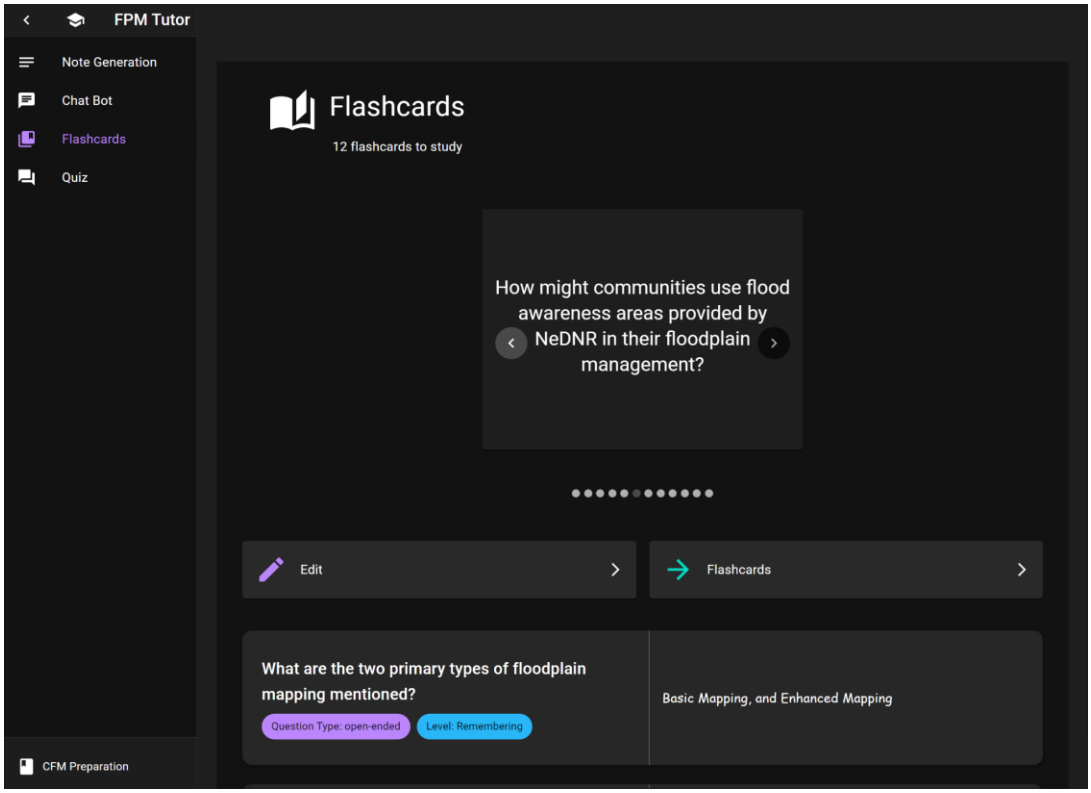

Figure 2: Personalized flashcards generation interface with sample questions

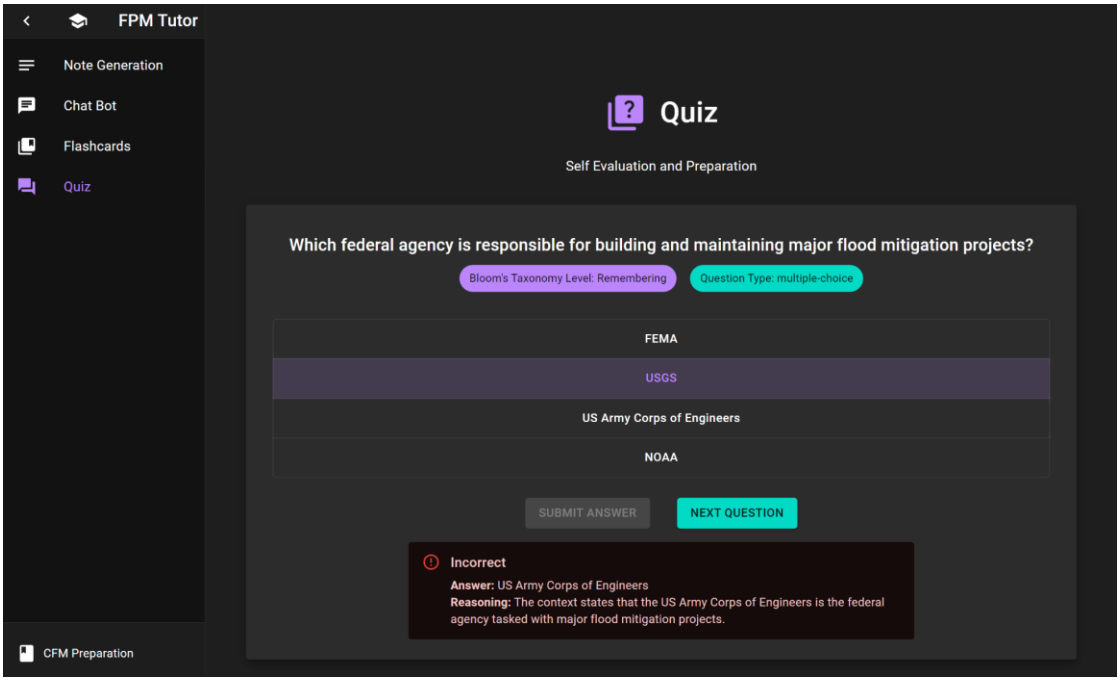

Figure 3: Adaptive quiz generation interface with sample questions

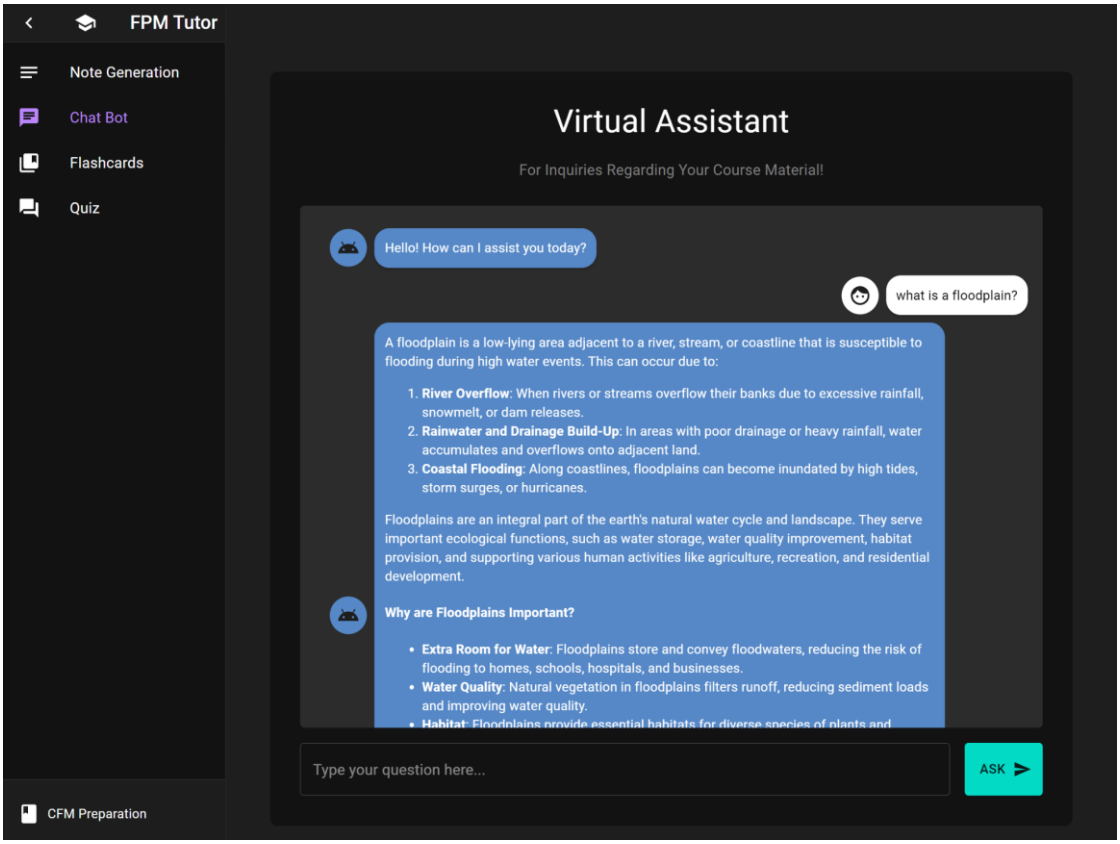

Figure 4: Interactive virtual learning assistant (chatbot) interface and sample question

The dynamic notes generation feature shown in Figure 5 automatically summarizes key information from course materials, quizzes, and user interactions. The interface presents these notes in an organized, easy-to-read format, allowing users to quickly review important topics and streamline their study process. This feature is particularly useful for consolidating large amounts of information into concise, actionable notes.

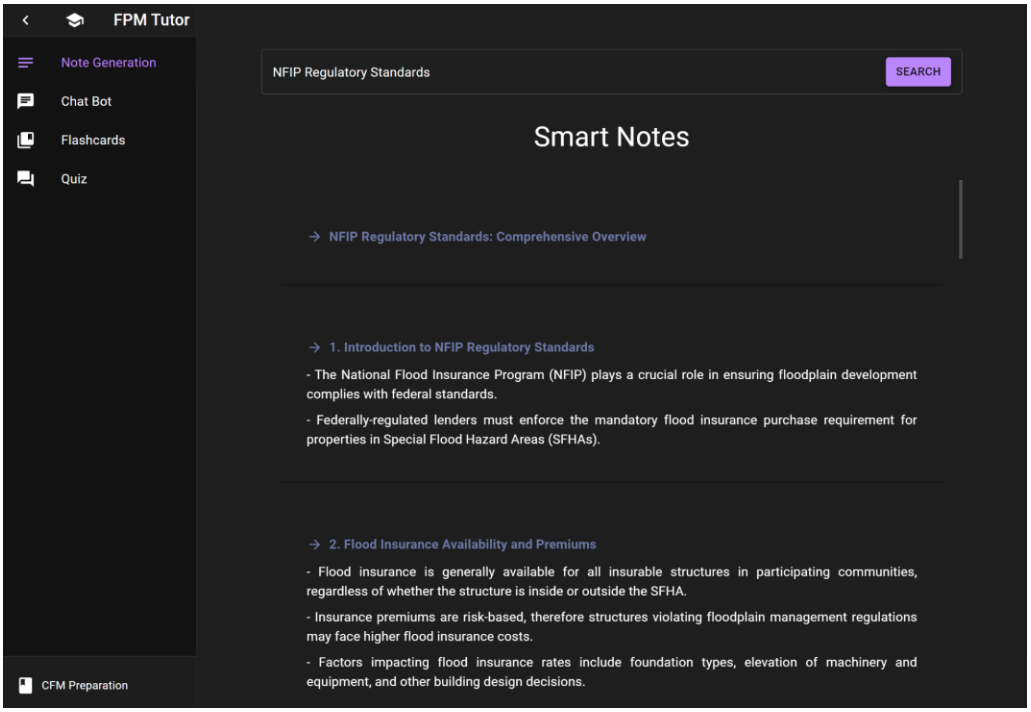

Figure 5: Dynamic notes generation interface with topics and summaries

4.2. Evaluation Methodology

The evaluation of the FPM educational tool's effectiveness was conducted using a structured approach to measure the tool's accuracy in answering both open-ended and multiple-choice questions. To assess the tool's performance, we focused on its ability to provide correct answers compared to a set of known correct answers. For the evaluation, we used the following definitions: a) **Correct (positive answer):** The tool provides the correct response; b) **Incorrect (negative answer):** The tool provides an incorrect response. The accuracy of the tool was calculated (Eq. 1) based on the proportion of correct answers out of the total number of questions:

$$Accuracy = \frac{Total\ Correct\ Answers}{Total\ Number\ of\ Questions} \qquad \text{Eq. 1}$$

where a) **Total Correct Answers** = The number of questions for which the tool provided the correct response; b) **Total Number of Questions** = The total number of questions (including both open-ended and multiple-choice questions) used in the evaluation.

4.3. Open Ended questions

In this section of the evaluation, we tested the FPM educational tool's ability to answer 145 open-ended questions. These questions were categorized based on the core topics covered in the CFM exam, as outlined by the ASFPM. The question categories were designed to mirror the structure of the actual exam and ensure that the tool's responses reflected a realistic test scenario (Table 2).

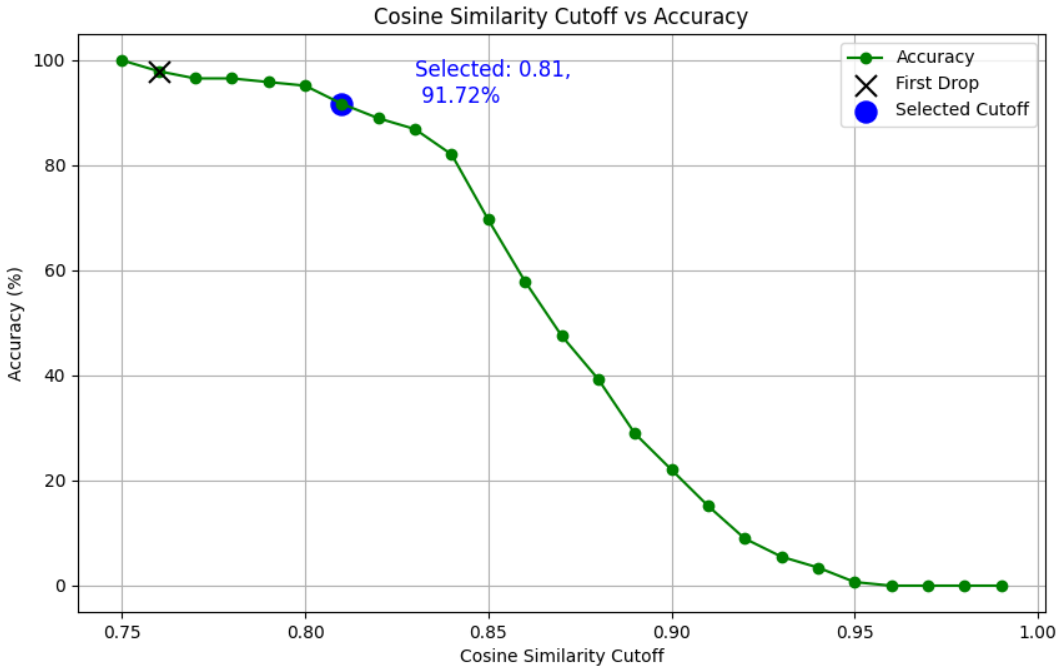

Figure 6: Cosine Similarity vs Accuracy

We manually evaluated the tool's performance by checking the accuracy of its responses compared to the correct answers, achieving a 91.03% accuracy based on manual evaluation. Additionally, we used cosine similarity to further assess the tool's performance. Cosine similarity measures how closely the tool's responses align with the correct answers. An average cosine similarity of 0.864 was observed across all responses, indicating a high level of similarity between the tool's answers and the correct answers.

To automate this process for scalability and consistency, we explored the accuracy across different cosine similarity cutoffs, as shown in Figure 6. Through experimentation, we found that at a cosine similarity cutoff of 0.81, the results closely matched the manual accuracy, which was approximately 91.03%. Therefore, we chose this threshold as the most appropriate for automating the evaluation of the open-ended questions. Figure 6 illustrates the relationship between different cosine similarity cutoffs and the resulting accuracy. As seen at a cutoff of 0.81, the system achieved an accuracy of 91.72%, which aligns closely with the manual evaluation process. This cutoff was selected for future automated assessments.

4.4. Multiple Choice Questions

In the multiple-choice section of the evaluation, the tool was tested on 67 questions derived from the NFIP 101 course and other relevant study materials. As with the open-ended questions, these multiple-choice items were categorized according to core topics from the CFM exam, as outlined in Table 3. This approach allowed us to assess the tool's performance in an exam-like setting, offering a realistic evaluation of its ability to handle structured questions. Table 4 provides a detailed breakdown of the tool's accuracy by category. The tool achieved 100% accuracy in several areas, including *Flood Insurance*, *Flood Hazard Mitigation*, *Natural and Beneficial Functions*, and the *Overall Context of Floodplain Management*.

These results suggest that the tool is particularly effective in answering questions related to flood insurance policies, mitigation strategies, and overarching floodplain management principles. In some categories, such as *Floodplain Mapping* (92.31%), *NFIP Regulatory Standards* (91.67%), and *Regulatory Administrative Procedures* (90.91%), the accuracy was slightly lower but still strong. The tool demonstrated a strong performance in this section, achieving an overall accuracy of 95.52% for multiple-choice questions, showcasing its reliability in handling structured, exam-based queries.

Table 4: Accuracy per Category

Category	**# of Questions**	**% of Category**
Floodplain Mapping	13	92.31%
NFIP Regulatory Standards	12	91.67%
Regulatory Administrative Procedures	11	90.91%
Flood Insurance	9	100%
Flood Hazard Mitigation	6	100%
Natural and Beneficial Functions	1	100%
Overall Context of Floodplain Management	15	100%
Total	**67**	**95.52%**

4.5. Discussions

The evaluation results demonstrate the FPM educational tool's significant effectiveness in preparing candidates for the FPM certification exam. With a high accuracy of 91.72% for open-ended questions and 95.52% for multiple-choice questions, the tool has proven to be an invaluable resource for users. By integrating personalized study methods such as dynamic flashcards and adaptive quizzes, the tool offers a customized learning experience, helping candidates focus on areas that need improvement while reinforcing key concepts. This tailored approach ensures that users are better prepared for the range of topics covered in the CFM exam, providing them with the knowledge and confidence needed to succeed.

When compared to traditional study methods, the AI-powered tool offers clear advantages. Traditional methods, such as reviewing static course materials or manually creating flashcards, are often time-consuming and less adaptive to the user's progress. In contrast, the tool

dynamically adjusts content based on performance, making it a more efficient and targeted study aid. The ability to receive immediate feedback on quizzes and answers further sets this tool apart from traditional methods, as it enables continuous self-assessment and real-time correction of knowledge gaps. This adaptability, combined with personalized learning experience, makes the tool a more modern and effective approach to exam preparation.

The broader implications of this tool suggest that AI-powered educational tools have great potential in vocational and professional certification training. As the demand for specialized skills grows, such tools offer a scalable solution for preparing individuals for certification exams in various fields. By integrating AI capabilities such as NLP and real-time content retrieval, these platforms can provide tailored learning experiences, making them highly effective in meeting the needs of vocational learners. The FPM educational tool serves as a model for how AI-driven systems can streamline certification preparation, ultimately enhancing the quality of vocational training and making it more accessible.

However, there were several challenges and limitations encountered during the development and deployment of the tool. One of the primary technical challenges was the acquisition and integration of both national-level and state-level data. While the NFIP 101 course provided a solid foundation at the national level, collecting state-specific floodplain regulations was more difficult due to inconsistencies in how the information was presented across different states. Another challenge was the lack of open datasets for testing the tool, as no public CFM exam datasets were available. This led to reliance on platforms like Quizlet and the NFIP 101 course to gather questions for evaluation purposes.

The tool's current implementation also has certain limitations. While the tool demonstrates high accuracy in generating correct answers, it relies heavily on cosine similarity for evaluating open-ended responses. Although this approach works well for measuring lexical overlap, it may not always capture the full nuance of complex regulatory questions or measure semantic accuracy. Commonly used evaluation metrics such as BLEU (Papineni et al., 2002) and ROUGE (Lin, 2004) were not employed here, as they tend to prioritize exact matches over the meaning of responses. These metrics often penalize valid answers that use different wording or paraphrasing. BLEU and ROUGE also struggle to assess fluency and grammatical correctness, which is crucial when evaluating responses to open-ended questions. By contrast, cosine similarity provides a better balance for this specific context, though future improvements may involve more sophisticated methods to evaluate both lexical and semantic aspects of the tool's responses.

5. Conclusion

The development and implementation of the FPM educational tool marks a significant advancement in the use of AI-powered technology for floodplain manager certification exam preparation. Designed to provide aspiring floodplain managers with a personalized and adaptive learning experience, the tool incorporates features like dynamic flashcard generation, adaptive quizzes, and real-time chatbot support. Through a rigorous evaluation process, the tool demonstrated a high level of accuracy in answering both open-ended and multiple-choice

questions, achieving 91.03% and 95.52% accuracy, respectively. This, along with positive user feedback, confirms that the tool is an effective resource for preparing candidates for the CFM exam.

The tool's success highlights its impact on FPM certification preparation, offering a more efficient and personalized approach to studying. By focusing on the core topics of the CFM exam and providing targeted practice and feedback, the tool simplifies the preparation process, helping users identify knowledge gaps and focus on areas where improvement is needed. Beyond the FPM context, this development illustrates broader implications for vocational and professional training. The integration of AI-driven educational tools can significantly enhance learning outcomes, providing a scalable solution for certification and skills development in various professions.

Several enhancements and upgrades are planned for future versions of the tool, based on user feedback and identified limitations. Planned improvements include more detailed explanations for complex regulatory topics, expanded customization options for quizzes, and enhancements in the natural language understanding capabilities of the chatbot. Additional features, such as topic-specific study modes and questions adjusted for difficulty, are also being considered to further personalize the user experience and continue meeting the evolving needs of future users.

While the FPM educational tool was developed specifically for floodplain management certification, its underlying architecture and functionality hold potential for broader applications. Similar AI-powered study tools could be applied to other vocational and professional certification exams, including fields such as environmental management, disaster response, and public safety. The scalability of the tool's design opens up opportunities for expansion into certification in different countries in the world, and different certification domains, allowing it to provide tailored study resources to a wider range of learners. Future research and development efforts could explore these possibilities, expanding the tool's utility and impact across multiple industries.

The integration of AI-driven virtual assistants in professional education represents a transformative shift in how vocational training and certification preparation are approached. The FPM educational tool exemplifies the potential of these technologies to improve learning outcomes by offering a more personalized, interactive, and efficient study experience. As the demand for specialized skills continues to grow, tools like this will play an increasingly important role in meeting the needs of both learners and industries. The future of vocational training lies in harnessing AI to create customized learning experiences that empower individuals to succeed in their professional development.

6. Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this manuscript, the authors used ChatGPT, based on the GPT-4 model, to improve the flow of the text, correct grammatical errors, and enhance the clarity of the writing. The language model was not used to generate content, citations, or verify facts. After

using this tool, the authors thoroughly reviewed and edited the content to ensure accuracy, validity, and originality, and take full responsibility for the final version of the manuscript.

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8. Credit Author Statement

Ramteja Sajja: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data Curation, Writing - Original Draft, and Visualization. **Vinay Pursnani**: Conceptualization, Validation, Formal analysis, Investigation, and Data Curation. **Yusuf Sermet**: Conceptualization, Methodology, Writing - Review & Editing, Investigation, Validation, and Visualization. **Ibrahim Demir**: Conceptualization, Methodology, Writing - Review & Editing, Project administration, Supervision, Funding acquisition, and Resources.

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