

Empowering Secondary School Teachers: Creating, Executing, and Evaluating a Transformative Professional Development Course on ChatGPT

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Abstract—Background and Context. This innovative practice full paper describes the development and implementation of a professional development (PD) opportunity for secondary teachers to learn about ChatGPT. Incorporating generative AI techniques from Large Language Models (LLMs) such as ChatGPT into educational environments offers unprecedented opportunities and challenges. Prior research has highlighted their potential to personalize feedback, assist in lesson planning, generate educational content, and reduce teachers' workload, alongside concerns such as academic integrity and student privacy. However, the rapid adoption of LLMs since ChatGPT's public release in late 2022 has left educators, particularly at the secondary level, with a lack of clear guidance on how LLMs work and can be effectively adopted.

Objective. This study aims to introduce a comprehensive, free, and vetted ChatGPT course tailored for secondary teachers, with the objective of enhancing their technological competencies in LLMs and fostering innovative teaching practices.

Method. We developed a five-session interactive course on ChatGPT capabilities, limitations, prompt-engineering techniques, ethical considerations, and strategies for incorporating ChatGPT into teaching. We introduced the course to six middle and high school teachers. Our curriculum emphasized active learning through peer discussions, hands-on activities, and project-based learning. We conducted pre- and post-course focus groups to determine the effectiveness of the course and the extent to which teachers' attitudes toward the use of LLMs in schools had changed. To identify trends in knowledge and attitudes, we asked teachers to complete feedback forms at the end of each of the five sessions. We performed a thematic analysis to classify teacher quotes from focus groups' transcripts as positive, negative, and neutral and calculated the ratio of positive to negative comments in the pre- and post-focus groups. We also analyzed their feedback on each individual session. Finally, we

interviewed all participants five months after course completion to understand the longer-term impacts of the course.

Findings. Our participants unanimously shared that all five of the sessions provided a deeper understanding of ChatGPT, featured enough opportunities for hands-on practice, and achieved their learning objectives. Our thematic analysis underlined that teachers gained a more positive and nuanced understanding of ChatGPT after the course. This change is evidenced quantitatively by the fact that quotes with positive connotations rose from 45% to 68% of the total number of positive and negative quotes. Participants shared that in the longer term, the course improved their professional development, understanding of ChatGPT, and teaching practices.

Implications. This research underscores the effectiveness of active learning in professional development settings, particularly for technological innovations in computing like LLMs. Our findings suggest that introducing teachers to LLM tools through active learning can improve their work processes and give them a thorough and accurate understanding of how these tools work. By detailing our process and providing a model for similar initiatives, our work contributes to the broader discourse on teaching professional educators about computing and integrating emerging technologies in educational and professional development settings.

Index Terms—K-12, large language models, chatgpt, professional development, secondary education

I. INTRODUCTION

Easily-available Large Language Models (LLMs) like ChatGPT¹ and Gemini² have become increasingly prevalent in

¹<https://openai.com/chatgpt>

²<https://gemini.google.com/>

the global discourse and various sectors of society following their respective public releases in November 2022 [1] and March 2023 [2]. One of these sectors is education. Although AI's involvement and impact on education are not new, and initiatives like AI4K12³ have been promoting AI literacy in classrooms, there are still limited resources for teachers to make informed decisions on AI's recent advances, such as LLMs. While research on AI and LLMs in education has increased remarkably, there is still a gap in strategies for helping teachers use LLMs effectively in classrooms.

To the best of our knowledge, there were no comprehensive, freely accessible, and vetted resources available for instructors, especially at the secondary level, to understand how to integrate LLM tools like ChatGPT into their curricula and workflows when we initiated this workshop in the summer of 2023. As it stands, there are still few resources for this population, particularly ones that include supplementary materials for instructors, like lesson plans and available slides. Motivated by AI literacy movements and the aforementioned gaps, we aimed to help teachers learn about LLMs for their own professional development and impart this knowledge responsibly to their students and peers.

With these goals in mind, we created these workshops to be accessible for instructors across disciplines, featuring an array of support materials, including lesson plans, slides, activities, discussions, and interactive learning opportunities. We designed these materials with the broader goal of contributing to existing AI literacy efforts and resources for teachers on LLMs. We evaluated the effectiveness of these workshops through post-workshop surveys, interviewing teachers about ChatGPT before and after the workshops, interviewing teachers a few months after the workshop, and conducting a thematic analysis of the results. In conclusion, our findings indicate a successful intervention, demonstrating that teachers left with a substantially better understanding of ChatGPT and actionable plans for both personal use and classroom implementation.

II. RELATED WORK

A. LLMs in Education

Prior research has discussed a blend of LLMs' advantages and challenges for both educators and learners. To date, the majority of existing studies have focused on the benefits of integrating ChatGPT for students. Murgia et al. noted ChatGPT's capacity as a good resource within classrooms, which provides scaffolding for students' research processes [3]. Similarly, Tlili et al. noted ChatGPT's capability to assist students and create strong resources for in-class use [4]. Despite acknowledging the challenges and the need for caution, they supported the integration of ChatGPT in education. With a more cautious viewpoint, Vázquez-Cano et al. stated that while ChatGPT is a valuable support tool for students, it should not substitute for authentic learning [5]. In another commentary, Kasneci et al. discussed the opportunities and challenges of LLMs—they

mentioned LLMs' potential to enhance student engagement and personalize the learning experience while acknowledging concerns about output bias and misuse of these tools [6]. Despite the rising number of studies focusing on LLMs' impacts on education, those examining their effects on teachers specifically appear to be scarce. Kostka and Toncelli suggest that teachers should be encouraged by their institutions to engage with AI for all parts of their work, like curriculum design and decision-making [7]. However, there is a need for more research to understand the LLMs' impacts on teachers.

B. LLMs in Professional Development Opportunities and Resources

Professional development (PD) and career training offer teachers the opportunity to discover new resources, technologies, and methods to enhance their work processes and student learning. Prior research has found that structured PD opportunities have positive benefits for teachers, resulting in increased efficacy and knowledge [8] [9]. With an increase in the usage of LLMs like ChatGPT in the daily lives of millions around the world, there has been a surge in resources available for those eager to learn about these tools. For example, OpenAI has released a free guide on prompt engineering strategies [10] and has collaborated with DeepLearning.AI to create a short course on ChatGPT prompt engineering for developers [11]. However, access to some resources is restricted by payment requirements.

Universities like UNC, MIT, Vanderbilt, and Purdue have created online courses about AI and LLMs at different price points [12] [13] [14] [15]. Although these materials do come from reputable sources, we could not find university-sponsored courses on LLMs for educators. This gap pushes instructors seeking that knowledge to rely on less credible sources. Numerous resources for learning about ChatGPT in education have been developed by individuals and private organizations. For instance, a course on Udemy, "ChatGPT for Teachers: The Ultimate Guide to Simplifying Life," is available for \$109.99 [16]. Some websites like 'GPT for Educators'⁴ and 'ChatGPT for Teachers'⁵ provide a mix of free and paid materials for teacher education. ChatGPT's classroom integration is also discussed on platforms like LinkedIn [17], and various YouTube channels and Facebook groups that offer additional learning opportunities. However, these resources often lack a structured, easy-to-understand format for newcomers and are frequently not free. To address this issue, our workshop aimed to provide secondary teachers with evaluated, structured, and comprehensive resources to enhance their knowledge of LLMs, particularly ChatGPT, without the financial burden.

III. WORKSHOP DESIGN

Our workshops were developed using principles of effective teacher professional development, which have been used in prior professional learning workshops conducted for secondary teachers learning computational thinking [18], [19]

⁴<https://gptforeducators.com>

⁵<https://chatgptforteacherscourse.com>

³<https://ai4k12.org/>

and computer science [20], [21]. Specifically, we focused on highlighting content (specific ChatGPT concepts and skills), active learning (via the ICAP framework as mentioned below), and coherence through reflection and teachers focusing on their own practice. Research shows that these features can lead to increased teacher plans for classroom adoption [22].

We designed the workshops to include individual and group work, as well as individual reflections and group discussions, based on the ICAP active learning framework. The ICAP framework predicts that learning increases as learners transition from passive engagement to active, constructive, and finally interactive engagement [23]. The workshops were also crafted around specific learning goals and objectives [24], aligned with specific levels of Bloom’s taxonomy [25]. They were for a cohort of teachers participating in a summer research experience that also required them to develop classroom activities for their own classrooms. Therefore, we took a project-based learning approach where each workshop scaffolded the development of specific skills and led to a final project for teacher classroom activity creation [26]. Research has shown that the specific demonstration and teaching of project-based learning in teacher professional development leads to more integration of 21st-century skills into classroom teaching [27]. ChatGPT assisted in developing workshop outlines and some content, demonstrating to teachers in a meta way its potential as a valuable tool in curriculum design. For each workshop, we created a slide deck and associated lesson plan, which we shared with the teachers. We also made Piazza discussion forums [28] for the teachers to share their thoughts and work with each other throughout the workshops, in addition to our facilitating in-person group discussions. Below, we discuss each workshop’s layout, contents, and learning objectives (LOs) in more detail.⁶

a) Workshop 1: Introduction to ChatGPT: LO: Teachers will gain a foundational understanding of ChatGPT and its potential applications in the classroom. Teachers will learn how to formulate effective prompts to elicit desired responses from ChatGPT. Participants learned about ChatGPT, its basic capabilities and limitations, and how to use it. Participants were introduced to prompt engineering techniques, such as few-shot prompting [29] and the flipped interaction pattern [30]. They were also introduced to basic principles for effective ChatGPT use, like decomposing questions and being specific. Other LLM tools like BingAI were presented, and GPT 3.5 and 4 were compared. Finally, participants made their own lesson plans using ChatGPT, including LOs, materials, and procedures.

b) Workshop 2: ChatGPT and Classroom Ethics: LO: Teachers will understand the ethical considerations, risks, and responsibilities associated with using ChatGPT in the classroom. Participants learned about the risks and responsibilities associated with ChatGPT use. Specifically, participants discussed the biases and limitations of ChatGPT, as well as

⁶All of our materials are accessible, at no cost, via the following link: <https://sites.google.com/ncsu.edu/chatgpt-workshop/home>.

TABLE I
TEACHER PARTICIPANT DEMOGRAPHICS

#	Gender	Race	Age	Experience	Grade Levels	Subject
P1	Female	Asian	55-64	6-10 years	6-8	Science
P2	Female	White	25-34	1-5 years	6-8	Animal Science
P3	Female	Black	45-54	16-20 years	9-12	Mathematics
P4	Female	Black	55-64	16-20 years	9-12	Computer Science
P5	Male	White	35-44	16-20 years	6-8	Social Studies
P6	Male	Black	55-64	20+ years	9-12	Design

ethics and responsible use for both teachers and students. Participants discussed sources of biases and limitations and worked with ChatGPT to create hallucinated information (i.e., a nonsensical or inaccurate generated output [31]). Participants then tested ZeroGPT, a free tool that claims to be able to recognize generated text [32]. Participants also discussed academic dishonesty and misconduct in the classroom. Participants concluded by using ChatGPT to create AI-usage guidelines for their classrooms.

c) Workshop 3: ChatGPT for teaching: LO: Teachers will explore various ways to integrate ChatGPT as a resource in their teaching practice. Participants learned about more specific ways to incorporate ChatGPT into their classrooms based on their disciplines, using design principles derived from the 3C (Code, Connect, Create) teacher professional development model for integrating computing into other disciplines [18]. Participants learned how to generate problems (quizzes) with ChatGPT, as well as some of the issues with the process, like ChatGPT’s previous knowledge cutoff date (i.e., the fact that, at the time of our workshops, it had not been updated with information past September 2021 [33]). Participants finished by creating essay prompts, grading rubrics, and evaluating essays with ChatGPT.

d) Workshop 4: AI impacts on education: LO: Teachers will reflect on the impact of AI on education and envision potential future scenarios. Participants were reminded of ways that AI can be introduced to the classroom and then went through a guided activity to create an AI “tutor” via ChatGPT. This was done via an elaborate prompt that set up a figure called Mr. Ranedeer [34], which primed ChatGPT to answer students’ queries based on parameters like the student’s grade. Participants finally discussed the limitations of these tools, as well as their thoughts on using AI tutors in the classroom.

e) Workshop 5: Projects: LO: Teachers will apply their knowledge and skills by using ChatGPT to address a specific educational challenge. Participants worked on their final project: to create a lesson on ChatGPT, using ChatGPT, for their classrooms. After considering their topics and generating lesson plans using ChatGPT, teachers manually revised the plans and created student activities for their lessons. This workshop was primarily working time for participants, who finished by presenting their presentations to each other. We elaborate on these presentations in Section V and Table IV

IV. RESEARCH METHODS

A. Workshop implementation

As our participants were also participating in other events, we determined the best schedule would be over the course of four days. Consequently, our third and fourth workshops were held on the same day. The workshops were held in person in two mid-sized classroom spaces that allowed for the presentation of our slide decks.

1) *Workshop facilitators:* The workshops were facilitated by three of the researchers, who were all graduate students. Our first two workshops were presented in person by two of these students, while the remaining three workshops were presented by the third graduate student via Zoom. For these three workshops, the other two graduate student researchers were physically present to support the in-person audience.

2) *Participants:* Teacher participants were involved in a six-week summer research experience at the university in which these workshops were being held. Participants applied for the opportunity to be involved in the summer research experience, which included other PD opportunities beyond this workshop series. A total of six secondary teachers consented to participate in these workshops. These teachers taught mathematics, science, design, and social studies. Demographic information for each participant is presented in Table I.

B. Surveys and Interview Protocol

After each workshop, we requested that participants answer a brief survey about their thoughts on the clarity, relevance, and engagement of the workshops, as shown in Table II. In addition to these questions, we asked participants whether the workshops provided them with a deeper understanding of ChatGPT, had enough opportunities for hands-on practice and practical application, had clearly communicated and achieved workshop objectives, and if they would recommend the session to a colleague. Finally, participants were asked open-ended questions about the aspects of the workshops they found most valuable and the areas needing improvement.

We also conducted two focus groups (i.e., a group interview centered on a specific topic [35]) with our participants. We believed that our secondary education teacher participants would benefit from being able to relate to their peers' anecdotes and experiences [20]. Consequently, we chose to interview our participants via focus groups before and after the workshops. In both focus group sessions, we asked participants about their understanding of ChatGPT, their thoughts on its potential impacts, and their perceptions of the benefits and drawbacks of use, both as a teacher and a student. We also asked participants about what they were interested in learning about ChatGPT prior to the workshops, as well as what they had learned about ChatGPT after the workshops.

For the pre-workshop focus group, all six participants were interviewed together in person by two researchers: one asked questions, and the other recorded notes and asked follow-up questions as appropriate. In the post-workshop focus group, five participants were interviewed in the same room, while

one joined via Zoom (but was able to hear other participants' thoughts and contribute their own). A video of the session was captured via a laptop, and a transcript was automatically transcribed and then later corrected in multiple rounds by the researchers.

In late November 2023 (i.e., approximately five months after the workshops were conducted), the six participants were individually interviewed via a semi-structured format over Zoom by the aforementioned two researchers. Each participant was asked to discuss the longer-term impacts of the workshop series on them, focusing on how the workshops had impacted their careers and professional development, their leadership, their understanding of CS, their teaching practices, and their students' learning outcomes. Additionally, participants were asked whether they had been able to integrate LLMs and their final projects (referenced in Table IV) into their classrooms, and what successes or barriers they had faced in doing so.

C. Methods of Analysis

We conducted an inductive thematic analysis on our focus groups [36]. To do this, two researchers tagged each of the focus group transcripts independently, then came together to discuss and reconcile a single set of tags to represent each transcript. This resulted in a list of 86 individual tags across both focus groups. Then, the researchers grouped the tags into five major themes: concerns and negative attitudes, support and positive attitudes, neutral comments and attitudes, suggestions for ChatGPT's improvement, and impressions and takeaways. During our analysis, we focused on the first three themes listed to better understand how participants' sentiments and attitudes toward ChatGPT shifted over time. We focus on the remaining two themes in our discussion.

Of the nine survey questions asked, five were Likert scale questions ranging from Extremely Negative to Extremely Positive. Respondents' answers to these were converted to a 1 to 5 scale and averaged to create a relative score of quality for each question and workshop. Given the low number of responses for each question, we did not attempt to calculate significance. For questions using yes/no/maybe responses, we report the number of each response. As the fifth workshop did not have structured content, we did not offer a post-workshop survey for this workshop.

We also conducted a deductive thematic analysis of long-term follow-up interviews. We defined a set of themes based on the interview questions. More specifically, we analyzed each teacher's interview to find if the workshop's impacts on their career/professional development, leadership, CS understanding, teaching practices, and student performance/learning outcomes were positive, neutral, or negative. We also investigated whether they had positive or neutral takeaways from the workshop, successes in incorporating LLMs in the classroom or barriers, and successes in implementing lesson plans or barriers.

TABLE II
AVERAGE LIKERT SCORES ON WORKSHOP SATISFACTION (N=4-6)

Workshop Topic	Clarity	Structure	Engaging	Applicable	Avg.
W1: Introduction to ChatGPT	4.6	4.8	5	4.8	4.8
W2: ChatGPT Ethics	3.8	4.67	4.67	4.67	4.33
W3: ChatGPT for Teaching	4.83	4.67	4.5	4.83	4.43
W4: ChatGPT Impacts on Education	4.5	4.5	4.25	4.5	4.45
Average rating	4.43	4.66	4.61	4.7	

TABLE III
THE NUMBER OF QUOTES WITH SUPPORT OR POSITIVE ATTITUDES, OR CONCERNS/NEGATIVE ATTITUDES TOWARDS CLASSROOM LLM USE IN TEACHER FOCUS GROUPS PRE- AND POST-WORKSHOP.

	Support (+)	Concerns (-)	% Positive
Pre-Workshop	32	39	45%
Post-Workshop	55	26	68%

V. RESULTS

A. Surveys

Although not every participant responded to every survey, we received overwhelmingly positive responses to the workshops, presented in part in Table II. Results from our Likert scale questions show that participants felt our workshops contained satisfactory content, clear materials and presentations, and good organization and structure. For questions using yes/no/maybe responses, we found that, with the exception of one “maybe” in response to whether the participant would recommend workshop 4 to a friend, all participants agreed with our questions (i.e., answered “yes”).

B. Focus Groups

Table III presents a comparison of the quantities of quotes with positive and negative connotations alongside the proportion of positive quotes relative to the total number of positive and negative quotes combined. We define a quote as an uninterrupted speaking sequence from one participant. Notably, this proportion increased from 45% in the initial focus group to 68% in the final one. We present our tags divided by valance (i.e., negative and positive) in Figure 1; note that areas of overlap indicate themes that were found in both before and after the workshops were conducted.

During our pre-workshop focus group, we found that our participants had a limited understanding of ChatGPT and many accompanying concerns. Only one participant, P5, noted that he had had little experience with ChatGPT, having used the tool in class with his students while exploring the accuracy of its results. P1 stated that she had witnessed an academic misconduct case involving ChatGPT (a student had copied a generated essay from the tool). Two participants, P4 and P2, noted that they had almost no understanding of ChatGPT. Two participants, P3 and P6, expressed interest and optimism in the tool, albeit with a limited understanding of it.

During our analysis of the pre-workshop focus group, we found that there were more negative attitudes toward ChatGPT

than positive attitudes. In this session, participants mainly discussed their concerns about academic misconduct. They also pointed out not knowing their school districts’ policies toward ChatGPT and trusting in their ability to teach ChatGPT usage responsibly. For instance, P2 noted that “*I’m not comfortable enough with it to be like, ‘Oh, I trust that I could teach this in like a safe way,’ instead of being like the teacher who taught them how to use ChatGTP [sic], and now there’s like a rampant problem around the school.*” P1, P4, and P5 were concerned that the use of ChatGPT may hinder students’ critical thinking skills.

During our second focus group, we found that there were more positive attitudes toward ChatGPT than negative attitudes. P6 stated, “*I learn more and more about it. I can really start to see how it can really be a benefit to education and to schools and the students and the teachers.*” Participants also shared how their attitudes had shifted over the course of the workshops: P5 shared that “*[M]y original fear of the skill sets disappearing has been replaced with kind of like, it’s a new tool for them to use; we just got to teach them how to use it.*” Several participants shared their hope that ChatGPT will be utilized for positive purposes, such as reinforcing critical thinking. For example, P4 shared that “[...] I was thinking, like we – they can use it, they have to verify the information so that will put them into the habit of verifying and checking validity and then making that a habit, as opposed to just going with what the results return.”

Our post-workshop focus group featured nearly the same number of neutral statements toward ChatGPT in education—it included comments on ChatGPT, how ChatGPT compared to other resources like Wikipedia, and the importance of verifying information and critical thinking skills. Nevertheless, an interesting shift was observed in the nature of some neutral comments. For instance, prior to the workshop, P6 stated, “*We have to make sure we’re teaching those tools of discernment and critical thinking.*” This evolved into more positive remarks in the post-workshop discussions, such as “*At first. I was thinking that the critical thinking part was gone, but I think [it] is actually enhanced.*” Overall, we observed that teachers’ comments and approaches toward ChatGPT became more nuanced, and teachers, after the workshops, began to think more about ChatGPT’s impacts on student learning outcomes and how they could have a proactive influence on students’ tool usage.

In concluding our second focus group, we found that all of our participants were either interested in continuing to use

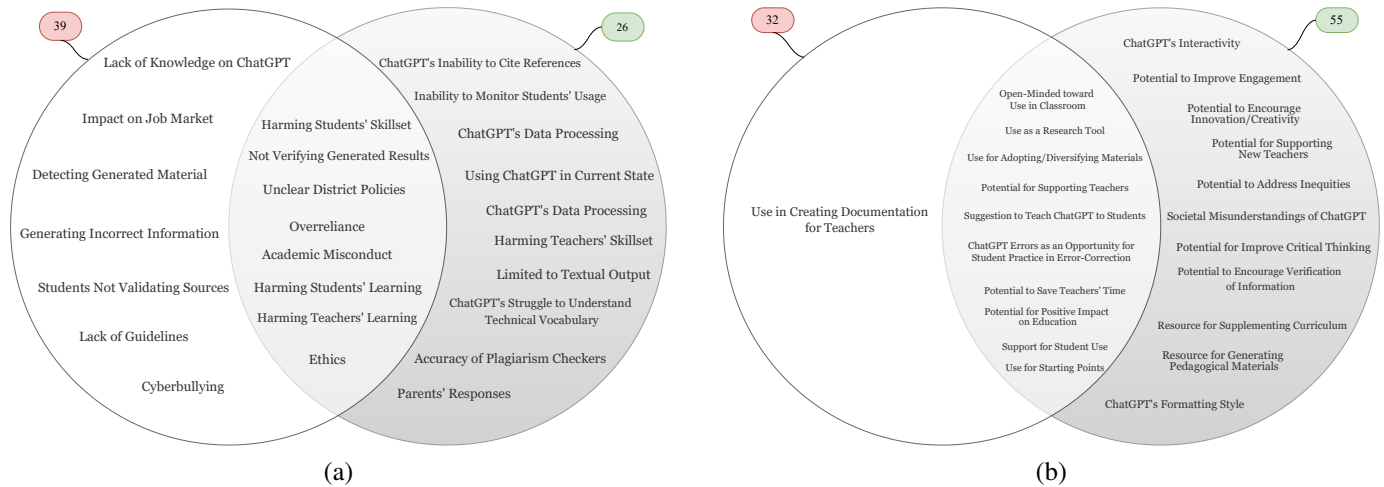


Fig. 1. (a) Concerns and Negative Attitudes and (b) Support and Positive Attitudes about ChatGPT: Pre-Workshop (left), Post-Workshop (right), Common (center). The numbers above each circle display the aggregate count of quotes related to the tags inside the circle.

or learn about ChatGPT in the future. They expressed interest in learning more about equity in AI (P6, P2, P5), as well as more benefits for students (P3). Additionally, our participants shared that they appreciated the structure and content of our workshops. P4 shared that “*I just think about the access to the information that I did not have because where would I find that information or that structured and that organized without [ChatGPT].*” P2 noted how, unlike most PD opportunities, which she described to be useless or a waste of time, “[*With this [workshop] I’m like, ‘Oh, I feel like we all need to know about it; this is a huge, huge, potential benefit.’*” P3 noted the benefits of learning prompt engineering: “*I feel like I learned the basics that now I can play with and learn different prompts to go in other directions with.*”

We note here that five weeks after these workshops, during a campus summer symposium intended to showcase anything that they had learned from their two-month research experience and intended to take back to their classrooms, all six teachers chose to discuss their plans to use their ChatGPT-based lesson plans with their students. The titles and short descriptions of participants’ projects are provided in Table IV.

C. Long-term follow-up interviews

Below, we present the results of the analysis of our long-term follow-up interviews, conducted approximately five months after the workshop series concluded. We organize these findings around our interview questions.

a) Impacts on Career and Professional Development:

Almost all (5/6) participants shared that the workshop series had a positive impact on their career or professional development. Speaking about the opportunity to learn about ChatGPT, P1 shared, “*It has saved my life a lot, I can assure you on that. So I’m really thankful to you all.*” This was because P1, who had initially been very skeptical of ChatGPT (as discussed in Section V-B), found that the tool was extremely useful to her workflow, helping her to save time answering questions, helping students for whom English was

not a first language, and generating assignments. P3 shared that she found the professional development opportunity to be empowering for both herself and her students: “*Improving my professional development practice, and having a deeper kind of understanding of the tools that are out there that could benefit my students as well as benefit me as a teacher—I guess in a way that is benefiting my career, because we teach to empower our students and make sure that they are learning [...] We teachers are always trying to explore other alternatives to help students master content and have a deeper understanding of the material.*”

P3 went on to say that the workshops inspired her to seek out further information from online programs to learn more about ChatGPT and other AI software that would allow her to support her students. Similarly, P4 and P6 noted that they had also continued to seek new information on LLMs and AI as a result of the program giving them a foundation upon which to build, and P5 shared that he had used ChatGPT to his benefit in pursuing a master’s degree as a result of the program.

Only one participant, P4, mentioned that the series had a neutral impact on her career. This was because she had begun working in a primarily administrative role during the school year; however, she did note that the workshops “*provided another tool that [she] can share with [the] teachers to use in their classrooms.*”

b) Impacts on Leadership: Similarly, the majority (5/6) of participants shared that the workshop series had a positive impact on their leadership skills. This was because the teachers were able to share their knowledge with their colleagues and students with more confidence than before. P3 noted that “*Anytime you gain knowledge on something that you can share with others, it has the potential to affect your ability to lead on the information that you are giving others.*” P6 shared how the workshops helped him to feel more in control of his experience due to the workshops: “*I’ve always been sort of an end user for computer stuff. So I know how to use a lot of different software and graphic stuff and different things [...] but nothing about*

TABLE IV
TEACHER PARTICIPANT FINAL PROJECTS FOR THEIR STUDENTS

	Final Project Title	Description
P1	ChatGPT in Middle School Science Classroom	ChatGPT's use, advantages, challenges, and the need for critical thinking and information verification.
P2	ChatGPT Activity: Animal Science	Introduction to ChatGPT, benefits, drawbacks, and engaging students with a critical assessment of information
P3	Math + ChatGPT: Math 1 Linear Functions	ChatGPT's pros and cons in linear functions, and AI's role in understanding math concepts and enhancing learning.
P4	Introduction to ChatGPT for Grades 9-12	ChatGPT's capabilities, limitations, and engaging students with ethical implications in various industries.
P5	Unveiling the Mystery of ChatGPT and AI	Introducing ChatGPT's capabilities and limitations, and engaging students with critical thinking and discussion about AI technologies
P6	Career Planning & PATHWAYS with AI	An activity to receive personalized career recommendations based on student interests, skills, and preferences.

programming. And so I think that was a big piece, just kinda trying to understand how [ChatGPT] works and what it is was huge.” He further detailed how the structure and resources of the workshops allowed him to explore further resources on equity in AI for his community and how it may impact people of color and other marginalized groups, thus allowing him to share with others in his cohort and help diversify the AI space.

c) *Impacts on CS understanding:* All participants shared that the workshop series had a positive impact on their understanding of computer science. Participants primarily shared that this was because they had previously known very little about AI and LLMs. For instance, P2 shared, “I think the workshops really help me understand, at least AI, and how it can relate to classrooms.” P5 shared that the workshops “helped a little bit when we’re talking about the computational thinking and understanding how AI functions in general, and then [the workshops] gave us some good ideas on how to apply a computer science tool to everyday work.”

d) *Impacts on teaching practices:* Four participants pointed out the positive impacts of ChatGPT on their teaching practices, three of whom noted its help in lesson planning. P2 emphasized how ChatGPT helps with ideation and adding variety to her course, mentioning, “[ChatGPT] has helped me come up with a couple of different ideas for games in the classroom. So, I have this whiteboard game that we play for vocabulary now. And we do like charades, too, with the vocabulary.” Meanwhile, P5’s view was neutral; he discussed the proper use of ChatGPT in the classroom and the concept of authenticity but did not mention any specific impact on his teaching practices. P4 was unable to comment as she had not been teaching since the workshop ended.

e) *Impacts on student performance and learning outcomes:* Identifying this theme in interviews was relatively challenging because participants shared their views from different perspectives. Two participants (P2 and P3) discussed how their use of LLMs for designing activities improved their students’ learning. P6 shared that he foresees significant capacity in LLMs for assisting non-traditional students and language learners, especially in personalizing materials.

P5 believed, however, that it is too early to have a clear

understanding of LLMs’ impact on student performance. P1 mentioned that she had not seen any noticeable differences in assessments because students’ screens would be locked during assessments. She also shared that although students were allowed to use LLMs as a resource for their projects, she did not encounter any case of visibly LLM-generated answers. She attributed this to the design of her projects, which required students to write physically. This was also noted by P2 that her projects and assignments are based on designing and creating which are not straightforward to perform with ChatGPT. P4 did not have any personal comments on this matter due to not having taught after the workshop.

f) *Incorporating LLMs in the classroom:* Four participants shared that they had faced barriers in incorporating LLMs into their classrooms. The two primary barriers were district or school-wide restrictions and the ChatGPT minimum age requirement. The former, as faced by P3 and P6, was due to constraints imposed by the schools they worked at. The latter is due to the fact that OpenAI requires that individuals be at least 14 years old in order to use ChatGPT. Consequently, those working with middle-school students were unable to work with ChatGPT.

Some participants did share that they had successfully incorporated LLMs into their classrooms regardless, or had somewhat navigated their limitations. We will discuss this further in the following paragraph.

g) *Implementing designed lessons:* For similar reasons to those mentioned earlier, three participants struggled to implement the lesson plans they had created during the workshop series. Participants who did implement the plans often had to modify them for their real-world classroom contexts. For instance, P3 printed off her conversations with ChatGPT and used them in her classroom, which allowed her to bypass her school’s issue with students using the tool online; however, this limited her to only being able to present her prompts and queries. P5, who worked with middle school students, shared that while he was frustrated at being unable to use ChatGPT due to its age restriction, he was able to implement his lesson

plan using Perplexity.AI⁷, translating the ChatGPT activities to the new LLM tool. However, at least one participant, P1, was able to use her original lesson plan, and P6 successfully delivered his lesson plan to a group of high school students at a summer experience at the same university in which the study was conducted.

h) Overall workshop takeaways: All participants shared that their takeaways from the workshop were positive. P1 highlighted ChatGPT's time-saving benefit. P2 appreciated the introduction to the free LLM detectors introduction in the workshop, which, at the time of the workshop, were not reliable. She also expressed her joy from creating activities with ChatGPT and having students engage with it when appropriate. P3 shared her deeper understanding of ChatGPT after the workshop and mentioned, *"I felt really excited about the project that I initially had planned for my class. So, besides everything else of all this information right at our fingertips, I was just more excited to be able to try something new in my classroom, to engage students and help them really be able to problem-solve and develop deeper thinking practices and find errors in problems."*

P4 mentioned that LLMs' workshop was her first introduction to LLMs, which was delightful for her. She also mentioned she practices with ChatGPT frequently and is keen on finding out how it can be used in other avenues. P5 pointed to the workshop's sections on prompt engineering techniques and hallucinations as parts he found useful. Finally, P6 also shared that the workshop's outcome of how ChatGPT can be used was powerful.

VI. DISCUSSION

A. Lessons Learned

In focusing on the workshops, the feedback from teachers showed that while there is room for fine-tuning, the core structure of our workshops was effective. Simplifying the background and technical terms, presenting guided activities, incorporating relevant video and images into the slides, and prioritizing the applicability of the content over complex theories will be maintained in future iterations. Additionally, the positive feedback for our hands-on activities along with described skills and concepts, introducing how to use ChatGPT as an AI tutor, developing rubrics [37] with ChatGPT, and leveraging the Piazza discussion forum for interactive feedback and discussions, was highlighted in the survey responses.

This study's broader implications revealed a capacity to transform the misconceptions and apprehensions about new technologies like ChatGPT into a more proactive and supportive approach. This transformation was evident in our focus group discussions. For example, the prevalent concerns about academic misconduct were shifted to inquiries about monitoring student activities on ChatGPT, indicating a transition for teachers from concern to a solution-oriented mindset. The post-workshop focus group highlighted ChatGPT's potential as a valuable resource for both educators and students.

⁷<https://www.perplexity.ai/>

B. Limitations

Internal Validity. Several factors within our study design could potentially impact its internal validity. The teachers voluntarily applied to participate in the summer research program, which introduces the possibility of volunteer bias. Additionally, the inductive nature of our analysis did not allow for calculating the inter-rater reliability (IRR), a metric to assess the degree of agreement among different researchers conducting the same analysis [38]. However, to mitigate potential bias, each researcher conducted the analysis independently, which was followed by a collaborative review process.

External Validity. At the time of conducting our workshops, ChatGPT was relatively new, and consequently, there was limited availability of resources to support our materials and provide prior examples of ChatGPT's deployment in K-12 classrooms. This might limit the generalizability of our study to future scenarios where ChatGPT becomes more established and widely used in educational settings. We also recognize that the limited sample size in our workshops (six participants) restricts the scope of our findings. We aim to hold more workshops to expand our participant base, which will accumulate a larger, more representative sample over time.

Reliability. To mitigate any threats to reliability, we have detailed our entire process, starting from the creation of materials to the analysis. However, we acknowledge that achieving repeatability is challenging as the landscape of LLMs and the resources associated with them evolve continuously. Consequently, we hope that future researchers may use this as a work to reference and iterate upon as the technology changes over time.

VII. CONCLUSIONS AND FUTURE WORK

In this paper, we outlined the design, execution, and analysis of a five-session workshop series on ChatGPT for teachers. The workshops were designed based on best practices for teacher professional development that integrate project-based learning, active, constructive, and interactive learning, with a focus on teacher-professional classroom practice. Our overarching aim was to provide teachers with an understanding of ChatGPT that could be utilized for their professional development. We also aimed to enable educators to guide their students in using ChatGPT responsibly and effectively. The workshops resulted in teachers learning about ChatGPT, and shifts in teachers' beliefs and confidence that they could have agency and influence over the use of ChatGPT in classrooms and for the development of student critical thinking and 21st century learning skills. Furthermore, all six participants planned classroom activities integrating ChatGPT with their disciplinary content, demonstrating that the design principles for the workshops were effective in developing teachers' intentions to translate their learning into classroom practice. In our future work, we will continue to advocate for and support teachers as professional learners who can integrate new technologies, collaboration, creativity, and project-based learning into their classrooms.

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