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Board 309: Impact of RET Summer Program Designs on Teachers' Technological-Content Knowledge and Lesson Plan Development Outcomes

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This study was conducted at a Research Experiences for Teachers (RET) Site in a university on the northern Gulf Coast. The National Science Foundation (NSF) Division of Computer and Network Systems funded the RET site to offer a research-intensive program in artificial intelligence (AI) computing systems. Since the summer of 2021, Science, Technology, Engineering, Mathematics (STEM) middle- and high-school teachers have participated in an annual six-week summer program [1]. They participated in technology and instructional workshops, work sessions, and authentic artificial intelligence (AI) research activities with the university faculty, graduate, and undergraduate students. In the subsequent semesters, they developed and taught AI-integrated lessons in their classes.

As this RET site aims to bring AI knowledge to middle- and high-school classes, it is important to understand how the summer program enabled teachers to develop and teach AI-integrated lessons in their STEM courses. This study aimed to compare two RET summer program designs and explore whether and how the different program designs influenced participating teachers' technological-content knowledge (TCK) and lesson plan development. Our research questions were: 1. How did teachers' technological-content knowledge differ in different program designs? 2. How did teachers' lesson plans differ in different programs?

Two designs of the summer program were implemented in 2021 and 2022. The 2021 program focused on immersing teachers in authentic AI projects, while the 2022 program focused on developing teachers' foundational knowledge before joining a specific AI research project. Teachers in both summers took an orientation in the first week. In the 2021 summer program, teachers participated in one of the four research projects, including AI application in cancer detection, AI algorithm, architecture and circuit, and device from Week 2 mornings. They gathered in the afternoons to share their research, participate in instructional workshops and discussions, and develop lesson plans for middle- and high-school students. What changed in the 2022 summer program was the morning research component. Teachers learned foundational AI algorithm and hardware knowledge together before they were divided and spent a couple of weeks on a specific AI research project.

Eight teachers participated in the 2021 program (Table I). All of them were from Title I schools. Six teachers were females, and two were males. One teacher was African American, and the others were Caucasians. Five teachers taught high-school math, one taught middle-school math, and two taught high-school science.

Twelve teachers participated in the 2022 program (Table I). Among them, ten were from Title I schools, one from a highly competitive public school, and another from a private high school. Eight teachers were females, and four were males. Fifty percent of the participants were African Americans, and the rest were Caucasians. The subjects the teachers taught ranged from biology and chemistry (N=3), mathematics (N=6), earth science (N=1), to computer science and engineering (N=2).

TABLE I
PARTICIPANTS' DEMOGRAPHICS INFORMATION

	2021 Cohort (N)	2022 Cohort (N)
Gender:		
Female	6	8
Male	2	4
Ethnicity:		
Caucasian	7	6
African American	1	6
Schools:		
Title I	8	10
Other Public	0	1
Private	0	1
Subjects Taught:		
High-school Math	5	5
High-school Science	2	3
High-school Computer Science & Engineering	0	2
Middle-school Math	1	1
Middle-school Science	0	1

An online survey was delivered at the beginning of each program, collecting teachers' demographics, experiences, and current TCK knowledge [2, 3]. At the end of the summer program, another online survey was delivered asking for teachers' TCK knowledge at that time. Teachers took less than 10 minutes to complete each survey. Each teacher was also required to submit a lesson plan that they will use to teach their students AI knowledge at the end of the summer program.

TCK Results We used the Mann-Whitney U tests to examine the differences in participants' TCK between the 2021 (N=8) and 2022 (N=12) cohorts. Our results did not show a significant difference between the two cohorts in both pre-surveys and post-surveys respectively.

We used the Wilcoxon signed-rank tests to examine the changes in teachers' TCK before and after the summer program in both cohorts. Results showed that the 2021 cohort did not have a significant improvement in their TCK (Z=-1.86, p=.06) (Fig. 1). However, the 2022 cohort's TCK significantly improved at the end of the summer program (Z=-2.20, p<.05).

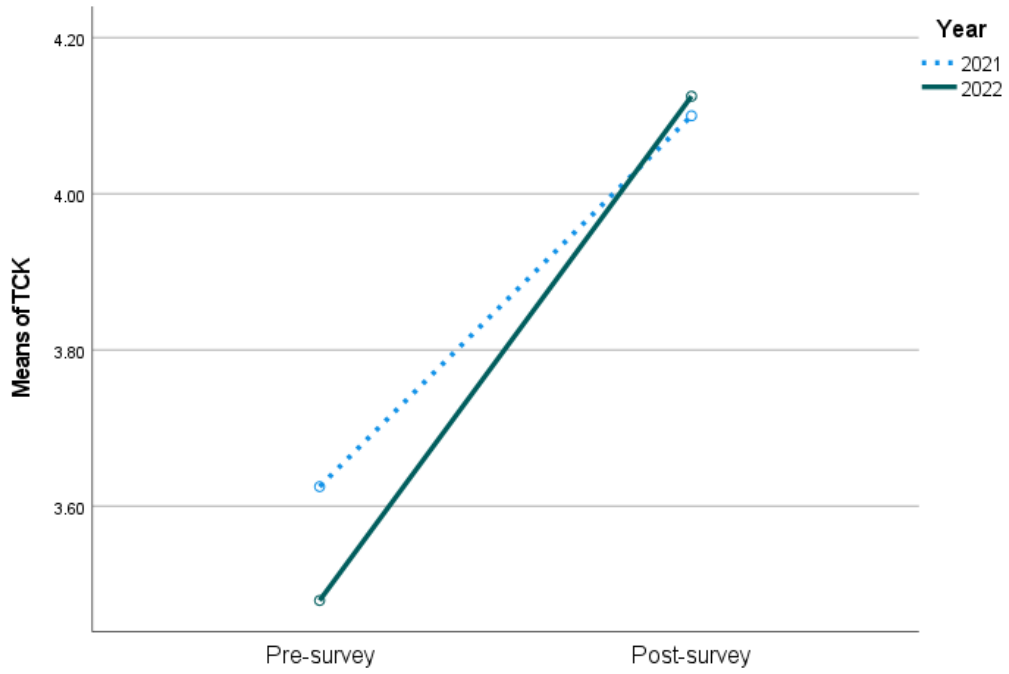

Fig 1. Change of teachers' technological-pedagogical-content knowledge

Lesson Plans Results 19 lesson plans were submitted by teachers at the end of the 2021 and 2022 summer programs. We used the following questions to code the lesson plans: 1) What AI or project-relevant topics were included in the lesson plan? 2) What AI topic/pedagogy/learning technologies did the teachers adopt to their lessons?

A couple of differences were observed between and 2021 and 2022 cohorts. 1) The lesson plans developed by the 2022 cohorts demonstrated more AI integration in STEM classes. Those developed by the 2021 cohorts included concepts not on AI but relevant to the RET research projects, which could be a medical research topic or a foundational Computer Science or Engineering concept. 2) Teachers were adept at applying interactive learning technologies that explain AI working mechanisms to non-experts. The 2022 cohort learned to use the Teachable Machine and Thonny IDE. All their lesson plans included the use of either or both technologies. The 2021 cohort learned python coding or hyperspectral imaging processing depending on their research groups. We also observed teachers bringing those technologies or knowledge to their classes.

Overall, the results of this study suggested a need to share the foundational AI concepts and learning technologies with all teachers if our purpose was to enable them to integrate AI into their classes. In the future iterations, we will continue the program structure from the 2022 cohort to develop all participating teachers' foundational AI knowledge before they participate in different research projects. We also plan to develop an online module to introduce AI to teachers before they come to the summer RET program. Meanwhile, we will continue to explore and share tools that teachers can use for their classroom teaching of AI literacy.

References

[1] N. Gong and S. Zha, "Research Experiences for Teachers Summer Program in Biologically-inspired Computing Systems," presented at the 2022 ASEE Annual Conference, Minneapolis, MN, 2022.

[2] P. Mishra and M. J. Koehler, "Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge," *Teachers College Record,* vol. 108, no. 6, pp. 1017-1054, 2006.

[3] P. Mishra, "Considering Contextual Knowledge: The TPACK Diagram Gets an Upgrade," *Journal of Digital Learning in Teacher Education,* vol. 35, no. 2, pp. 76-78, 2019.