The design of a TPACK survey for Gen AI: A preliminary study

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Abstract

What knowledge do teachers need to have in order to intelligently integrate Generative AI in their practice? This question has become increasingly relevant as these Generative AI tools (ChatGPT being just one of them) become a part of education. We build on the TPACK framework (Mishra & Koehler, 2006; Mishra, Warr & Islam, 2023) as well as previously validated research (Schmid, Brianza & Petko, 2020) to develop a survey instrument to measure teachers' TPACK. The instrument also includes additional items directly focused on teachers' knowledge of and experience with AI tools in general. In this paper we describe the design of the survey instrument and the results of a pilot test with a group of pre-service teachers.

Introduction

Generative Artificial intelligence (Gen AI) has affected everyone in the world. With the existing knowledge of the world as a training dataset, tools like ChatGPT, Claude.ai can create and replicate texts, images and videos almost instantaneously. This technology has the potential to revolutionize a range of sectors including healthcare, entertainment, finance, and education by allowing the creation of new content, providing personalized experiences and identifying patterns and trends in data. At the same time this technology is not without controversy. These bots often provide unreliable information, perpetuate biases, and more (Nas,2023; Stokel-Walker & Van Noorden, 2023; Allen & Weyl, 2024; Warr, Oster & Isaac, 2023). It is important, therefore, that educators have a better knowledge not just of these tools but also their pedagogical and disciplinary affordances if they are to effectively and ethically use them in their practice. Moreover, we need instruments to evaluate this form of teacher knowledge. To examine their perception about integrating this transformative technology in teaching and learning, we designed a survey tool for pre-service teachers to better understand their knowledge and beliefs about integrating Gen AI in their work.

Literature review

What is it that teachers need to know in this age of Gen AI, to intelligently incorporate these tools in their teaching? Mishra, Warr & Islam (2023) explored this transition in teacher knowledge in the era of Gen AI through the well-established technology integration framework for teachers' Technological Pedagogical Content Knowledge, or TPACK. They argue that the rise of Gen AI impacts all the subsections of the framework (TK, TPK, TCK, TPCK and XK).

In terms of TK (Technological Knowledge), they suggest that educators need to learn of both the characteristics that Gen AI shares with other technologies (such as that of being: protean, opaque and unstable) as well as attributes that make it unique: namely its generative, conversational and multimodal nature (Mishra, Oster & Henriksen, 2024). Its protean nature is magnified by its ability to fluidly interact with diverse digital media through natural language and its wide applicability for creative and analytical tasks. Its opacity results from the complexity of its neural networks. Teachers should also develop awareness about the quality of the content based on this instability. Along with straightforward machine-based errors like incorrect response, it hallucinates and generates biased content. Secondly, teachers should also consider its generative and social nature. Gen AI is generative in that it creates original, unanticipated content on the fly rather than simply retrieving pre-existing information. Thirdly, humans are prone to anthropomorphizing these tools due to its conversational nature. Mishra et al. (2023) suggest

that it may be fruitful to see these tools as being a "psychological other" rather than merely a productivity tool. In essence, they argue that teachers should approach Gen AI tools as an expert yet unreliable collaborator who can assist with complex conceptual tasks but whose proclivity for confabulation requires vigilance. Most significantly, Gen AI requires a philosophical shift in TPACK from viewing technology as a tool to recognizing the emergent, reciprocal dance between users and technologies like Gen AI. Rather than passive objects, these social, generative technologies actively shape interactions. The learning space now includes a non-human, alien intelligence.

This would also mean shifts in how we conceptualize TPK (Technological Pedagogical Knowledge)—such as how these tools can assist pedagogy, assessment and more. Similarly, TCK (Technological Content Knowledge) would shift to focusing on how these tools can expand the manner in which students engage with disciplinary ideas. However, the biggest transition was in their conceptualization of XK (Contextual Knowledge). They argue that, given Gen AI's potential to transform the socio-cultural landscape, XK must expand in scope, to factor in time. While XK traditionally focuses on the physical and institutional contexts within school systems, we must now also consider broader personal, cultural, political, and ethical implications of AI over extended timescales (Mishra, Oster, & Henriksen, 2024). These include impacts on notions of truth, trust in institutions, mental health, and workforce disruption that schools will need to address. Finally, the changes across all these different knowledge domains mean that the overall construct of TPACK has to shift as well.

This shift in TPACK from a toolset view to one recognizing the emergent relationships between users, contexts, and AI technologies, requires us to develop new instruments to evaluate teachers' TPACK Knowledge. Existing survey tools based on TPACK have limited applicability in this new emerging context. This is true both for in-service and pre-service teachers. That said, we argue that there is no need to start all over from scratch, particularly given that there already exist, in the research literature, a few robust and validated instruments to measure TPACK.

Acknowledging this, we chose to adapt an existing survey (Schmid, Brianza, & Petko, 2020). We also brought together the recommendations suggested by Mishra et al. (2023) in developing this survey. Finally, we conducted a pilot study using the instrument with some pre-service teachers. Specifically, we focused on the following questions:

1) What are some of the considerations for adapting a TPACK based survey instrument for a new domain like Gen AI?
2) What are future educators' perceptions about integrating Gen AI tools like ChatGPT in education?

Designing the Questionnaire

The original instrument created by Schmid, Brianza, & Petko (2020) contained 28 items with 5-point Likert scales where responses ranged from strongly agree (5) to strongly disagree (1). The survey has 4 items for each construct / sub-construct of the TPACK framework.

We changed the initial questionnaire by adapting the items and adding a new section. The revised instrument contains four sections. The first section contains questions about participants' familiarity with Gen AI and the final section focuses on general demographic information about the participants. For the purpose of this paper, our main focus will be on section 2 titled "Gen AI tools integration in teaching" with 7 TPACK constructs and 28 items and section 3 titled "General Perception of Gen AI tools." with 4 constructs and 38 items. Each item has a 5-point Likert scale response option. Additionally, section 3 contains 6 open ended questions.

In section 2, we contextualized the entire initial questionnaire based on our main concept (Mohler et al., 2016). It involved two changes: First, adapting the items by replacing general terms of technology with Gen AI terms and phrases. This modification was applied to the items for those TPACK constructs which contained the term "technology."

For example, for items under the construct TK, general terms of technology were replaced with Gen AI terms, phrases and examples like ChatGPT. Claude.ai. Instead of statements like "I keep up with important technologies", we used "I keep up with important Gen AI technologies." For TPK, instead of items like "I can choose technologies that enhance students' learning during lessons.", we used "I can choose Gen AI technologies

that enhance students' learning for a lesson." Second, we modified the instructions for the constructs by adding a small description about what each construct represents through the items. For instance, we changed instructions for the CK construct from "Please rate the following statements in relation to the subject in which you have written the lesson plan." to "The following set of questions refer to the understanding of the subject matter for teaching and learning a course. Please rate the statements in relation to the subject area(s) you have taught, currently teach, or want to teach."

Keeping the social and ethical implications of Gen AI in mind, we added section 3 where we addressed participants' general perception about the tool. This section contains 4 constructs: knowledge, belief, ethics of personal use and ethics for learner use of Gen AI tools. The "Knowledge of Gen AI tools" construct had 11 items which focused on pre-service teachers' understanding and efficiency about Gen AI system use. So, items contained phrases like 'I can' or 'I have' to ask participants if they understand how these tools work, if they can use it for different purposes like, creating prompts or checking students' work. The "Beliefs about Gen AI tools" construct contained 7 items with phrases like 'Gen AI tools can/will' to ask about their level of agreement for Gen AI's potential for different disciplines or choosing official sources for information. The "Ethics" construct was divided into two parts with 20 items in total, with 4 items for ethics related to teacher use and 16 items related to ethics for students use. We were more interested in teachers' perception of students' possible interaction with Gen AI. Items contained phrases like 'I think' to make an inquiry about how pre-service teachers visualize students' interaction, like, whether they will become dependent, or get more personalized learning experience, become confused, evaluate the generated content, etc. This section also had 4 open-ended questions where participants shared their opinions about the advantages and disadvantages of Gen AI and how it can affect teachers.

Conducting the survey

Using a Google form, we tested this questionnaire with 11 preservice teachers (from freshmen to seniors), enrolled in an educational technology course. Almost half of the participants were majoring in education from the teachers college and other participants were from different colleges majoring in philosophy, communication and history. Most of them had no teaching experience.

Initial findings

Our study started with the research question: What are some of the considerations for adapting a TPACK based survey instrument for a new domain like Gen AI? Table 1 shows the adapted questionnaire based on Schmid, Brianza, & Petko (2020). We focused on pre-service teachers' perception related to ways of integrating Gen AI for TK, TCK, TPK and TPCK.TK was aimed at their awareness about the Gen AI tools and how they interact with it in general. TCK was aimed at their knowledge about the applicability of Gen AI for their subject-area. For TPK and TPCK, our focus was on pre-service teachers' self-efficacy when it comes to choosing Gen AI technologies for teaching strategies.

Keeping the broad social and psychological impact of emerging technologies like Gen AI on teachers' contextual knowledge, the section related to knowledge of Gen AI tools focused on identifying pre-service teachers' skepticism, level of understanding and view about the uniqueness of this emerging technology. Similarly, survey items related to the section "Belief about Gen AI tools" focused on identifying their perception about the impact of Gen AI tools on their professional development.

We recognize that Gen AI related ethical concerns can take two forms for teachers based on their personal adaptation policy and student integration in a new technology. Hence, the ethics of Gen AI for pre-service teachers was addressed in both teaching contexts and in classroom and student related contexts. The questions here mainly focus on professional ethics and moral values related to the use of this technology. While teacher related Gen AI ethics involved statements about their level of trust related to tools like ChatGPT generated content, the students related ethics focused on impact of Gen AI use related to factors like academic integrity, student performance, student autonomy.

	N	M	SDV
Technological knowledge (TK)			
a) I keep up with important Gen AI technologies	11	2.82	1.33
b) I frequently explore or play around with the Gen AI tools.	11	2.82	1.17
c) I know a lot about different Gen AI technologies.	11	2.55	1.29
d) I have the technical skills I need to use Gen AI technologies.	11	3.00	1.34
Technological Content Knowledge (TCK)			
a) I know how technological developments related to Gen AI have changed the field of my subject area(s).	10	3.40	0.96
b) I can explain which technologies related to Gen AI have been used in research in my subject area(s).	10	3.10	1.28
c) I know which new technologies related to Gen AI are currently being developed in the field of my subject area(s).	10	2.50	1.08
d) I know how to use Gen AI technologies to expand my knowledge in my subject area(s).	10	3.20	1.03
Technological Pedagogical Knowledge (TPK)			
a) I can choose Gen AI technologies that enhance my teaching approaches for teaching lessons.	8	3.50	0.93
b) I can choose Gen AI technologies that enhance students' learning during lessons.	9	3.22	1.09
c) I can adapt the use of Gen AI technologies about which I am learning to different teaching lessons.	9	3.33	1.12
d) I can think critically about how to use Gen AI technology throughout my lessons.	9	3.89	0.78
Technological Pedagogical Content Knowledge (TPCK)			
a) I can use strategies via which I can combine content, Gen AI technologies, and teaching approaches given what I learned about in my coursework.	10	3.30	0.95
b) I can choose Gen AI technologies that enhance the content I teach for teaching lessons.	10	3.40	0.97
c) I can select appropriate Gen AI technologies to use in my classroom that will help me enhance what I teach.	10	3.70	1.06
d) I can select appropriate Gen AI technologies to use in my classroom that will help me enhance how I teach.	10	3.40	1.07
e) I can select appropriate Gen AI technologies to use in my classroom that will help me enhance what students learn.	10	3.60	1.07
f) I can effectively combine my teaching subject area(s), Gen AI technologies, and teaching approaches.	10	3.50	0.97
Knowledge of Gen AI tools			
a) I understand how Gen AI tools work.	10	3.40	1.07
b) I am excited about Gen AI tools.	10	2.90	1.45
c) Gen AI can help make me more creative as a teacher.	10	3.30	1.25
d) I can ask Gen AI for lesson plans.	10	2.80	1.13
e) I have worked with Gen AI tools.	10	3.50	1.17
f) I have effectively worked with Gen AI tools.	10	3.30	1.34
g) Working with Gen AI is like using a superior search engine.	10	3.20	1.23
h) Working with Gen AI is like having a conversation.	10	2.60	1.26
i) I can create prompts to have a conversation with Gen AI.	10	3.40	1.17
j) I can use Gen AI to check students' work.	10	2.20	1.39
k) I can teach students about Gen AI use.	10	2.90	1.19
Belief about Gen AI tools			
a) Gen AI tools can be used with any discipline.	11	3.09	1.37
b) Gen AI tools will make learning about any subject area(s) easier.	11	3.09	1.37
c) Gen AI tools will make learning about any subject area(s) better.	11	2.64	1.12
d) I can use Gen AI tools to help train me to teach.	11	2.73	1.19
e) I see Gen AI tools helping to make me a better teacher.	11	2.64	1.12
f) Gen AI tools are necessary for learning.	11	2.09	1.22
g) Gen AI tools take information from official sources.	11	2.36	0.92
Ethics at issue when using Gen AI tools			
a) Gen AI tools are biased (e.g., along dimensions of race, gender, ethnicity, etc.).	11	3.36	1.36
b) I trust the results derived via Gen AI tools.	11	2.45	1.04
c) I think it is ethical to use Gen AI tools in my teaching.	11	2.45	1.29
d) I am worried about the ethics involved when using Gen AI tools.	11	3.82	1.40
Ethics at issue when students using Gen AI tools			
a) I think students will become dependent on Gen AI tools.	10	4.30	0.95
b) I think it is ethical for students to use Gen AI tools.	10	2.90	1.28
c) I think using Gen AI tools will help students learn.	10	2.90	1.10
d) I think Gen AI tools will help personalize learning for all students.	10	2.50	1.35
e) I think students will seek to understand concepts because of using Gen AI tools.	10	2.50	1.35
f) I think Gen AI tools will help students get better grades.	10	3.40	1.43
g) I think students can use Gen AI tools when they do homework.	10	2.90	1.52
h) I think students should use Gen AI tools when they do homework.	10	2.40	1.26
i) I think Gen AI tools can confuse students.	10	3.90	0.87
j) I think Gen AI tools can help students become more creative.	10	2.80	1.39
k) I think Gen AI tools can help shy students.	10	2.70	1.33
l) I think Gen AI tools can help weak learners.	10	2.60	1.43
m) I think students can submit Gen AI generated content.	10	2.30	1.41
n) Teachers and students have similar Gen AI experiences.	10	2.60	1.17
o) I think students can evaluate the quality of Gen AI generated content.	10	2.90	1.37
p) I think students generally trust Gen AI tools.	10	3.80	0.92

Table 1: Descriptive statistics (M, SDV) of adapted TPACK questionnaire

Our second research question was "What are future educators' perceptions about integrating Gen AI tools like ChatGPT in education?" To answer this question, we conducted a pilot study with the adapted questionnaire. To analyze the data from this survey, using descriptive statistics, we calculated the Likert scale responses from the 11 constructs used to measure pre-service teachers' perception in the survey (See table 2). Each construct contained multiple Likert scale items and participants rated on a scale of 1 (strongly disagree) to 5 (strongly agree). We calculated the mean score for the items in each construct to identify the central tendency and standard deviation to assess the variability in their responses. The average responses for the constructs with a mean score of 3 show that participants have a mostly neutral attitude about their knowledge of the tool and how to integrate it. The lowest mean (2.66) can be seen for participants' disagreement about their belief in the capability of Gen AI tools while the highest score (4) for Content knowledge shows their confidence in their domain.

Construct items	M	SDV
Pedagogical Knowledge (PK)	3.92	0.64
Content Knowledge (CK)	4.00	0.63
Technological Knowledge (TK)	2.79	1.23
Pedagogical Content Knowledge	3.89	0.73
Technological Pedagogical Knowledge	3.48	0.96
Technological Content Knowledge (TCK)	3.05	1.09
Technological Pedagogical Content Knowledge (TPCK)	3.48	0.97
Knowledge of Gen AI tools	3.04	1.24
Belief about Gen AI tools	2.66	1.19
Ethics at issue when using Gen AI tools	3.02	1.35
Ethics at issue when students using Gen AI tools	2.96	1.33

Table 2: Descriptive statistics of the Constructs from the Pre-service Teachers Perception Survey

While the initial findings are too small for definite conclusions about aspects of pre-service teachers' perception, it gives a picture of their current mindset about Gen AI integration for teaching and learning purposes. Regarding their TPK, TCK and TPCK of Gen AI integration, participants' attitude was mostly neutral. In contrast, when asked about their perception and knowledge, participants mostly disagreed about their current TK related to Gen AI. For both TPK and TPCK, statements related to pre-service teachers' self-efficacy like, "I can select" or "I can think how to use" Gen AI technologies……" showed a higher score. However, the TK score did not indicate that they keep up with the current trends of Gen AI. The common beliefs related to the effectiveness of Gen AI tools (See table 1) were not supported by the pre-service teachers in this study. In terms of its usability for training and supporting teachers, they did not believe it could help them be better teachers. They did not even believe in the necessity of Gen AI for learning. Moreover, the ethical concerns for themselves were different from their outlook about ethics for students. While participants mostly showed a neutral attitude about ethical issues related to teachers using Gen AI usage, they disagreed about the ethical questions related to Gen AI when students use them. Participants highly agreed on one ethical issue: the possibility of students becoming dependent on Gen AI tools (M=4.30). The attitude was neutral about statements related to the impact of Gen AI on grades, how students trust or distrust this technology. They did not support the idea of students using Gen AI for homework, learning support, better communication or evaluation of generated content.

Overall, participants showed mixed attitudes towards the use of ChatGPT. While they believed in the creative power of the tools, they were concerned about the risk of over-dependence on Gen AI. For the most part they had a positive attitude towards integrating these tools. They also believed that they were capable of using it effectively. They did not, however, believe they could use it for specific tasks like to grade students' work. Despite

their frequent use of conversational chatbots like ChatGPT, they did not believe they could have a conversation with Gen AI. They did not consider the communication factor related to Gen AI, rather considered it a tool.

Limitations

We believe there are two main limitations of this study. First of all, a small number of participants took the survey. In addition, it would have been good to have triangulated the survey items with another data collection method (such as focus groups with the participants).

Conclusions

In this paper we have described the design of an instrument to measure the TPACK of educators around their insertion of Gen AI in their pedagogical practices. Though preliminary, we believe this survey (based as it is on an existing robust and validated instrument) is an important step in developing a more analytical approach towards teacher knowledge in this new space.

References

Allen, D., & Weyl, E. G. (2024). The Real Dangers of Generative AI. *Journal of Democracy*, *35*(1), 147-162.

Mohler,P., Dorer, B, Jong, J.D & Hu, M. (2016). Adaptation. Cross-cultural Survey Guidelines. https://ccsg.isr.umich.edu/chapters/adaptation/

Mishra, P., Warr, M., & Islam, R. (2023). TPACK in the age of ChatGPT and Generative AI. *Journal of Digital Learning in Teacher Education*, *39*(4), 235-251.

Mishra, P., Oster, N., & Henriksen, D. (2024). Generative AI, Teacher Knowledge and Educational Research: Bridging Short- and Long-Term Perspectives. *TechTrends*. https://doi.org/10.1007/s11528-024-00938-1

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowl-edge. *Teachers College Record: The Voice of Scholarship in Education*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Nas, D. (2023, Jan 7). 5 Sectors that will be most affected by Generative AI.Medium. https://deborahnas.medium.com/5-sectors-that-will-be-most-affected-by-generative-ai-fd4c23bc3b0

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK. xs) and comparing the factor structure of an integrative and a transformative model. *Computers & Education*, *157*, 103967.

Stokel-Walker, C., & Van Noorden, R. (2023). What ChatGPT and generative AI mean for science. *Nature*, *614*(7947), 214-216.

Warr, M., Oster, N. and Isaac, R. (2023). Implicit Bias in Large Language Models: Experimental Proof and Implications for Education http://dx.doi.org/10.2139/ssrn.4625078