Exploring the Potential of ChatGPT as Codesigners for Culturally Relevant and Inquiry-Based Mathematics Tasks

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As the school-age population in the United States is becoming more racially and ethnically diverse (de Brey et al., 2019), teachers need support in effectively teaching students with experiences that differ from their own. Culturally relevant tasks that draw on students' lived experience and funds of knowledge (Moll et al., 1992; Civil, 2007; González et al., 2005) and that have high cognitive demand (Smith & Stein, 2011) are important for mathematics learning for all students and particularly for multilingual students, where a rich task can provide multiple entry points that can highlight students' cultural and linguistic diversity as an asset (Chval et al., 2021; Chval & Khisty, 2009). Persistent problems exist where students in underserved communities have differing learning experiences (NCTM, 2020) and inequalities in mathematics resources**.**

Creation of rich problem-based lessons that are culturally responsive and accessible to diverse learners are limited and time consuming to create. AI has the potential to serve as a thinking partner for teachers who are interested in adapting a task to be more culturally relevant and inquiry based. Within the many roles that ChatGPT can play to enrich teaching and learning (UNESCO Education, 2023), one that our study focused on was the role of AI assisting in the design process, a "co-designer" in creating a rich task (Smith & Stein, 2011) that was culturally relevant. One of the key components of our study was to explore how teachers could leverage ChatGPT as a co-designer and how they would evaluate the ideas generated by ChatGPT. This evaluation entailed assessing the rigor of the task as well the level of cultural relevance which requires culturally responsive teachers to be culturally competent (NCTM 2021, Ladson Billing, 2014).

Co-Designing Culturally-Relevant Lessons with ChatGPT

Twenty-one teachers and mathematics specialists in a program preparing mathematics teacher leaders in a public university in the mid Atlantic region of the US, enrolled in a graduate course called Curriculum Development in Mathematics Education, focused on adapting math curriculum to be more culturally relevant. After reading Chval's book (2021) about teaching mathematics to multilingual learners and an article by Gallivan (2017) that provided five strategies for revising tasks to be more culturally relevant, students asynchronously explored how to use ChatGPT to support their lesson planning and considered ways it might help teachers in modifying tasks (See Figure 1). As part of the course assignment, participants were tasked with designing a lesson (either creating a rich task or modifying an existing one) that would be more equitable, engaging, and culturally relevant.

Figure 1.
Exploration with Chat GPT as a co-designer

Exploring Chat GPT to assist with revising tasks to be Culturally Relevant

You read Chval's chapter called Engage with culturally relevant contexts in the text *Teaching Math to Multilingual Students* and Gallivan's article "Revising Tasks to be Culturally Relevant." Explore how Chat GPT might assist teachers in modifying tasks. Use these prompts or create your own.
https://classtechtips.com/2023/08/12/prompts-for-math-teachers/

ACTIVITY
Explore how Chat GPT (http://chat.openai.com) might assist teachers in modifying tasks. Use these prompts from this article or create your own to modify: a) *Connecting to students' home or community experiences; b) Connecting to students' broader culture*, c) modifying to be more *realistic to the mathematics in the context, d) Relating to the mathematical practices the students engage in, e) creating inquiry-based tasks with differing levels of mathematics for different grades*
https://classtechtips.com/2023/08/12/prompts-for-math-teachers/

In the DB thread, a) post the prompt you used in "quotes" and the "output" or link the output; b) evaluate the modified task; c) critique the affordance and limitation of Chat GPT for modifying the task.

Benefits and Constraints of ChatGPT as Co-Designer

Using an inductive, open-coding process (Saldaña, 2021), we first identified segments where teachers discussed the benefits and constraints of ChatGPT in our analysis of the teacher reflections on the discussion board threads which included the ChatGPT inputs and outputs. In addition, we had a recorded discussion from class where we discussed this ChatGPT lesson design exploration. Through our analysis, we found three major themes teachers identified as affordances and constraints of using ChatGPT as a lesson co-designer, particularly in its usefulness to promote culturally relevant pedagogy and generating inquiry based learning.

Theme 1: ChatGPT generated many but superficial cultural contexts

ChatGPT can be a useful starting point for teachers to generate novel ideas for culturally relevant rich tasks. It provides a wealth of examples situated in different cultures that may not have otherwise been a part of a teacher's awareness. For instance, Ms. R. had ChatGPT incorporate students' home and cultural experiences into a mathematics task and it proceeded with a budgeting lesson featuring food trucks from different cultures and, when prompted, an additional lesson about respecting different cultures and appreciating taste preferences. Similarly, Ms. D. broadened a field trip context with sharing food to incorporate landmarks from different countries and signature dishes from these cultures. Ms. M., a 6th grade teacher, asked ChatGPT to create a lesson where students would compare food items imported from other

countries with the currency and compare the price with US dollars. This provided extension opportunities where students might highlight the difference in price of their favorite imported products. Ms. T., who was a kindergarten teacher, asked ChatGPT to create a lesson where it focused on "*Family Traditions: Discuss how different families have their unique traditions. Share stories about family celebrations like quinceañeras, bar mitzvahs, and baby naming ceremonies. Ask students to mark these events on the calendar.*" Ms. T reflected how this would make calendar math more personally meaningful for the students and highlight their cultural celebrations. Similarly Mr. N. focused on a mathematics activity like making Rangoli designs to celebrate Diwali and Ms. A. focused on a recipe to celebrate Ramadan using fractions in the recipe.

Teachers commented that many of the suggestions were helping them learn more about ways mathematics can connect to cultural contexts, but they did not move beyond surface-level activities for cultural explorations; most often, they substituted cultural elements, such as holidays or foods. While this does increase representation and visibility of the diverse cultures of students, teachers cautioned that ChatGPT could result in cultural appropriation or perpetuate existing stereotypes if one did not use it carefully. Teachers agreed that they would want to incorporate meaningful elements of mathematics from cultures through "ethnomathematics" (D'Ambrosio, 1977), as well as mathematics contributions from diverse cultures to "appreciate the diverse ways of knowing, being, and doing that have led to mathematizing" (NCTM, 2021, p. 1).

Theme 2: To obtain the best results from ChatGPT, it was necessary to generate different prompts, phrasing and to provide specificity through iterations

Teachers observed that they often needed to continue generating questions or rephrasing their request to produce a lesson they would readily use. When they further promoted ChatGPT, asking it to be more culturally relevant or incorporate students' home experiences, it did produce better results. For instance, Ms. R.'s earlier examples of food trucks for budgeting and Ms. D.'s different countries for field trips, were a result of multiple, progressive questions to ChatGPT. Ms. D. was particularly intentional and specific in her requests asking ChatGPT to write a fourth-grade measurement lesson to align with the standards, be culturally relevant to students who are Mongolian, and to connect it to the culinary dish Buuz. Knowing that cooking would align well with measurement and that Buuz is a popular Mongolian dish, she was able to reference a familiar cuisine to highlight students' culture. As teachers revised their prompt to more specific requests and questions, teachers noticed that they received better lessons that were more tailored to their design prompts.

Theme 3: Teacher's knowledge is essential to adapt ideas to the classroom, standards, and students

Connecting to both the first and second themes, teachers found that ChatGPT could produce many ideas and improve upon them, but that it still required a teacher's knowledge to adapt it for their individual classroom, standards, and students. Ms. D. 's measurement lesson with Buuz was one that the teacher planned to implement, but she had to revise it to narrow the focus to measuring ingredients, as the suggested lesson also included a lesson on perimeter and area that was not appropriate and seemed

contrived. Ms. L., who was teaching radicals to 8th graders and had a large populations of Latinx students who loved "futbol" prompted ChatGPT to make a list of mathematics connection and was impressed initially and stated "the shear speed that it can generate a comprehensive list on the topic presented is mind boggling." After reviewing some problems on the list, she realized she needed to be more specific with the standards as some problems aligned to more advanced standards beyond the grade level. Ms. R. had ChatGPT suggest scaffolds for ELL students and the output gave sentence starters, vocabulary words, and suggestions for visual aids which she made available for her students. But she also noticed that ChatGPT also suggested lessening the rigor of the lesson for multilingual learners as an accommodation, which was at odds with best practices. There was a consensus among the teachers that ChatGPT was a useful resource for co-planning culturally relevant inquiry-based math tasks, but it was not a readily-made resource and needed many components of mathematics knowledge for teaching (Ball et al, 2008) to adapt it before implementing it.

Implications

The integration of ChatGPT as a co-designer for culturally relevant math tasks that are more inquiry based provides Mathematics Teacher Educators (MTEs) and classroom teachers with a starting place. We also recognize that math is not culturally neutral (NCTM, 2021) and there is a need for teachers to develop cultural competencies that align with the increasingly diverse cultural backgrounds of students. The findings from our study reveal both the potential and the challenges of utilizing AI, specifically ChatGPT, in the design of a mathematics curriculum that is equitable, inquiry-based, and culturally relevant. One of the primary implications of our study is the potential of AI to serve as a dynamic resource for teachers seeking to create or adapt lessons with a higher degree of cultural relevance. ChatGPT's ability to generate a wide array of cultural contexts and connections can serve as a catalyst for teachers to explore novel ideas and incorporate diverse cultural elements into their lessons and leverage the cultural assets students bring to the classroom.

However, the study also underscores the importance of critical engagement and ethical considerations when using AI tools like ChatGPT. The tendency of ChatGPT to suggest cultural contexts without deeper integration highlights the need for teachers to critically evaluate and modify AI-generated ideas to avoid cultural appropriation and the reinforcement of stereotypes. According to Randieri (2023), AI algorithms often simplify and generalize characteristics of a group due to the lack of access to extensive data for target populations. Historical exclusion from research and statistics results in these groups being underrepresented in the AI algorithms' training data. This underrepresentation can lead to oversimplification and stereotyping, potentially reinforcing existing biases.

We call for a deliberate and thoughtful approach to the use of AI in lesson design, emphasizing the role of the teacher as both a curator and a critical editor of content. While ChatGPT can propose innovative ideas and contexts, the refinement and alignment of these suggestions with classroom standards and the specific needs of students remain the responsibility of the teacher. This highlights the complementary

nature of AI tools and professional expertise, where AI serves as a partner in the creative process rather than a substitute for the teacher's judgment and knowledge. Educators must be equipped not only with the skills to effectively integrate AI tools into their practice but also with the critical perspective necessary to navigate the ethical and pedagogical challenges that come with it (Gomez & Hardison, 2024). MTEs can work together with other educators to focus on developing teachers' abilities to harness the potential of AI for creating culturally relevant lessons while maintaining a critical stance towards the content generated by these tools. There is a need for ongoing collaboration between educators, researchers, and AI developers to ensure that AI tools like ChatGPT are designed and refined in ways that support culturally relevant pedagogy and inquiry based learning and address the complex needs of diverse student populations.

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