

Open Educational Resources in Mathematics Education

A Position of the National Council of Teachers of Mathematics

It is essential that teachers have the agency to select and modify curricular materials. Given the proliferation of OER, teachers must approach incorporating these materials with reflection and critical thought, and have an understanding of the components of a high-quality curriculum.

The quantity of open educational resources (OERs) continues to grow rapidly. OERs are “learning, teaching and research materials in any format and medium that reside in the public domain or are under the copyright that has been released under an open license that permits no-cost access, re-use, re-purpose, adaptation and redistribution by others” (UNESCO, 2024, paragraph 1). Given their wide range of purposes and quality, we must consider various factors in assessing their role in teaching and learning mathematics. Our position is built on the following assumptions. First, high-quality curricula a) are coherent, b) attend to mathematics content and practices, c) balance opportunities for students to develop conceptual understanding and procedural fluency, and d) provide windows and mirrors that reflect a range of students’ identities. Next, the materials teachers use in teaching mathematics impact students’ opportunities to learn. Thus, having high-quality curricula is fundamental to creating equitable mathematics spaces. Finally, we value the work of teachers and understand the complex task of balancing standards, attending to individual students’ needs, creating enrichment opportunities, and providing additional practice. Therefore, we assert the importance of teachers’ agency in selecting and modifying curricular materials and remind teachers of the importance of being both reflective and critical in selecting and using OERs.

Educators must be selective when using OERs, as the coherence of the resources is key to building a strong mathematical foundation. We also understand that some schools and districts may have limited resources and use OERs to access high-quality curriculum materials. Any materials chosen or adopted should be research-based, include challenging mathematics content, provide access to a range of students, consider the intersections of culture and mathematics, and leverage technology (and other tools) in equitable ways. We expound on these points below and offer educational professionals guiding questions to support you as you assess and select OERs.

1. THERE IS A PLACE FOR OPEN EDUCATIONAL RESOURCES.

The landscape of mathematics curriculum development is evolving. Historically, most mathematics curriculum materials came from publishing companies. However, with advancements in modern technology and increased access to information, individuals are now in the position to produce and distribute curriculum materials to others much faster than conventional sources. We believe OERs have a place in mainstream education. Inclusive and equitable materials for all are readily available via a range of OER channels. Unfortunately, not all materials available via OER are equal in quality. Researchers identified that mathematics materials from virtual resource pools (Shapiro, Dick, Sawyer, & Wismer, 2021) and artificial

intelligence chatbots (Sawyer & Aga, 2024; Wu, 2023) can contain misconceptions, biased information, and inappropriate materials. Yet, regardless of the source, we believe all resources, whether from publishing companies or OER libraries and various sharing platforms, should have the opportunity to be selected, adapted, and curated for the classroom.

2. HIGH-QUALITY CURRICULA DEMONSTRATE COHERENCE.

Although there is an important role for OER to play in the mathematics curriculum, it is not advisable to overly rely on miscellaneous materials from varied sources because the resulting collection may lack coherence. Curriculum coherence refers to a carefully planned sequence of topics that reflects either the hierarchical nature of the content or a research-informed trajectory of students' conceptual development (or both) (Schmidt & Houang, 2012). Coherence also entails connections between the ideas, representations, and terminology within that sequence of topics. As stated in *Principles and Standards for School Mathematics* (NCTM, 2000, p. 14), "A curriculum is more than a collection of activities." Clearly, having a well-articulated, high-quality, coherent curriculum at the school and district level is even more important in the age of OER because it is the curriculum that establishes the learning goals in a coherent progression and helps teachers see and understand the multiple pathways that students take through the progression. But teachers can help bring coherence, even to an ad hoc collection (see #3), and selection criteria used by educators accessing OERs can help improve coherence (see #4).

3. TEACHERS MUST HAVE AGENCY, AUTHORITY, AND POWER.

Teachers strive to be responsive to their students. The craft of teaching involves designing and enacting instructional experiences that engage students in powerful learning opportunities. Teachers should have the authority to select or adapt the resources that will best support their students' needs. To support teachers and students, school districts may have invested in curriculum materials. Prior to adapting the curriculum materials that have been provided, it is worth carefully analyzing them. High-quality curriculum materials afford opportunities to develop conceptual understanding prior to procedural fluency and to engage students in reasoning and sense-making (NCTM, 2014). Adaptations are warranted if teachers' curriculum materials do not align with powerful opportunities to learn mathematics.

4. TEACHERS ARE RESPONSIBLE FOR THEIR SELECTION.

Teachers selecting the resources in mathematics classrooms are responsible for the quality of instruction in their classrooms; thus, they should use a critical lens on all mathematics resources to support students' learning ability. Questions to guide such reviews might include: (a.) Do the resources take students beyond procedures toward conceptual understanding? and (b.) Do the resources promote inclusivity and cultural responsiveness? Such inquiries help teachers be transparent to themselves, encourage thinking about equity and inclusion, and promote effective mathematical pedagogy. We believe in mathematics teachers being "professionals who are critical curators, adapters, and creators, rather than technicians" (Sawyer et al., 2020, p. 534). Therefore, these professionals are responsible for their selection's impact on the students in their keep.

REFERENCES

- National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics.
- Sawyer, A. G. & Aga, Z. (2024). Counterexamples to demonstrate artificial intelligence chatbot's lack of knowledge in the mathematics education classrooms. *Association of Mathematics Teacher Education's Connections*.
<https://amte.net/sites/amte.net/files/Connections%20%28Sawyer%29.pdf>
- Sawyer, A. G., Dredger, K., Myers, J., Barnes, S., Wilson, R., Sullivan, J., & Sawyer, D. (2020). Developing teachers as critical curators: Investigating elementary preservice teachers' inspirations for lesson planning. *Journal of Teacher Education*, 71(5), 518-536.
<https://doi.org/10.1177/0022487119879894>
- Shapiro, E., Dick, L., Sawyer, A. G., & Wismer, T. (2021). Critical consumption of online resources. *Texas Mathematics Educator*, 67(1), 6–11.
- Shelton, C. C., & Archambault, L. M. (2019). Who are online Teacherpreneurs and what do they do? A survey of content creators on TeachersPayTeachers.com. *Journal of Research on Technology in Education*, 51(4), 398-414.
<https://doi.org/10.1080/15391523.2019.1666757>
- Schmidt, W. H., & Houang, R. T. (2012). Curricular coherence and the Common Core State Standards for Mathematics. *Educational Researcher*, 41, 294-308.
<https://doi.org/10.3102/0013189X12464517>
- United States Department of Education (2023). U.S. Department of Education Shares Insights and Recommendations for Artificial Intelligence. Press Office. May 24, 2023
<https://www.ed.gov/news/press-releases/us-department-education-shares-insights-and-recommendations-artificial-intelligence>
- UNESCO. (2024) Open Educational Resources. Retrieved from:
[https://www.unesco.org/en/open-educational-resources#:~:text=Open%20Educational%20Resources%20\(OER\)%20are,adaptation%20and%20redistribution%20by%20others.](https://www.unesco.org/en/open-educational-resources#:~:text=Open%20Educational%20Resources%20(OER)%20are,adaptation%20and%20redistribution%20by%20others.)
- Wu, G. (2023, Sept 17). *8 big problems with OpenAI's ChatGPT*. MakeUseOf.
<https://www.makeuseof.com/openai-chatgpt-biggest-probelms/>