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# Open Education Exploration Grant: Leah Nillas

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I am incorporating these selected OER materials into two curriculum and pedagogy courses: Educ 330 (Mathematics, Science and Technology Curriculum and Pedagogy in the Elementary Classroom) and Educ 362 (Curriculum and Pedagogy in Grades 6-12 Mathematics). Both courses focus on preparing preservice teachers to teach mathematics and STEM in K-12 schools. Throughout the years, I have incorporated different instructional tools to make specific mathematics learning activities interactive. However, some of these tools (e.g., Geometer's Sketchpad, interactive whiteboards, Tinkeplots, Fathom, TI Nspire) cost significant money to update and manage. As a result, I have to rethink how to continue to deliver dynamic and interactive mathematics content without constantly asking for software upgrade funds. In both classes, I provide students opportunity to engage, explore, explain, and elaborate their mathematical proficiency (i.e., conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition). Part one of my redesign plan is to identify OER materials that can be integrated into these two curriculum and pedagogy classes. I searched through these databases: Open Textbook Library, OER Commons, OpenStax, CARLI, and Mason OER. I browsed several materials but focused on these popular ones.

**Summary and Evaluation of OER Materials:** I selected an open textbook, online data, websites, simulation, and teaching videos as relevant learning and teaching materials for Educ 330 and Educ 362. Each material is briefly summarized based on its pedagogical usefulness and quality of content. I also explain how these materials support my pedagogical goals in teaching mathematics and STEM curriculum and pedagogy courses.

As an open textbook, the Mathematics for Elementary Teachers (Manes, 2017) is a relevant text that engages elementary preservice teachers in problem-solving, reasoning, and constructing arguments. These skills are emphasized in Educ 330. Although this text does not cover data analysis and algebra, it focuses on important mathematical K-8 concepts which include number systems, number operations, and geometry. Consistent with the competencies covered in Educ 330, preservice teachers will learn how to integrate the use of multiple representations, encourage multiple ways to solve a problem, and develop their perseverance in solving problems through the use of this text. I plan to use this text as a supplementary material when reviewing K-8 math concepts. I can assign problems from this text and emphasize skills on problem-solving, argumentations, and use of multiple representations. The goal is for preservice teachers to be comfortable with solving problems, thinking of multiple solutions, validating solutions, and persevering throughout the process of problem-solving. These are important competencies that preservice teachers need to model to their K-12 students. I also searched but failed to find a good open textbook for high school teachers. I will continue to search for a high school level mathematics textbook that our secondary preservice teachers can explore.

Although Khan academy is well known internationally, I really enjoy exploring a subset of learning videos from this Khan Academy OER series collection. Preservice teachers can benefit from the use of these good quality OER learning videos from Khan Academy. Although one can go directly to their website and create a teacher account, using the OER Series lessens the steps in navigating millions of topics covered in the websites. Preservice teachers can easily apply filters to search for elementary and secondary topics which will be helpful for students to explore to review concepts they have learned in schools or examine how the concepts are explained and taught. Given that some K-12 schools are delivering lessons virtually, our preservice teachers can also use these videos as part of their synchronous or asynchronous online teaching.

These Geogebra classroom resources are full of interactive activities, practice exercises, simulations, lessons, and games for mathematics and science. Geogebra currently launched their free digital middle school and high school Illustrative Math curriculum. These curriculum materials are easily accessible to any K-12 teachers who can create a Geogebra classroom using any lessons from their digital curriculum and share the materials to their selected group of students. The lessons are interactive and can easily be adopted for a specific class as remote learning activities. I will have my students explore these resources as learners of mathematics for them to experience how mathematics can be taught through the use of dynamic visualizations and hands-on exploration. This an important learning experience for preservice teachers who are learning about meaningful instructional design.

Similar to Geogebra, Desmos classroom activities are collections of engaging mathematics activities that are customizable to specific needs of a class. Students engage in several formative assessments that are designed to scaffold students' developing understanding through the use of images, sketches, and multiple choice responses to content questions. As a class, a teacher can see students' progress and analyze class data pertaining to any question, task, or activity in each lesson. Generally, shared lessons are of good quality and evaluated by peers and users. Starting this year, Desmos 6-8 mathematics curriculum is available. Preservice teachers in my two classes will explore selected Desmos activities from this curriculum. I will also create my own content using Desmos activity builder where I can integrate different interactive features and embed specific formative assessments that can be customized for in person and online teaching.

The Common Online Data Analysis Platform (CODAP) STEM activities focuses on online exploration of data where students can interact with data and engage in dynamic data analysis. It is similar to paid data analysis software like Fathom and Tinkerplots except that CODAP is free and open source. Students can examine data in different ways, import their own collected data, or other data from different sources. Students' created work in CODAP can be saved to a class shared GDrive which can easily be shared with their peers for review and with me for grading. Without the software cost, I can provide opportunities for my students to engage in hands-on data analysis. Since CODAP is new and still evolving as an open source platform, more data sets are needed and improvements are being made. Regardless, I personally think that it is a better free alternative to other proprietary software. Students in my class can utilize this platform to engage in interactive and dynamic analysis of data.

Just like most educators are familiar with Khan Academy videos, some are also familiar with PhET simulations developed and maintained by the University of Colorado Boulder. I have not used them in my classes since my focus was on virtual mathematics manipulatives. With recent integration of STEM in my Educ 330 class, I have to update my learning materials to include science simulations. Consistently with the principles of engaging students in exploration by using PhET simulations, preservice teachers can engage in inquiry and discovery in a game-like learning environment. With the integration of HTML5 for some of these simulations, I can easily embed selected simulations into our course Moodle page. The simulations are well-developed and research-based. Moreover, shared lessons created by teachers all over the world can be additional resources for our preservice teachers. Students in my two classes will explore these simulations and review the lessons shared on the site.

To explore phenomena-based teaching, preservice teachers can also explore Exploratorium Teaching Science with Phenomenon activities. This is a growing collection of hands-on science activities designed for K-5 teachers for both in person and virtual learning environments. Students will engage in inquiry guided by exploration video which introduces the topic and

carefully scaffold learning activity. Teachers can customize these learning materials to suit their learning goals. I appreciate the use of a variety of phenomena and quality videos in this collection. Preservice teachers in my two classes can explore these video samples, which model the Next Generation Science Standards' (NGSS) three dimensional learning framework.

**Evolving role of OER in mathematics or STEM education:** Every year, costs of textbooks, software, graphing calculators, and physical manipulatives are getting more expensive for teachers to purchase and maintain. For example, most non-OER texts on teaching mathematics for elementary teachers cost more than $100 for students to purchase. We are seeing more and more students struggle to purchase expensive textbooks and other learning materials. For most cases, students who are unable to purchase these materials are lagging behind in learning the content being taught in their classes. Through this OER grant, I'm happy to find Manes' (2017) open textbook. It can be downloaded in different forms and is of no cost to students. I do hope that other faculty members who require expensive textbooks spend time to search OER databases to find open textbooks that are appropriate for their courses or even create their own open textbooks for their classes. I found another one for my research class which I'm using this coming spring semester.

With the pressing demand to improve mathematics and STEM education, several publications compete for school districts' limited instructional materials budget. Schools can not sustain paying for increasing and constantly changing subscription rates for some of the technology tools used in teaching mathematics and science. Open source tools and materials like Geogebra, Desmos, CODAP, and PhET simulations allow teachers to continue to be creative in delivering mathematics and STEM content and emphasizing inquiry, discovery, and explorations in their classes. Through these learning materials, students are developing their understanding of mathematics and STEM through hands-on explorations. It is true that just like any other teachers, I need to invest time to learn about these instructional tools. I allot my summer professional development for that purpose. I, however, know that I don't have to worry about funds to maintain these tools since they are free and I can focus on learning more about these tools through professional development training. With these tools I reviewed and explored through this OER grant, I plan to redesign specific course assignments and projects to fully integrate them in teaching Educ 330 and Educ 362.