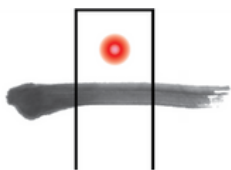




Credit: Rubén Perea

Yidan Prize



— 丹 獎

# Annual Report

January - December 2021

# Snapshot of Accomplishments

## PhET Team Expanded

To address PhET's growing research activities and international outreach plans, PhET has added five new members to their team.



**Lora Kaldaras**  
Post-Doctoral Researcher



**Zachariah Mbasu**  
Africa Ambassador



**Rebecca Vieyra**  
Associate Director of Global Initiatives



**Sola Olateju**  
Africa Specialist Consultant



**Nosa Oghafua**  
Project Strategy and International Relations Intern

## New Funding

PhET has successfully acquired additional funding to bolster its global impact.

### Gordon and Betty Moore Foundation: \$2.25M

To develop a new suite of simulations and enhance current simulations to promote data fluency, including the management of measurement uncertainty.

### Schmidt Futures: \$500K

To advance development of PhET-iO simulations as a tool for learning research and engineering.

### Organization of American States: \$10K

To develop a virtual workshop on the use of science sims for the Caribbean.

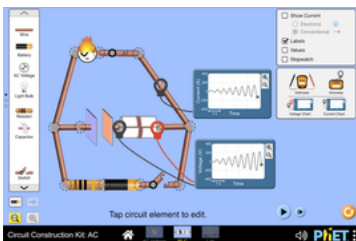
## Sims Developed and Improved

Numerous simulations have been developed or improved in 2021, with full or partial support from this grant. **We now have 94 simulations in HTML5**, all CC-BY licensed.

Several simulations are in progress.

Completed

- **Collision Lab**
- **Circuit Construction Kit (Suite of 4 simulations)**
- **Density**

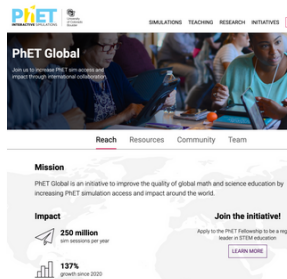


In progress

- **Geometric Optics** (prototype)
- **Normal Modes** (prototype)
- **Buoyancy** (in development)
- **My Solar System** (designed)

## New Global Activities and Programs Developed

### Webpage

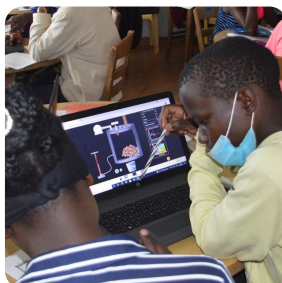


### PhET Fellowship for Latin America and Africa



Credit: Rubén Perea

### Africa Translator Network



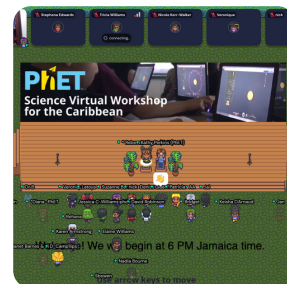
Credit: Zach Mbasu

### Africa Practitioner-Researcher Webinar Series

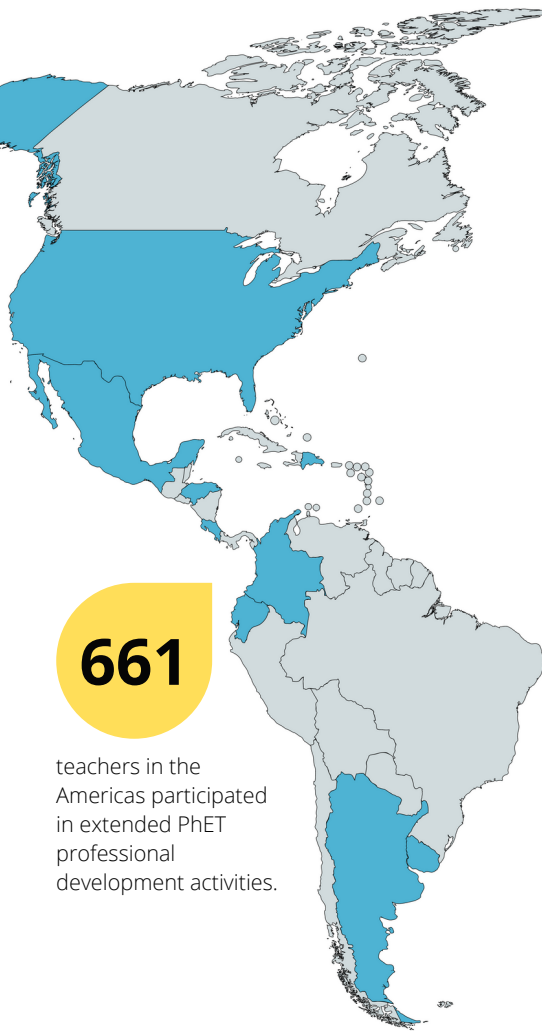


Credit: Diana López Tavares

### Science Workshop



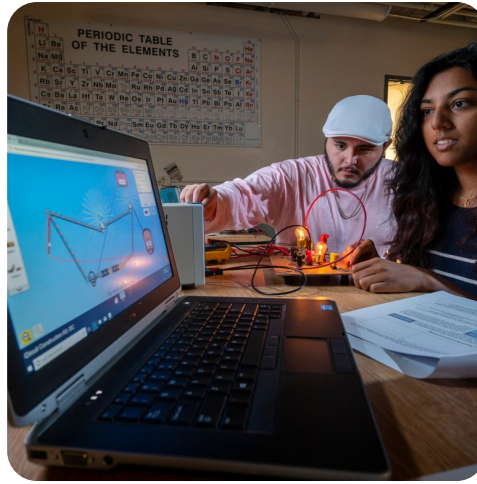




## Expanded Access through Teaching Materials and Workshops

25K+

teachers reached globally through short dissemination activities, such as presentations and webinars.



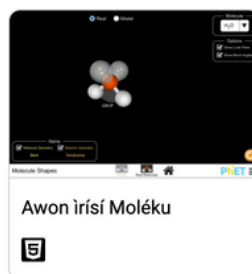
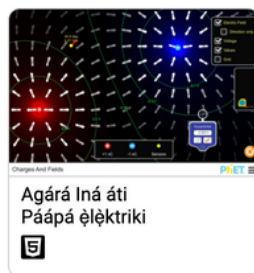
Created with mapchart.

## Translated all 90 HTML5 Sims into Yoruba

90 Results

Sort by: A-Z

Yoruba



50M

speakers of the Yoruba language now have access to PhET's most updated simulations, expanding PhET's impact across West Africa, including Nigeria, Benin, Cote d'Ivoire, Sierra Leone, and The Gambia.

# Research

## Goal 1: Build the research base on simulation-supported STEM expertise development.

*To carry out new research to examine and further advance the educational value of PhET simulations*

To prepare for expanded research activities, PhET conducted an extensive search and hired **Dr. Leonora Kaldaras** as a post-doctoral research associate working directly with **Dr. Carl Wieman's Research Group** at Stanford University. Leonora (Lora) holds a Ph.D. in Education from Michigan State University and a M.S. in Chemistry from Bowling Green State University. Her work focuses on designing learning environments and assessments to support students in developing deep understanding of big ideas in science. She has worked with teachers and students in a wide range of educational settings, including middle, high school and undergraduate gateway courses in science. She is a co-author of award-winning NGSS-aligned curriculum materials for high school called "Interactions". Her research with Dr. Wieman will study student learning and instructional design strategies to support the development of conceptual understanding and bridging conceptual and mathematical understanding across scientific disciplines



**Dr. Carl Wieman**  
& research team at  
Stanford University



**Dr. Leonora Kaldaras**  
Post-Doctoral  
Researcher

Academic activities funded by this grant will support explorations to answer the following **research questions**:

- How well do students learn predictive frameworks through sim-based educational activities?
- How well does this learning process transfer?

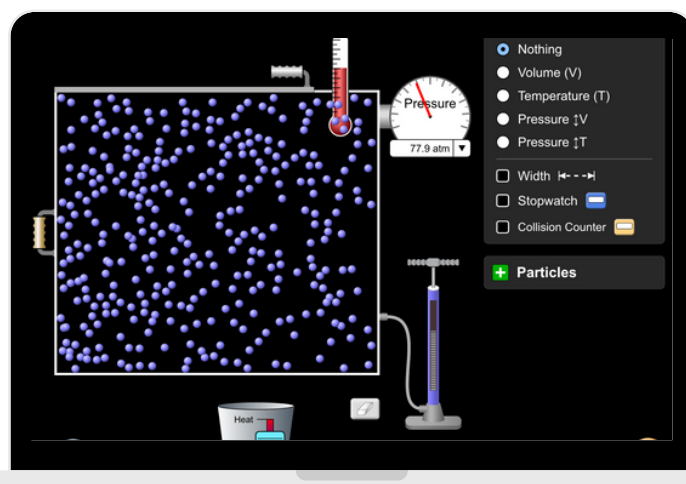
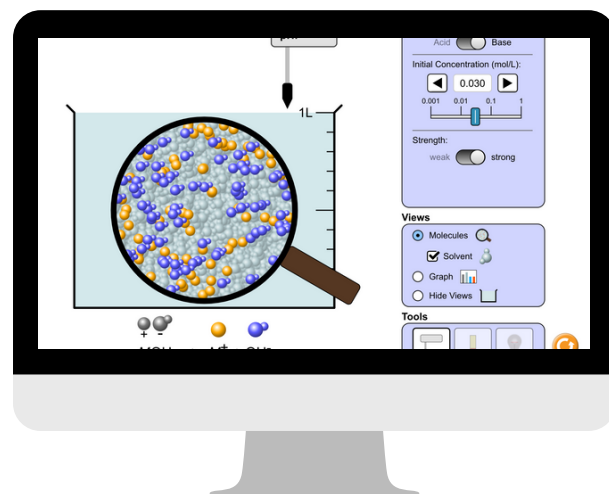
Lora is developing a **theoretical framework for mathematical sense-making in science using complex systems**. She has used PhET simulations to conduct interviews with 12 students to probe their sense-making across physics, chemistry, and climate science.

Tentative findings indicate that **PhET simulations allow the evaluation and support of students' ability to make sense of scientific phenomena mathematically**.

Next, Lora will develop:

- a mathematical sense-making in science assessment, and
- mini instructional sequences using PhET simulations to support their skills.

Lora has already submitted a chapter proposal to the *Information Age Publishing* call for chapter proposals on teaching in online, distance, and non-traditional contexts, entitled "**PhET simulations with implicit scaffolds: Overview of cognitive and non-cognitive learning outcomes and implications for online and hybrid teaching contexts.**"



# Access

## Goal 2: Expand simulation content coverage and access.

*To complete the design and development of 8-10 next-generation HTML5 PhET simulations for both physics and chemistry, filling in some of the most critical conceptual gaps in the current collection*

### Simulations

The following simulations have been developed, improved, or progressed, with partial or full funding support from this grant:

- **Circuit Construction Kit - DC** (republished with enhancements)
- **Circuit Construction Kit - DC Virtual Lab** (republished)
- **Circuit Construction Kit - AC** (newly published)
- **Circuit Construction Kit - AC Virtual Lab** (newly published)
- **Collision Lab** (newly published)
- **Density** (newly published)
- **Geometric Optics** (prototype published)
- **Normal Modes** (prototype published)
- **Buoyancy** (in development)
- **My Solar System** (designed)

### Offline Access

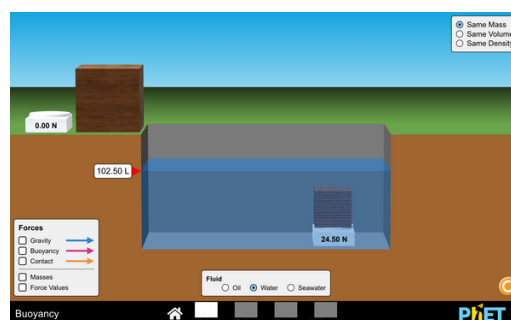
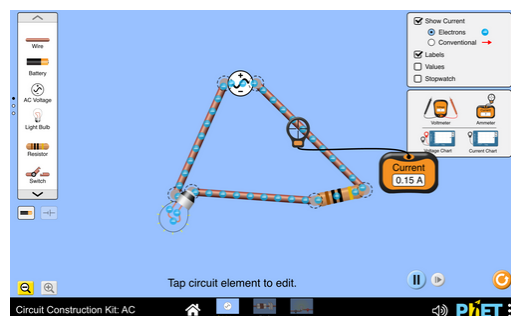
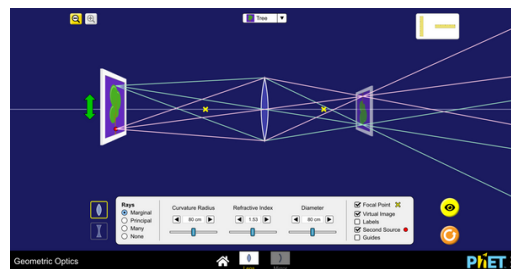
In January, PhET released the first version of the PhET **offline desktop app**. Users download and install the desktop app onto their Windows or MacOS computer, providing seamless use of all HTML and Java simulations without internet access. Ongoing work continues to add improvements to the user interface and functionality.

### Localization

**Technology:** The PhET team is working on needed improvements to PhET's translation tool (Rosetta), improving the user interface and enabling translators to easily identify untranslated words and simulations.

**Language:** To increase access, the team worked with its Africa specialists to identify translators for African languages. In a pilot program, all 90 simulations were translated into **Yoruba**, a language spoken by ~52 million speakers, mostly within Nigeria and surrounding countries.

**Usage Analytics:** The PhET team has created analytics reports to track educational and technological tendencies across Latin America and Africa with respect to PhET visitors. Throughout the grant, the team will track these analytics annually to observe any large-scale changes.

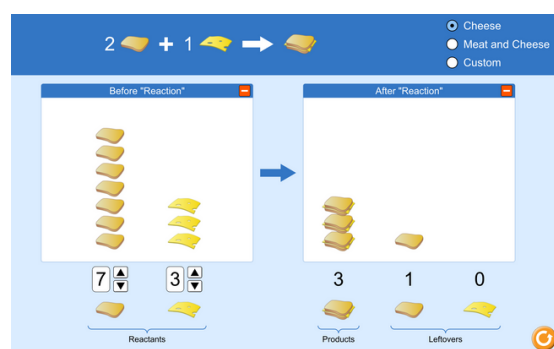


### Offline Access

- Desktop/Laptop
- Chromebook
- iPad



**Culture:** The team is also developing ideas for re-design of simulations that make use of analogies that lack cultural relevance in non-western cultures. For example, the **Reactants, Products and Leftovers** simulation uses sandwiches to illustrate ideas of chemical equations and limiting reactants. In cultures where sandwiches are not standard fare, this simulation will be adjusted for something more relatable.





# Access

(continued)

## PhET Translator Network & Trusted Translators

While PhET will continue to crowd-source translations of its simulations, website, and teaching resources from volunteers, the PhET team has prepared to launch a new program - the **Africa PhET Translator Network**.

This three-month cyclical program, to start in April 2022, will target translator recruitment and support for the following priority languages:

- **Northern African Region**
  - Berber
- **Southern African Region**
  - Chewa
  - Zulu
- **Western African Region**
  - Akan
  - Hausa or Fulani
  - Igbo
- **Eastern African Region**
  - Amharic
  - Kinyarwanda
  - Malagasy
  - Oromo
  - Somali
  - Swahili
- **This program may also support other African languages for which translators express a need.**



Beyond simply increasing language translations, the African PhET Translator Network includes a cohort-based experience that aims to increase a sense of global community, as well as to identify and recognize math and science educators who contribute their skills in service of their regions. Participants who successfully complete one cycle as a member of the network may be invited to receive a contract and stipend for extended work.

<b>1 March 2022</b>	Application
<b>15 March 2022</b>	Selection
<b>April 2022</b>	<b>Professional Learning (2 hours)</b> <ul style="list-style-type: none"><li>• Introduction to PhET simulations</li><li>• Translations<ul style="list-style-type: none"><li>◦ Web translation tools</li><li>◦ Quality assurance</li><li>◦ Language considerations</li></ul></li><li>• Culturally-relevant visualizations<ul style="list-style-type: none"><li>◦ Design considerations</li></ul></li><li>• Personal Translation Plan</li><li>• Monitoring</li></ul>
<b>May 2022</b>	<b>Network Activities</b> <ul style="list-style-type: none"><li>• Translation work (5 hours minimum across cycle)</li><li>• Monthly gathering (<b>1 hour</b>)</li></ul>
<b>June 2022</b>	<b>Network Activities</b> <ul style="list-style-type: none"><li>• Translation work (5 hours minimum across cycle)</li><li>• Monthly gathering (<b>1 hour</b>)<ul style="list-style-type: none"><li>◦ Reflection on Personal Translation Plan</li><li>◦ Cohort celebration</li></ul></li></ul>

The program cycle will be repeated multiple times until all HTML5 PhET simulations are available in the African priority languages. Later, we expect to expand the program to other high-needs languages beyond Africa.

**[Click to Learn More!](#)**



# Teaching Materials

## Goal 3: Create simulation-based lessons and teaching materials.

*To create high-quality simulation-based lessons and teaching materials for each next-generation PhET simulation with a co-design approach which involves experienced secondary physics and chemistry teachers from US, Canada, Latin America, and Africa regions*

In **Mexico**, two teachers have been recruited to work on national curriculum-aligned lessons, which are currently in development under the supervision of the Latin America PhET Ambassador. Other initiatives in progress include the incorporation of PhET materials into a science textbook to be adopted by 30+ schools in the state of Veracruz.

Additionally, the **PhET Global** team has contributed their own lessons as part of their team-building and professional on-boarding experience.

A total of 13 new lessons have been developed by the PhET team, including 7 Spanish-language lessons and 6 English-language lessons.

**Dr. Diana López**  
Latin America  
PhET Ambassador



**Rubén Perea Leyva**



**José Orozco**

Para responder las siguientes preguntas haz uso de la simulación con las opciones "velocidad" y "gráficas" activadas. (Sin fricción)

Elige la imagen en la cual el patinador tenga mayor energía potencial:



Explica ¿Por qué seleccionaste esa opción?

13



In **Colombia**, in collaboration with **IU Digital de Antioquia**, PhET developed **20 sim-based lesson modules** including student worksheets and teacher guides for biology, physics, and chemistry. These materials are accessible from the IU Digital Comunidad de Aprendizaje website, and also on the PhET Teacher Materials pages for their respective simulations.

PhET has updated its **curriculum alignment** guides for the **USA's Next Generation Science Standards** Performance Expectations and the **Common Core State Standards for Math**, as well as added new alignment guides for **Mexico's national science curriculum**.



¡Bienvenido a tu Comunidad de Aprendizaje!

Un espacio para el acompañamiento en la construcción individual y colectiva de escenarios de aprendizaje para el aula de clase.



## Alignment of PhET sims with NGSS

[HS NGSS Alignment 05-12-2021.docx](#) - 77 kB

[MS NGSS Alignment 09-02-2020.docx](#) - 69 kB

[Download](#) all files as a compressed .zip

# Global Professional Development

## Goal 4: Support global dissemination and teacher professional development.

*To enhance offline dissemination and access of PhET simulations globally and create a network of partnerships between PhET and global, regional, and local partners with an ultimate reach of at least 2,000 STEM teachers through the train-the-trainer model*



**Rebecca Vieyra**  
Associate Director of  
Global Initiatives

## Worldwide Activities

To prepare for expanded global initiatives, PhET conducted an extensive search and hired **Rebecca Vieyra** to support activities related to global professional development, dissemination, and partnerships. Rebecca brings her experience as a STEM education-focused program manager for the Inter-American Teacher Education Network of the Organization of American States. Previously, she served as K-12 Program Manager for the American Association of Physics Teachers. Rebecca is a prior high school physics teacher, and currently a doctoral candidate in Science Education at the University of Maryland. She received the Presidential Award for Excellence in Math and Science Teaching, and is an alumna of the Albert Einstein Distinguished Educator Fellowship where she advised NASA Aeronautics on education efforts.

PhET has engaged in extensive professional development and outreach activities across the globe, including those listed below.

### Partnerships



#### mEducation Alliance

PhET joined a global partner in the alliance's math-focused initiative, *MathPower!*, and is participating as a panel member in its September global virtual event.



#### Virtual Pro

Virtual Pro - an education technology company in Colombia - has integrated PhET sims into its digital laboratories.

### Worldwide Professional Development

#### Philippines

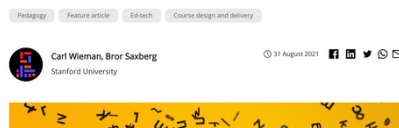
March 3: Hosted by MinSCAT

### Publications

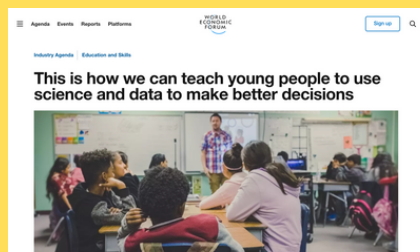
**Times Higher Education** (August 31)

#### Follow the (learning) science and put problem solving at the centre of teaching

Rather than a digital transformation, universities should undergo a learning transformation that supports evidence-based teaching, argue Carl Wieman and Bror Saxberg



**World Economic Forum** (August 20)



### Worldwide Dissemination

(external to Africa and Latin America)

*Presentations given by Dr. Carl Wieman*

#### Brazil

July 19: NSEF Colloquium

#### Canada

March 31: McGill University

#### China

November 15: Teaching Excellence Summit

#### Italy

November 27: State General for Digital School

#### Japan

September 21: Kagoshima University

#### Malaysia

November 10: UniMap's International STEM & Innovation Virtual Colloquium

#### Myanmar (Burma)

January 15: Parami University

#### Netherlands

January 28: University of Groningen

#### Saudia Arabia

August 16: KFUPM

#### United Kingdom

April 21: Cardiff-UCL DBER STEM Webinar

#### USA

- January 15: National Partners in Science Conference
- September 8: The Optical Society
- September 9: Andre Adler Science Education Colloquium
- September 27: Cornell University
- October 21: University of Mississippi
- December 7: Materials Research Society Education Symposium

*Presentations given by other members of the PhET team*

#### Qatar

December 9: WISE Summit 2021

#### USA

- October 20: Rocky Mountain Regional ACS Meeting
- October 22-23: Illinois Section of the American Association of Physics Teachers
- November 16: Paradise Valley Unified School District, Arizona



# Global Professional Development

(continued)

## PhET Fellowship

To support multiple goals related to access and impact, by April 2022 the **PhET Fellowship** will identify a cohort of 12 educators across Latin America and 12 educators across Africa.

PhET Fellows will:

- Improve PhET sim access by disseminating PhET simulations and pedagogy.
- Improve PhET sim impact by providing professional development opportunities for other educators.
- Embed PhET Fellowship activities directly into their existing work and professional activities.
- Participate in 150+ hours of professional development with 20+ other educators across the globe.
- With the support of PhET, develop and execute a Professional Leadership Plan to increase PhET sim access and impact by influencing other educators in your region.



as of January 1, 2022, PhET has received 438 expressions of interest and 31 applications.

<b>March 2022</b> March 1	Fellowship Applications Close (11:59 PM, applicant's local time)
<b>April 2022</b>	Application Review, Interviews, and Selections
<b>May 2022</b>	<b>Professional Learning Begins (80+ hours total)</b> <b>Community-Building</b> <ul style="list-style-type: none"> <li>• Getting to Know You / Starting the Journey (2 hours)</li> <li>• Developing Soft Skills / Collegiality (2 hours)</li> <li>• Developing a Vision for STEM Teacher Leadership (2 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>June 2022</b>	<b>Instructional Leadership</b> <ul style="list-style-type: none"> <li>• Making the Case for PhET Sims—the Research (2 + 2 hours)</li> <li>• Mathematics &amp; Science Virtual Workshop - Introduction (2 + 5 hours)</li> <li>• Mathematics &amp; Science Virtual Workshop - Preparing your Lesson Plan (2 + 5 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>July 2022</b>	<b>Instructional Leadership</b> <ul style="list-style-type: none"> <li>• Mathematics &amp; Science Virtual Workshop - Implementing and Reporting your Lesson (2 + 10 hours)</li> <li>• Mathematics &amp; Science Virtual Workshop - Sharing &amp; Peer-Review (2 + 10 hours)</li> <li>• Principles of STEM Teacher Education (2 + 2 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>August 2022</b>	<b>Association Leadership</b> <ul style="list-style-type: none"> <li>• Leadership for Learning (2 + 2 hours)</li> <li>• Personal Networking and Communities of Practice (2 + 2 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>September 2022</b>	<b>Policy Leadership</b> <ul style="list-style-type: none"> <li>• Understanding Systems to Conceptualize Challenges (2 hours)</li> <li>• Developing Logic Models to Solve Problems (2 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>October 2022</b>	<b>Final Lesson Plan Due</b> <b>Professional Leadership Plan Due</b> <ul style="list-style-type: none"> <li>• Personal Coaching (2 hours)</li> <li>• Poster Session (2 hours)</li> <li>• Community of Practice Reflection (2 hours)</li> </ul>
<b>November 2022</b>	<b>Professional Leadership Practice Begins (70+ hours total)</b> <ul style="list-style-type: none"> <li>• Monthly update form, monthly coaching (as needed)</li> </ul>

The 18-month Fellowship includes 80+ hours of professional learning (May - October 2022) and 70+ hours of PhET-coached independent professional leadership practice (November 2022 - October 2023). Each Fellow will receive a stipend payment for successful completion of the program.

Expected outcomes of this program will include:

- 24 highly skilled PhET Fellows who serve as change agents for active learning with PhET simulations in their countries and continents
- 480 educators trained in-depth by PhET Fellows
- 48+ contributions of new activities documented on the PhET website
- Substantial evidence of dissemination activities carried out with thousands of teachers and students across Latin America and Africa

[\*\*Click to Learn More!\*\*](#)



# Global Professional Development

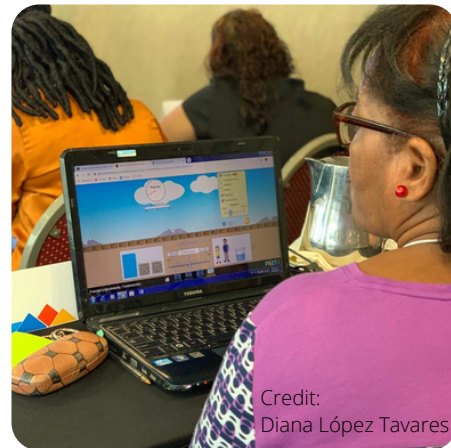
## (continued)

## PhET Research-Practitioner Webinar Series

The **PhET Research-Practitioner Webinar Series** will consist of a line-up of monthly webinars featuring researchers and educators across Africa.

The purpose of this series will be to transform PhET-related education research into classroom practice, and to elevate the voices of researchers and practitioners who desire to connect with other like-minded professionals.

A line-up of events will be available publicly in the first quarter of 2022.



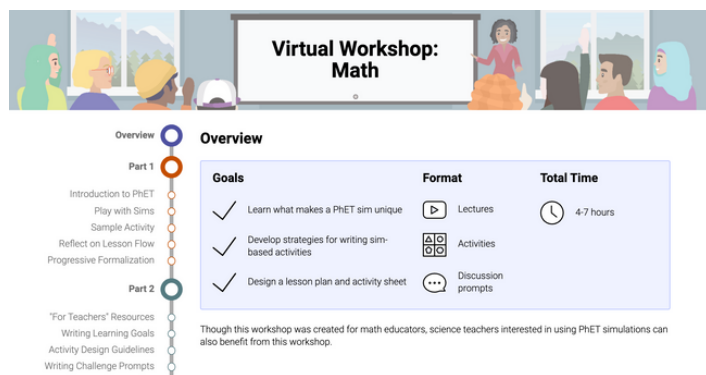
Credit:  
Diana López Tavares

## PhET Math and Science Workshops

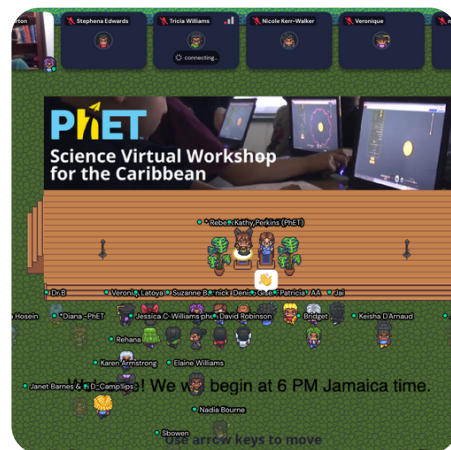
To support self-paced professional development anywhere and anytime, PhET has designed and developed virtual workshop templates. The virtual workshops may be self-paced or used in conjunction with facilitation from the PhET Global team, as described below.

### Math Virtual Workshop

Developed in early 2021, the Math Virtual Workshop built off of PhET's prior success with in-person extended workshops to introduce educators to PhET's pedagogical techniques, including progressive formalization, writing learning goals, activity design, and challenge prompts.



The Math Virtual Workshop is available in English, Dutch, Italian, Portuguese, and Spanish.



### Science Virtual Workshop

Developed in late 2021 as part of a collaboration with the Organization of American States (a multilateral organization serving 34 countries of the Americas), the Science Virtual Workshop was piloted in November and December with over 500 teachers from the Caribbean.

The workshop experience was facilitated through four synchronous sessions, including a final poster session in which participants provided evidence of PhET simulation implementation.

The Science Virtual Workshop is under revision and will be posted publicly in English and Spanish in 2022.

# Global Professional Development

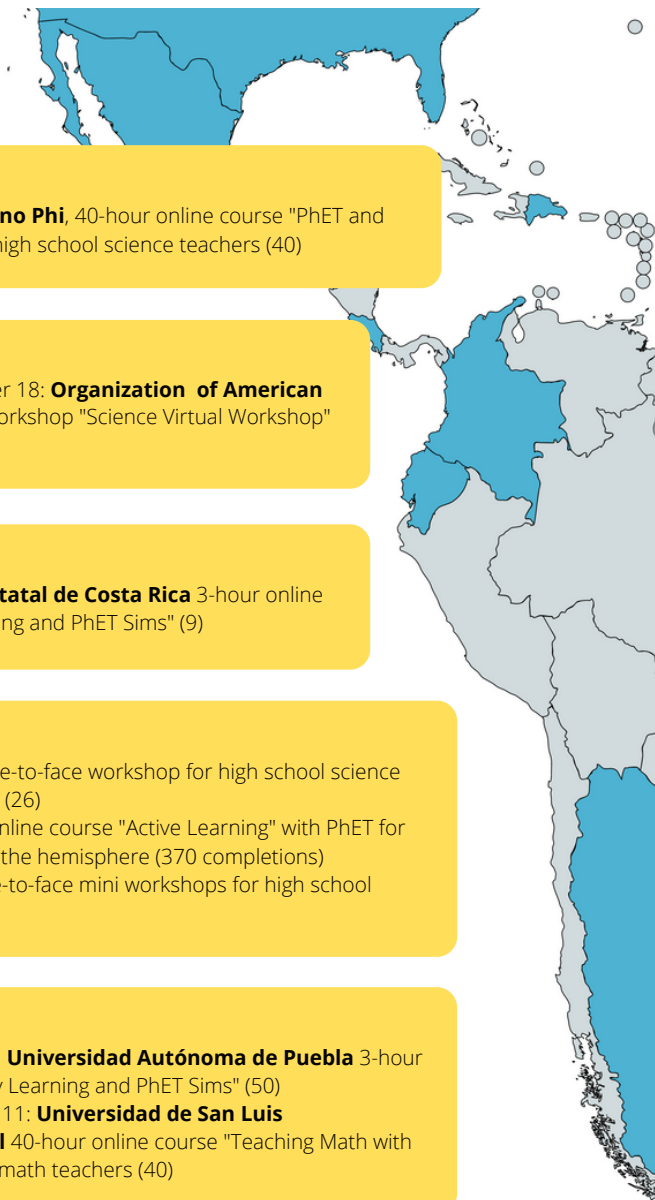
(continued)

## Latin America and the Caribbean

PhET's work across Latin America and the Caribbean is carried out primarily by Dr. Diana López, a specialist in physics education who has extensive experience in teaching. Together with a number of on-the-ground partners in secondary and tertiary schools, Diana is leading initiatives to integrate PhET into undergraduate coursework, student textbooks, and teacher professional development programs.



Credit: Diana López Tavares



### Argentina

- April 5-May 28: **Fenómeno Phi**, 40-hour online course "PhET and Inquiry" for middle and high school science teachers (40)

### Caribbean Region

- November 12 - December 18: **Organization of American States** 30-hour online workshop "Science Virtual Workshop" (500+)

### Costa Rica

- July 6-8: **Universidad Estatal de Costa Rica** 3-hour online workshop "Inquiry Learning and PhET Sims" (9)

### Colombia

- March 12: **IU Digital** face-to-face workshop for high school science teachers in rural regions (26)
- April 19-23: **IU Digital** online course "Active Learning" with PhET for 3,500 registrants across the hemisphere (370 completions)
- July 9-23: **IU Digital** face-to-face mini workshops for high school science teachers (60)

### Mexico

- May 28-29: **Benemérita Universidad Autónoma de Puebla** 3-hour online workshop "Inquiry Learning and PhET Sims" (50)
- September 2-November 11: **Universidad de San Luis Potosí/Escuela Normal** 40-hour online course "Teaching Math with PhET" for middle school math teachers (40)

### Regional Dissemination

(Educators reached in parentheses)

#### Argentina

- August 3: **Ministerio de Educación de Tucumán** (20,000+)

#### Brazil

- October 27: **LASERA** (25)

#### Colombia

- February 3: **Universidad de la Sabana** (80)

#### Costa Rica

- April 13: **Universidad Nacional de Costa Rica** (200)

#### Ecuador

- October 25: **Universidad Politécnica** (130)

#### Dominican Republic

- January 21: **SoDoFi** (135)

#### Honduras

- July 16: **Escuela Pedagógica de Honduras** (170)

#### Jamaica

- September 9: **Shortwood Teachers College** (130)

#### Mexico

- Feb 3: **DGTEY** (1080)
- March 8 / May 26: **Ieducando/APISEC** (730)
- March 24: **Universidad de la Salle Bajío** (200)
- May 11 / June 9 / July 15: **Escuela Normal Superior de Guanajuato** (107)
- June 18: **Universidad Autónoma del Estado de Hidalgo** (30)
- August 10: **ColMeNaB** (35)
- August 11: **IEMS** (52)
- August 19: **IPN** (119)
- October 29: **Universidad de la Salle** (50)
- November 11-13: **American Association of Physics Teachers Mexico Section** (20)
- November 16: **CBTIS Chiapas** (53)
- November 23: **Academy of the Secretary of Education, Nuevo León** (199)
- November 23: **Movimiento STEM** (20)

#### United States

- January 11: **American Association of Physics Teachers** (10)

#### Regional

- August 5: **Ministerio de Educación y Cultura de Uruguay, Universidad Autónoma de Santo Domingo Dominican Republic, Ministerio de Educación de Tucumán Argentina, and Fundación Patagónica Cruzada Argentina** (552)



# Global Professional Development

(continued)

## Africa

The PhET team has begun to lay the foundation for intensive work in Africa, adding three specialists. **Zachariah Mbasu** and **Sola Olateju** are respectively located in Kenya and Nigeria, and will advance professional development and dissemination efforts across Africa. Zach Mbasu is a prior math teacher and founder of African Maths Initiative with expertise in managing educational research projects and STEM camps across the continent. Sola Olusola brings experience disseminating and supporting the adoption of education technology solutions and teacher professional development across Africa. **Nosa Oghafua** is founder of Learnira, an organization engaged in teacher professional development using PhET sims in Nigeria, and is currently an MBA student at CU-Boulder.

This work will be accelerated with substantial grant funding from an additional partner. In addition to funding HTML5 sim development, this grant will fund PhET partnerships for 10 African edtech companies, professional development with 12 universities, localization of sims for the African context, and a African-focused PhET webinar series.

**Zachariah Mbasu**  
Africa PhET Ambassador



**Sola Olateju**  
Africa Specialist  
Consultant



**Nosa Oghafua**  
Project Strategy and  
International Relations Intern

### University Network

PhET is working to establish connections with universities in the following countries:

<b>Benin</b>	<b>Kenya</b>	<b>Tanzania</b>
<b>Cameroon</b>	<b>Rwanda</b>	<b>Uganda</b>
<b>Ethiopia</b>	<b>Senegal</b>	
<b>Ghana</b>	<b>South Africa</b>	

### South Africa

- Integration of 90 PhET simulations into **Zibuza.net**, a virtual platform funded by the **Dr. CL Smith Foundation** that provides free resources to thousands of math and science teachers.



### Rwanda

- March 10-11: **University of Rwanda** 6-hour virtual workshop for 40 education faculty and leaders of a large World Bank funded curriculum project.

### Regional

- November 23: **Conference on Mathematics, Science and Technology Education in Africa (COMSTEDA)** Two 90-minute virtual workshop for 90 educators across Africa



Credit: Zach Mbasu

