



FOSSEE Summer Fellowship Report

On

Creating Spoken Tutorials for PhET Simulations

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I am exceedingly thankful for this fellowship as it is a major milestone in my professional development. Going ahead, I will try to adapt these skills into my career and life. I hope to work with FOSSEE and the Spoken Tutorial team again in the future.

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Chapter 1

Overview

Spoken Tutorial and FOSSEE (Free/Libre and Open Source Software for Education) are projects at Indian Institute of Technology Bombay. They aim to promote the use of open source tools throughout India and reduce the use of proprietary software.

During my two month fellowship, I was tasked to create tutorials using PhET simulations for Mathematics and Chemistry. I was able to contribute 5 tutorials to the PhET series. To create these tutorials, I performed various roles like exploring the PhET simulations, writing scripts, preparing slides, novice review, recording, etc.

It was an incredible learning opportunity which I have detailed in this report. I have started with describing the Spoken Tutorial project and its process. I have also mentioned the tutorials I have worked on. After that, there is a detailed account of my contributions. Finally, I conclude the entire experience.

Chapter 2

Spoken Tutorial

2.1 Spoken Tutorial Project

Spoken Tutorial is a multi-award winning educational content portal. It provides numerous different resources on free as well as open source software so that any user can learn them at their own convenience. It also provides the freedom to choose from multiple languages. According to their expertise, a learner can choose from courses ranging from Beginner to Advanced level. To ensure the active participation of the learner, the tutorials include side by side practice as well. The Spoken Tutorial project is funded by the National Mission on Education through Information and Communication Technology (ICT), launched by the Ministry of Human Resources and Development, Government of India. In these times where digital learning has become increasingly popular, initiatives like the Spoken Tutorial Project are of vital importance.

2.1.1 Process of creating a Spoken Tutorial

- **Outline:**
An outline for the topic is created to help us get a basic understanding of the subject and to give some idea about the structure and sequence of the overall tutorial.
- **Script:**
A script is the written form of the spoken tutorial. Each sentence said during the recording is according to the script. This is made according to the guidelines by the ST team. For a good spoken tutorial, the script needs to be simple with appropriate visual cues.
- **Slides:**
Slides are made to help explain certain topics in the script. They are made corresponding to the script. LaTeX Beamer environment is used to create the slides. For a specific FOSS, templates are used to make the slides. These slides should follow the guidelines given by the ST team.
- **Novice check:**
Novice check is done by a person who has a very little knowledge about the

ST to make sure that the script and slides are easy to understand. The novice also points out mistakes made in the script and slides.

- Recording:

The video is made according to the ST guidelines. Extra care is taken to minimize mistakes and ensure the proper quality of recording.

- Review:

After the above steps, all the related files are sent to the reviewer who verifies the recording and files according to the spoken tutorial guidelines and checklist. This is to ensure a good quality of the content being uploaded. Once all the criteria is met, the reviewer publishes the tutorial on the spoken-tutorial website.

Chapter 3

PhET Simulations

3.1 PhET Interactive Simulations Project

The Physics Education Technology (PhET) project was started in 2002 by Nobel Laureate Carl Wieman. His aim was to significantly improve the way science is taught to help boost students' understanding. It is a non-profit project at the University of Colorado, Boulder. All the simulations are available freely at their website- <https://phet.colorado.edu/>. They can even be downloaded for offline use.

PhET simulations are interactive simulations covering a wide-range of topics in different subjects such as Mathematics, Chemistry, Physics, Biology etc., for elementary, middle and high school levels. PhET simulations animate concepts which are otherwise invisible through the use of graphics and intuitive controls such as click-and-drag manipulations, sliders and radio buttons. This help students visually comprehend those topics.

The design process for each simulation involves defining the learning goals, then animating the design and lastly taking feedback from students and teachers to make improvements.

3.2 PhET Simulations for Mathematics

The mathematics simulations allow students to learn math concepts in an highly interactive and engaging environment to further deepen their knowledge. There are simulations for a large number of concepts including the number line, fractions, areas, vectors, graphs etc.

3.3 PhET Simulations for Chemistry

The chemistry simulations gives students a platform to construct their own understanding of some of the most fundamental concepts. The simulations include topics

such as atoms, molecules, states of matter, energy forms, diffusion, pH scale, concentration, molarity etc.

I have explored 5 different simulations, their teaching resources and the teacher-submitted activities to learn more about them. It gave me a better grasp of the interface and how to explain the topics in a tutorial. I have described them in detail in the next section.

Chapter 4

Contributions

4.1 Creating Spoken Tutorials for Mathematics PhET Series

In the Mathematics PhET simulations, I have worked on 3 tutorials:

- Number Line: Distance
- Number Line: Integers
- Number Line: Operations

4.1.1 Number Line: Distance

This tutorial explains how to represent integers on a number line and further calculate their distance on the line which will be equal to their difference.

I explored this simulation. It has 2 screens, namely **Explore** and **Generic**, and various different tools such as a number line, distance labels, point labels, distance statement box to automatically calculate the distance etc. The Explore screen has 3 scenarios. Then, I wrote the script and made the slides for this tutorial. After it was checked by my mentor and a novice, I also completed its recording.

4.1.2 Number Line: Integers

Building on the 'Number Line: Distance' tutorial, this tutorial uses integers to define positive and negative values in different real-life contexts. Then, it explains how to compare them on the number line.

This simulation also has 2 screens- **Explore** and **Generic**. Some of the tools are similar to the Number Line: Distance simulation such as the number line, labels and different scenarios. However, the simulation has a comparison statement box to compare integers on the number line. After exploring and understanding the simulation, I wrote the script and made the slides for this tutorial. After it was checked by my mentor and a novice, I also completed its recording.

4.1.3 Number Line: Operations

This tutorial is a continuation in the Number Line tutorial series. It explains how to add as well as subtract integers using the number line.

This tutorial has 4 screens- **Chips**, **Net Worth**, **Operations**, and **Generic**. All of them have a number line, operation labels and descriptions, and a total box to calculate the total amount after all operations are performed. We can add assets and debts to the line using the tools and functions present on each screen. I wrote the script and made the slides for this tutorial. After it was checked by my mentor and a novice, I also completed its recording.

4.2 Creating Spoken Tutorials for Chemistry PhET Series

In the Chemistry PhET simulations, I have worked on 2 tutorials:

- Building Molecules and Molecule Shapes
- Concentration and Molarity

4.2.1 Building Molecules and Molecule Shapes

This tutorial explains how to build molecules using atoms. It also describes their different types of geometries.

I explored the Build a Molecule and Molecule Shapes simulations. Build a Molecule has 3 screens- **Single**, **Multiple** and **Playground**. All of them contain various atoms that can be joined together to make molecules. Molecule Shapes has **Model** and **Real Molecules** screen. We can add single, double, triple bonds and lone pairs to an atom to check different molecular and electron geometries. I wrote the script and made the slides for this tutorial. After it was checked by my mentor and a novice, I also completed its recording.

4.2.2 Concentration and Molarity

This tutorial defines concentration and molarity of a solution. It also displays the relationship between concentration and color of a solution as well as concentration and volume of a solution.

Both the Concentration and Molarity simulations have only one screen. In the Concentration simulation, we can choose from many different solutes and mix different quantities in water. We can check the concentration using a special tool. Similarly, we can select from a number of solutes in the Molarity simulation as well. Here a bar displays the molarity after we select the solute amount and solution volume. After exploring both these simulations, I wrote the script and made the slides for this tutorial. After it was checked by my mentor and a novice, I also completed its recording.

Chapter 5

Novice Check

In the Mathematics PhET simulations, I performed the novice check for 3 tutorials:

- Vector Addition
- Curve Fitting
- Least Squares Regression

In the Chemistry PhET simulations, I performed the novice check for 2 tutorials:

- Salts and Solubility
- Conductivity

Apart from the above novice checks, I have done a novice check of a GeoGebra script- Scripting and LaTeX in GeoGebra.

Chapter 6

Professional outcomes

Professional skills developed during this internship are:

- Workplace communication skills
- Time management
- Working in a team with other interns
- Creating work reports and presentations using LaTeX

Chapter 7

Challenges

Challenges that I faced during the fellowship:

- Exploring and understanding the PhET simulations
- Writing spoken tutorial script according to given guidelines
- Using LaTeX to make presentations and report for the first time
- Recording a spoken tutorial
- Time management
- Revising chemistry concepts such as concentration and molarity

Chapter 8

Conclusion

In conclusion, being a part of the FOSSEE Summer Fellowship 2022 was a remarkable experience. It helped me gain new knowledge through working on 5 tutorials in PhET series. Along with brushing up my understanding of some fundamental mathematics and chemistry, I also learned a lot of valuable soft skills such as communicating with one's peers and mentors, and managing one's time efficiently. Additionally, I got a chance to learn about some new prospects of open source software.

Each of these newly imparted skills will definitely be extremely useful in my professional career. I feel a sense of accomplishment and contentment knowing that my work in this fellowship would be of use to an umpteen number of people via the Spoken Tutorial website. I would like to express gratitude to all my mentors as well as my fellow interns who turned this fellowship into such a fascinating experience.

Chapter 9

Useful Links

9.1 PhET Simulations for Mathematics

Number Line: Distance :

<https://drive.google.com/drive/folders/1VI-d6z0HZG1DGXhrjyt8pyGLs0MhZDb7>

Number Line: Integers :

https://drive.google.com/drive/folders/1g3A_FSahRZ1KII0IuIG1WWNFJQXh2gWk

Number Line: Operations :

<https://drive.google.com/drive/folders/1uWuEjRzNugj5NBwtGCXxgxVc2QueCb6Q>

9.2 PhET Simulations for Chemistry

Building Molecules and Molecule Shapes :

<https://drive.google.com/drive/folders/1NXBT5QqXf84Krn9U6FVUmbenf5NfNN23>

Concentration and Molarity :

https://drive.google.com/drive/folders/1dqmcdeNx_MeTABe-2kgP9tqwQv1gSKpo

9.3 Recordings

https://drive.google.com/drive/u/1/folders/1Is_ef0E1kxNj7v8IjS9BLrkGbsh6_m11

9.4 Reference

- <https://spoken-tutorial.org/about-us/>
- <https://spoken-tutorial.org/>
- <https://phet.colorado.edu/>