



“Re-Simulating”: Physics Simulations for Blind Students

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Abstract

Most of the current research emphasizes that computer simulations support comprehension of physics concepts. However, it is still inefficient tool for blind students since simulations are based on visual senses. Activities which just involve changes behind a screen without use of other senses are pointless for blind students. At this point, two questions become prominent: “How can a physics teacher adapt these useful materials into a suitable form for a blind student?” and “In which degree adapted simulations will be useful for the blinds?”. To explain these questions our study focuses on a motion simulation and adapts it for blind students by using a simple tool. A simple tool was chosen due to two reasons. Firstly, simple materials are obtainable and cheap to buy. Secondly, we have no possible method to make simulations visible for blinds except for making them tactile using similar models.

In this study we separate a typical simulation into two main parts. One of them is independent part in which users enter values and manipulate variables. The other one is dependent part demonstrating what have been chosen. For the case of this study we selected “Moving man Simulation” from Colorado University’s Phet Group. In that simulation, there are three boxes to enter the values of position, velocity and acceleration. The position of man and motion graphs changes accordingly to these values. Graphs and motion part may be thought as a dependent part and the part in which values were entered as independent part of the simulation since the motion graphs and man’s motion are dependent on the entered values. For each part, dependent and independent, there are two steps to prepare a similar and tactual simulation for blinds. First step is focusing on transforming simulations into a tactile structure by the help of simple tools. Second one is defining similarities of the adapted material and the simulation. Computer simulations are virtual forms of real events. Similarly, adapted physics simulations for blind students are tactile form of virtual forms. The whole process of adaption can be called as “re-simulating”. Although we do not claim that all computer simulations are appropriate to re-simulating and the re-simulated model will be same as original, we support the idea of that study that computer simulations can be re-simulated and adapted for blinds. Since simulations are not suitable for the use of blind students, they would prefer to work on re-simulated model, instead of just sitting, while their classmates are exploring the computer simulations. For this reason moving man simulation was re-simulated by using a ruler, marked at the middle as a reference point. A movable paper hoop was used as a moving man. Additionally, for the dependent part of simulation, a hot-plug surface was used to draw graphs.

1. Introduction

As a branch of science, physics seems highly complex and abstract domain among students. While learning physics, students have difficulty to establish connection between physics concepts and real world. Therefore, they show little interest toward physics and are unable to understand important topics. To enhance achievement and interest in physics, some useful teaching strategies can be regarded as a way of providing active engagement in physics lessons. Working with computer-based tools such as simulations can be considered as a useful support to enhance students’ learning [1][2][3][4]. Simulations create modeling environments, eliminate complicated parts and provide students to do experiments and observations. Students investigate complex concepts and make it visible; manipulate variables and explore easily relationships among phenomena [5]. Although simulations have lots of benefits in many ways for learning science especially learning physics, they are still inefficient tool for visually impaired students. Due to the structure, simulations mainly address visualization. But for blind students, being tactile is the most important feature for perception and meaningful understanding. Based on science for all, regardless of categorizing students as impaired or not, we aim to use simulations for all students as a part of inclusive education.



The researchers of this study try to make simulations accessible for blind students proposing the “re-simulating” model (Fig .1). After offering this model, it is expected that teachers modify simulations and use in their inclusive classrooms. Hereby, blind students can understand the topic easily with re-simulation, while classmates are operating simulations.

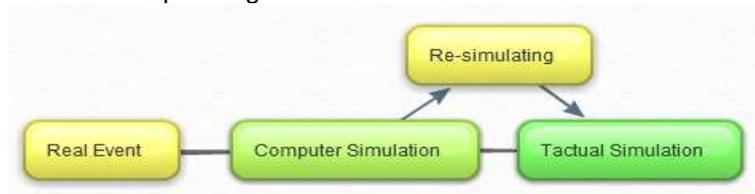


Fig. 1. Re-simulating

With the help of re-simulating (Fig 1 and Fig 2), teachers can choose appropriate simple materials that are easily accessible and cheap for making simulations suitable for visually impaired. In the light of these above, our study focuses on two questions:

- (1) How can a physics teacher adapt these useful materials into a suitable form for a blind student?
- (2) In which degree adapted simulations will be useful for the blinds?

2. Methodology

Based on the research questions, this study defines the steps to transform a simulation into tactile form for visually impaired students. This process is named as ‘Re-Simulating’. In addition, according to defined steps, an example re-simulation was developed. The usability of that simulation was tested with two blind students in the classroom environment.

2.1 Re-simulating steps

Re-simulating process is shown in Figure 2 with main steps. As seen in this figure, first step is to choose a simulation to re-simulate. Then, the dependent and the independent parts of the simulation need to be defined. Independent part is the part that users enter values and manipulate variables. Dependent part demonstrates the changes in terms of manipulated variables. The next step is to transform the dependent and independent parts into tactile form using simple tools. A simple tool was chosen due to two reasons. Firstly, simple materials are obtainable and cheap to buy. Secondly, we have no possible method to make simulations visible for blinds except for making them tactile using similar models. After that, the similarities and the differences between simulation and re-simulation for two parts should be determined. Lastly, connections between parts of the re-simulation need to be established. Clearly, making connections refers to the use of dependent part in terms of changes in the independent part.

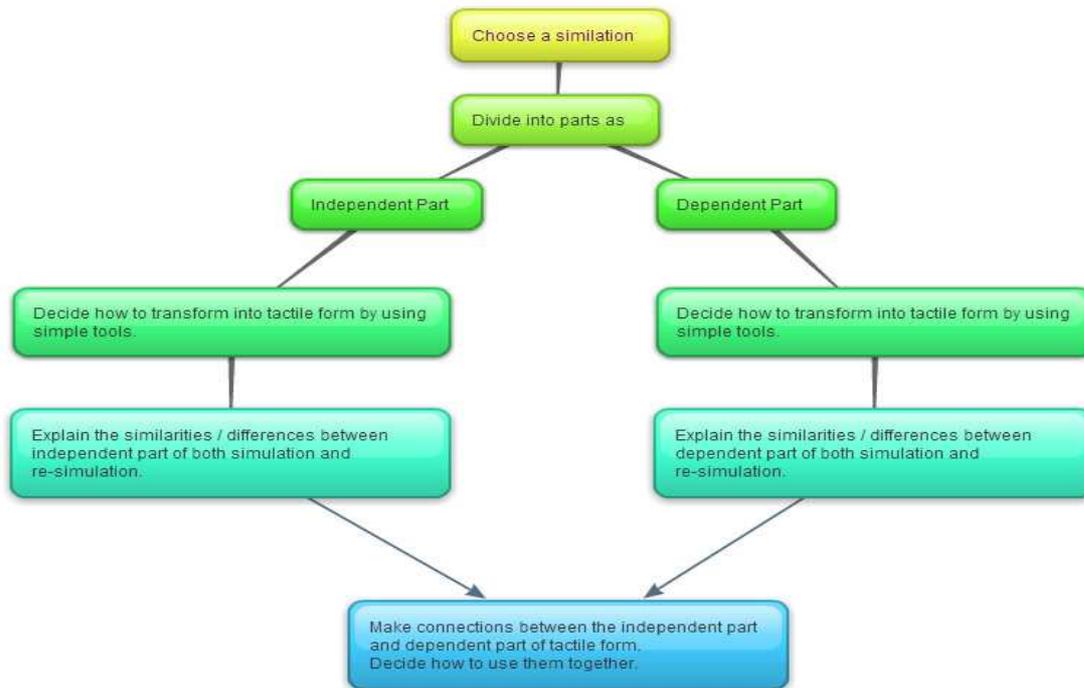


Fig. 2. Re-simulating steps

2.2 Re-simulating model

For the case of this study, “Moving man Simulation” [6] from Colorado University’s Phet Group was selected for re-simulating. In physics, research-based interactive simulations created by PhET (The Physics Education Technology) project from Colorado University are one of the most preferred tools to help students ensuring cause-effect relationships between variables [7]. The website has been updated regularly and developed. All simulations are accessible freely.

Moving man simulation is related to concept of motion including, position, velocity and acceleration graphs. In that simulation, there are three boxes to enter the values of position, velocity and acceleration. The position of man and motion graphs changes accordingly to these values. Graphs and motion part are defined as a dependent part and the part in which values were entered as independent part of the simulation since the motion graphs and man’s motion are dependent on the entered values. Simulation gives opportunity to use the moving man as dependent and independent variable. If students change moving man without entering position values, then the moving man part will be used as independent part. These parts are shown on Moving Man simulation in figure 3.

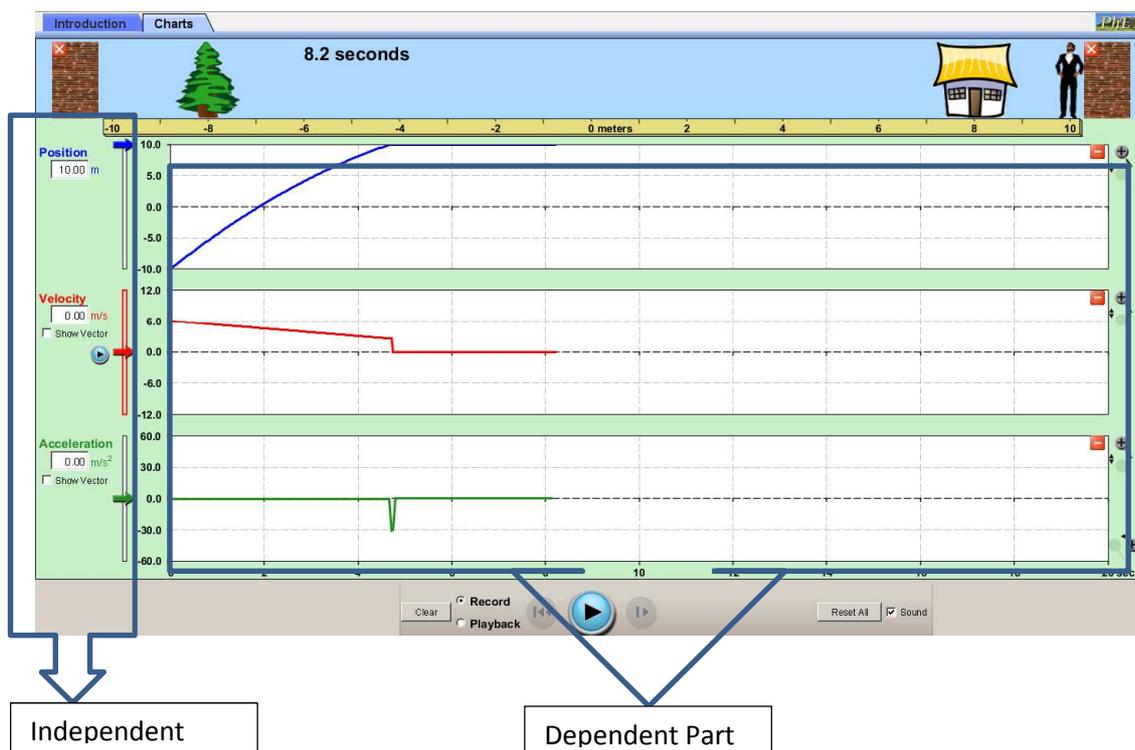


Fig. 3. Independent and dependent parts of moving man simulation

2.3 Re-simulating process for “moving man” simulation

At the beginning of re-simulating process, we divide the moving man simulation into two parts instead of teachers and explain them how to use during the course. There were two physics teachers from different schools. Both of them teach to 9th grade students and each one has a blind student. It was explained to the teachers that for sighted students, simulation will be used in a traditional way; and, for blind students, two different materials will be used for re-simulation. Table 1 shows the similarities between simulation and re-simulation.

Table 1. Similarities between simulation and re-simulation

	Simulation	Re-simulation
Independent Part	Boxes to enter position, velocity and acceleration	Verbal directions
	The moving man	A piece of paper circled around the ruler
	Path of the moving man	Ruler
Dependent Part	Graphs	Tactile graphs

Independent part consists of a system with a ruler and dependent part consists of a kind of board (figure 4). Ruler was marked at the middle as a reference point and a piece of paper was circled to move on the ruler. Paper simulates the moving man and ruler simulates the path of the man. This part is used as independent part because user decides the position of man and the direction of motion. The board which can be used for adding and removing black stick to draw a graph is defined as dependent part because of the fact that user has to show graphs according to his/her decision.



Fig. 4. Use of re-simulated materials; ruler and board by visually impaired

Generally, sighted students had decided which values will be entered to work simulation with and they wrote those values into the simulation's empty box (figure 5). Physics teachers organized the activity totally. They allowed students to test any of cases (figure 6) and checked what blind students do. Both teachers explain blind students how to use the re-simulated materials.



Fig. 5. Inserting data to the simulation by a sighted student



Fig. 6. Discussion about simulation

Although one class used interactive board and others used projector machine to see the graphs, both of the classes enjoyed the activity as it was predicted and additionally blind students are followed the course. One of the blind students answered a question correctly about the motion graph. During the courses it was observed that they were busy with re-simulated materials and they participated the course discussions.



3. Conclusion

This study gives directions to the teachers of inclusive classes about how to make simulation accessible for their visually impaired students. As an example, the researchers updated moving man simulation into tactile form for blind students in terms of defined re-simulation processes. Developed re-simulation was tested in two different classes. During the applications, re-simulation was found to be effective. Feedbacks from visually impaired students were positive. In this study, it is not claimed that all simulations are appropriate for re-simulating model; or simulation and re-simulation are totally the same. They have similar and different points that needed to be explained during re-simulating process. For re-simulation, there is not only one way. Different re-simulations can be emerged by different teachers for same simulations by using different materials. It is obvious that classroom application of re-simulation needs further studies to check and validate for utility in the inclusive classrooms.

References

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