Universität Potsdam

Solving Simple Linear Equations in VR

Exemplified with the Beam Balance

A Concept for Mathematics Education
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VR Math Space - Working in the VR Makerspace

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Introduction

This concept presents a VR application for mathematics lessons. By incorporating visual and haptic components in VR, students will gain a better understanding of solving (simple) linear equations through equivalent transformations. The application was developed in a short period for a specific purpose, but it can be further expanded to be used more broadly for solving linear equations (if deemed appropriate) rather than just as an introductory tool.

1. Background

In mathematics lessons, solving any type of equation often poses a challenge for students. Our application aims to make it easier for students to comprehend and practice the fundamental principle of equivalent transformations while solving basic linear equations. In traditional lessons, teachers may explain, "You need to subtract two from both sides" or "You need to divide both sides in half." In the VR application, students can visually recognize these operations and, hopefully, gain a better understanding.

For example, on the left side of the beam balance, they see two x-cubes (2x). On the right side, they see six unit cubes (6). This represents the equation $2x = 6$. They should then realize that they need to halve both sides (removing one x-cube on the left and three unit cubes on the right) to obtain the solution: $x = 3$. In this way, students learn to understand and apply equivalent transformations, which they can subsequently apply in written form.

2. Objectives

Since the application is intended for introducing the concept of solving linear equations in the seventh grade, specific learning objectives are formulated based on the Berlin-Brandenburg curriculum framework to facilitate its meaningful use in the school context. Considering a seventh-grade class at a gymnasium in Brandenburg, the goal is to achieve Level E proficiency. The following learning objectives are derived from the curriculum framework:

- Students can correctly solve linear equations through equivalent transformations, systematic trial and error, and virtual haptics.
- They can justify how and why they transform equations to solve them.
- They can independently verify their solutions. (cf. Curriculum Framework Brandenburg, Part C Mathematics, p.54 - Topic: Equations and Functions - Theme and Equations)

In addition, we have formulated an additional learning objective specifically for the VR environment: Students can set up and solve linear equations using a virtual beam balance in a VR environment.

3. Target Audience

The basic framework of our application can be used by students who are just starting to learn how to solve linear equations, regardless of the federal state or curriculum framework. The primary focus is to help them understand the concept of equivalent transformations and how to apply them.

4. Materials

4.1 Facilities

For implementing the application in class, a space suitable for multiple groups of students should be available. For example, a (large) classroom that has been cleared out or where tables and chairs have been rearranged could be used. Other suitable locations could include the schoolyard, an auditorium, or similar spaces.

4.2 Material List

- VR headsets (one per group) with controllers
- Tape to mark the area where the VR headset user will move
- Task sheets (and possibly solution sheets)
- (Evaluation forms)
- Pens and paper (for the writer)
- Role cards (VR headset user, writer, observer)
- Streaming device

5. Implementation

During the implementation, students should divide themselves into groups of two or three and assign the roles among themselves.

5.1 Role Cards

As indicated, there can be up to three roles that students can assume: VR headset user, writer, and observer. If a group consists of only two students, the last role can be disregarded since it does not interact with the other roles. The other two roles must communicate with each other, making them more crucial to maintain as a unit compared to the role of the observing person.

5.2 Procedure

Students form groups and distribute the roles among themselves after reading the role cards. They can then begin their work. The teacher serves as a support, ensuring the roles are adhered to, and assists with technical difficulties or comprehension issues. After completing all tasks, students can fill out the evaluation form (if time permits). Otherwise, the evaluation can be conducted through discussions with the involved students (allowing the teacher to assess whether the learning objectives were achieved).