Abstract

Linear algebra is one of the most important branches of mathematics, and it is part of many areas of science in general. Thus, it is required for students majoring not only in mathematics, but also in engineering, physics, economics, to name a few. Students with impaired vision have distinct challenges with conceptual understanding and procedural fluency in mathematics due to the lack of visual reception, visual information processing, and visual memory. These limitations create difficulties in manipulating mathematical expressions in particular linear algebra expressions. In this work, a novel framework was designed in order to facilitate manipulating mathematical content in a way that is convenient, accessible, and usable as well for students with visual impairments. Unlike other frameworks that were limited to facilitate manipulating mathematical algebraic content only, the new framework can be instantiated with different areas in mathematics. In this work, the new framework was instantiated with the domain of linear algebra. A set of techniques were built in order to allow the visually impaired student navigates the linear algebra expressions, selects one of them and performs the operations, then save the solution for further review and correction. These techniques were implemented through an interactive workspace that was developed for this purpose. The proposed workspace provides two modes in manipulating the expressions: regular and learning. It also provides the zooming in and out features in order to help students with sight impairments. Four experiments with different complexity of accessibility were conducted for evaluating the proposed workspace. The experimental evolution based on two main comparisons: comparison between the workspace and the conventional way, and comparison between the regular and learning modes of the workspace. The evaluation involved the effectiveness and the efficiency of the system. The results were analyzed using T-test. They showed that the proposed system and the learning mode of the system are respectively better in effectiveness than the conventional way and the regular mode of the system. They also showed that the proposed system in the experiments that are more complex in accessibility is better in efficiency than the conventional way while the system in learning mode is not better in efficiency than the system in regular mode.