Development and Application of STEAM Teaching Model Based on the Rube Goldberg's Invention

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Abstract STEAM is an acronym of Science, Technology, Engineering, Arts, and Mathematics. Rube Goldberg's Invention requires various inputs and efforts ranging from scientific knowledge, mathematical reasoning, engineering design, to ability for technical operation. It can be an ideal activity for STEAM education that stands for science, technology, engineering, art and mathematics. In this regard, the study identified elements of Rube Goldberg's Invention that could be applied to STEAM education.

Keywords Rube Goldberg · Elementary education · Creativity · STEAM

1 Introduction

The late Steve Jobs, an iconic figure of the 21st-century innovation, pioneered a new IT frontier with iPhone that blended technology, engineering elements and creativity [1–6]. These days, creative thinking and technology are directly related to the

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competitiveness of a society. In coming years, technical innovation will be about reinventing and converging existing technologies, rather than creating something out of nothing. In an era of convergence, leaders will need creativity and artistic sensibilities in addition to scientific knowledge and technical savvy [7–11]. In this circumstance, STEAM(Science, Technology, Engineering, and Mathematics) has emerged as a new educational catchphrase that will enhance students' understanding of mathematics and science. Many educational programs are being developed accordingly [12–16].

The basic idea of Rube Goldberg's Invention is to design the most complicated mechanism to solve the simplest problem. This process involves scientific principles, mathematical intuition, engineering maneuver, creative design and skills. It has all the elements that STEAM education aims to instill in students. This study compares the mechanical elements of Rube Goldberg's Invention with ideas of STEAM, in order to design learning materials that can be introduced to school curricula.

2 Need for STEAM Education

STEAM is an acronym of Science, Technology, Engineering, Arts, and Mathematics. As the low interests and accomplishments of American teenagers in math and science, the STEM education started as an educational solution [17–20]. However, the STEM education was missing a very important piece. This is that Art, a comparatively competitive and innovative field as STEM in creativity, was also needed. In addition, the science education could not keep up with the current changes in science, technology, and engineering and the teenagers who are used to the various advanced technology products were bound to lose interests as well as creating a gap in creativity cultivation in science education during elementary and middle school years.

Therefore, the experts argued for "amicability between science and art" because a dichotomous thought that art is illogical and science is not creative ruined the future and the art and science should be taught together before the concept of STEAM education emerged. In this perspective, the art education is crucial in developing creativity that is highly valued in modern education; therefore, the art education should be added to the education of science, technology, engineering, and mathematics.

3 Rube Goldberg's Invention for STEAM Education

3.1 Introduction to Rube Goldberg's Invention

Students watch video of Rube Goldberg's Invention contest or actual Rube Goldberg's Invention to develop interest and share ideas. By doing so, students are motivated and perceive that scientific activities can be familiar and easily approached.

Fig. 1 Working with an actual Rube Goldberg's invention

3.2 Exploring Scientific and Mathematical Aspects of Rube Goldberg's Invention

Students work with Rube Goldberg's Invention to examine and understand various scientific and mathematical principles involved such as operation of a pulley, conversion of energy on a slope, operation of a lever, and center of gravity. By working with an actual Rube Goldberg's Invention, students intuitively absorb scientific and mathematical ideas, and are encouraged to find examples of Rube Goldberg's Invention in a daily life (Fig. 1).

3.3 Analyzing Mechanical Design of Rube Goldberg's Invention

Students examine each part of Rube Goldberg's Invention to see how they are designed and interconnected.

3.4 Design of Rube Goldberg's Invention

Students work in a team to design Rube Goldberg's Invention. They are encouraged to apply the scientific ideas and principles to each part. Students draw design concepts and apply various scientific and mathematical principles, absorbing the knowledge through the process with an anticipation for the outcome (Fig. 2).

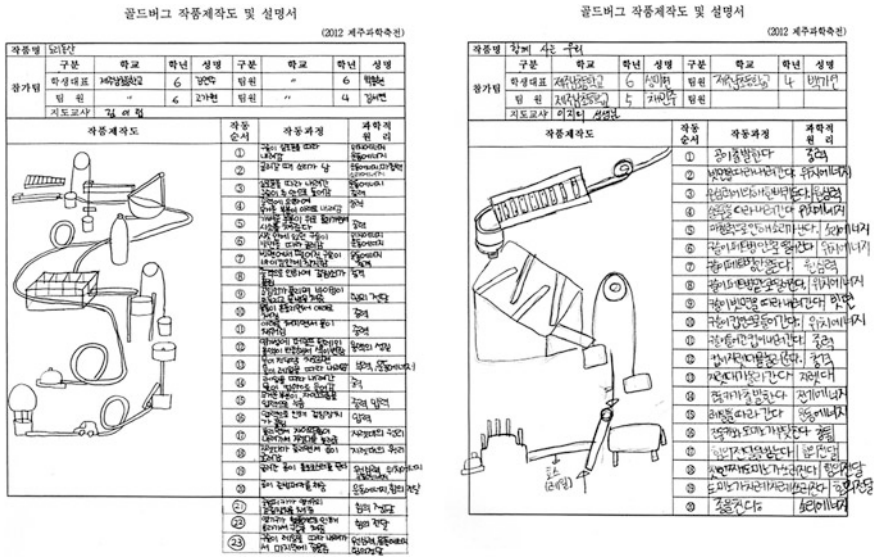

Fig. 2 Design of Rube Goldberg's invention

Fig. 3 Design of Rube Goldberg's invention

3.5 Manufacturing Rube Goldberg's Invention Using Colored Styrofoam and 4D Frame

With the design concept and drawing, students work in a team to construct Rube Goldberg's Invention and make necessary modifications.

3.6 Demonstration of Rube Goldberg's Invention

Students present mechanism and design of their Rube Goldberg's Invention and demonstrate its operation (Fig. 3).

3.7 Peer Review

Students compare and analyze various Rube Goldberg's Inventions and evaluate them.

4 Conclusion

The objective of the paper is to apply Rube Goldberg's Invention to explore how to connect school curricula with invention activities, establish a theoretical structure of invention education to draw lessons from mechanical and scientific principles. Also, it aims to design an invention program for schools. Rube Goldberg's Invention could be a useful tool to revitalize invention contests and programs at school. In the stages of understanding STEAM and Rube Goldberg's Invention, the related activities stimulate students' academic curiosity and interest (A) and help them develop a positive attitude toward science (S). They examine and analyze (ST) Rube Goldberg's Invention to learn its scientific (S) and mathematical (M) principles as well as engineering mechanism (E).

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