Investigating Mathematics Teaching Efficacy through Activities with Lego Bricks

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The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #21-059.

Abstract

This program focused on work in elementary mathematics and science with activities using Lego bricks and plates. Pre-service teachers self-evaluated teaching efficacy beliefs after a 6-hour, professional development session. Participant ratings of overall teaching efficacy and personal efficacy appeared to be acceptable, while participant rating of teaching outcome expectancy was at a lower level.

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Introduction

Lego bricks have been used across the curriculum and at varying grade levels. Geometry, science and engineering, and communication principles have been modeled with bricks. In this project, pre-service teachers completed a variety of standards-based tasks for mathematics and upon completion, responded to a survey regarding teaching efficacy beliefs.

Review of Literature

With regard to geometry, Mann (2013) drew attention to Legos by providing children with opportunities to work on skills related to spatial ability, visual ideation, reasoning, and innovation. Though these skills are crucial in the fields of engineering, technology, and science, they were not fully explored in the school environment. Mann advocated for parents to communicate with teachers about their talents so that these needs could be met in the classroom.

With regard to science and engineering, Li et al. (2016) conducted a study in which two groups of fourth-grade students worked through an engineering-based activity using LEGO bricks. One group was working according to traditional science pedagogy, while the other group used an updated engineering-based pedagogy. Results showed that, while there were no significant differences in level of science performance, the group using engineering-based pedagogy showed significant improvements in problem-solving ability.

With regard to communication, Althouse and Hedges (2015) described a classroom activity for teaching managerial skills such as good communication and effective decision making, as well as creativity, with first-year business students. Groups of students were tasked with creating a LEGO product that served a particular purpose, within a limited time. During the activity, several procedural changes were given to the groups, such as informing the students that they had less time to complete their product than was initially communicated, switching

members of different groups, and removing materials. These alterations were meant to teach adaptability, teamwork, and creativity in order to overcome hurdles in a managerial fashion. Results of this activity showed students gain an understanding that good communication and a decision framework can result in more efficiency, and it could create creativity and healthy competition between students.

Gadomska (2015) detailed the implementation of a LEGO activity meant to help university-level, English learners practice with the language while completing a task. In this activity, participants were tasked with designing a scene using LEGO blocks and writing a story to accompany it. The program involved online writing, digital photography, computer editing programs, animation, e-learning, and blogging, while, also, using LEGO bricks to teach English writing academic skills. The activity proved successful in incorporating pieces of an old LEGO activity and modern technology to create a more educational and impactful experience for students.

Šāblis et al. (2019) conducted a study with university students in an attempt to address and acknowledge some of the complications associated with completing projects on a global scale. Some potential issues included communicating across different languages, finding times to share information, and understanding various cultural contexts. For this exercise, groups worked to create two identical LEGO towers without being able to see what the other group's members were making. The only form of communication allowed was through written notes delivered by a designated middle-man. The article discussed seven runs of the exercise and the results of each. Results showed effectiveness in mirroring some of the difficulties associated with global projects, and that students had a better understanding of some of these difficulties. The exercise was a valuable tool to use to help students grasp the difficulties of global software engineering

and should be implemented in courses related to the subject. It helped students understand the cultural, geographic, and temporal differences involved in global work.

Taylor and Statler (2014) discussed the impacts of adding different materials into learning to see which material created the most emotional engagement, thus helping the participant to learn more effectively. One type of item used was LEGO bricks, as well as clay and paper. Results were ambiguous but suggested that LEGO bricks facilitated a more cognitive response, while clay created a more creative, emotional response to learning.

Methods

During the winter of 2022, 10 pre-service teachers, in elementary and special education programs, participated in one or two, 6-hour professional development sessions to use Lego bricks and plates to model standards-based topics in elementary and middle grades mathematics and science. Activities were drawn from the Brick Playbook: Parent Edition (Annenberg Foundation, 2024). Participants provided survey data for the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI; Enochs et al., 2000) after completion of the first day of attendance. MTEBI contains 21 questions on a Likert scale from 1 (low) to 5 (high). Possible scores range from 21 to 105.

The goal was to provide high-quality, teacher professional development while investigating the level of teaching efficacy belief. The measurable objectives were the following:

1. Determine the level of teaching efficacy belief in mathematics.
2. Determine the level of personal mathematics teaching efficacy.
3. Determine the level of mathematics teaching outcome expectancy.

Results

The average of the teaching efficacy belief in mathematics score, the personal mathematics teaching efficacy score (13 items), and the mathematics teaching outcome expectancy score (8 items) were 83.9, (79.9% of possible total), 54.3 (83.5 % of possible total), and 29.6 (74% of possible total). Participant ratings of overall teaching efficacy and personal efficacy appear to be acceptable. Participant rating of teaching outcome expectancy was at a lower level than the complete scale and the other subscale.

Discussion

The use of the MTEBI gave a snapshot of teacher confidence after a 6-hour, professional development session of using manipulatives to set up and solve problems. While pre-service teachers may have been at different levels of completion for degree coursework, all participants were engaged in the same activities for the session. Pre-service teachers had confidence in their teaching abilities but may not have been as confident that student learning would be influenced by their teaching. The student would, likely, gain more confidence in teaching ability with subsequent coursework, field placements, and professional development opportunities.

References

Althouse, N. R., & Hedges, P. L. (2015). Plan before you play: An activity for teaching the managerial process. *Decision Sciences Journal of Innovative Education, 13*(4), 515-528.

Annenberg Foundation. (2004). *Brick playbook: Parent edition*. https://www.learner.org/series/brick-playbook-parent-edition/

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics, 100*(4), 194-202.

Gadomska, A. (2015). Using Lego blocks for technology-mediated task-based English language learning. *Teaching English with Technology, 15*(2), 120-132.

Li, Y., Huang, Z., Jiang, M., & Chang, T. W. (2016). The effect on pupils' science performance and problem-solving ability through Lego: An engineering design-based modeling approach. *Journal of Educational Technology & Society*, *19*(3), 143-156.

Mann, R. (2013). Got LEGO bricks? Children with spatial strengths. *Parenting for High Potential*, *3*(2), 4.

Šāblis, A., Gonzalez-Huerta, J., Zabardast, E., & Šmite, D. (2019). Building LEGO towers: An exercise for teaching the challenges of global work. *ACM Transactions on Computing Education (TOCE), 19*(2), 1-32.

Taylor, S. S., & Statler, M. (2014). Material matters: Increasing emotional engagement in learning. *Journal of Management Education, 38*(4), 586-607.