

Research Brief

The Effects of Rigamajig® Play Materials on Elementary School Children's Early Development, Learning, and Interest in STEM

The Study

This independent study, funded by the CarMax Foundation in collaboration with KaBOOM!, examined the social group play of children 5 to 11 yrs. with Rigamajig® building materials. Researchers at Purdue University and Concordia University observed children's play with Rigamajig® materials in four elementary schools in Indiana. Children played in same-gender groups in weekly sessions over the course of one month. The main research questions were:

- When playing with Rigamajig® materials, do elementary students exhibit early engineering behaviors that parallel the basic design process used by professional engineers?
- When playing with Rigamajig® materials, are elementary students exercising physical skills, both fine- and gross motor?
- When playing with Rigamajig® materials, are elementary students displaying social competency work skills (21st century skills)?
- Are the engineering, physical, and social skills employed by girls and boys similar or different?
- How do play skills with Rigamajig® materials change across kindergarten, 2nd grade, and 5th grade?
- Does play with Rigamajig® materials increase elementary students' interest in STEM-related careers?

Research Methods

The researchers observed and video-recorded children's weekly 30-minute play sessions with Rigamajig® play materials in their home elementary schools. Each play group, consisting of either boys or girls, was observed in four 30-minute play sessions over a 5-week period. Play sessions were facilitated by classroom teachers, who provided an initial play prompt and maintained safety guidelines. All play sessions were video-recorded and later coded for frequency of engineering play, social competence, and physical movement. In addition, prior to the first play session and after the last play session, children completed a short survey assessing their interest in STEM-related careers.

Key Findings

Engineering Play

- **Early engineering behaviors occurred frequently within play groups of elementary school children**, an average total of 60-80 times for each child during a 30-minute play session.
- **Children at all three grade levels displayed similarly high levels of engineering play.** Though not statistically significant, 2nd graders had slightly higher levels of engineering play than kindergarteners, and 5th graders had slightly lower levels than 2nd graders.
- **Older children used significantly more language-based engineering behaviors than younger children.** Second graders and 5th graders used significantly more building explanations and STEM vocabulary words than kindergarten children.
- **Most early engineering behaviors declined slightly over four weekly play sessions, probably reflecting increased efficiency** in communication, design, and building, and with experience working together in a play group.
- **Engineering play by groups of boys and girls occurred with similar frequency.** Small differences favored boys, but were not statistically significant. Play with Rigamajig offers boys and girls similar opportunities to develop engineering and 21st century skills.

Physical Activity

- **Rigamajig offers rich opportunities for active play and physical development.** Overall, each child engaged in an average 125 gross motor behaviors and 57 fine motor behaviors per 30 minutes of play. As with engineering play behaviors, physical movement of most kinds decreased slightly over the four play sessions, perhaps due to increased efficiency in the groups' building processes.
- **Girls engaged in significantly higher rates of gross motor physical behaviors than boys.** Fine motor activity was not different by gender.
- **Children in the older groups displayed more fine motor actions (manipulating objects with hands) than kindergarteners, while kindergarteners were more active in gross motor behaviors (movement of the whole body) than older groups.** These patterns may occur because with age children gradually become more proficient at using their hands, and thus less reliant on large whole-body movements. Also, younger children may require more whole-body movements to carry and manipulate larger pieces.

Social Competence (21st Century Skills)

- **Children displayed impressive levels of social competence (21st century skills) within Rigamajig play groups.** On average, each child engaged in 38 cooperative behaviors and 8 leadership behaviors during each 30-minute Rigamajig play session.

- **Girls displayed higher overall rates of cooperative/team-based competency than boys, and sharing and cooperation increased for both boys and girls in higher grades.** Rates of positive emotional expression, leadership, and sharing were similar among boys and girls, and leadership and positive emotion expression were similar across age levels.
- **Collaboration in play occurred with high frequency and increased across grade levels, from 33% of the time in kindergarten groups to 57% in 5th grade groups.**
- **When children displayed higher levels of engineering play, they also were more likely to show more frequent social competencies (21st century skills.)**

Interest in STEM Careers

- **Children's interest in STEM careers (as reflected in the pre/post pictorial surveys) did not change significantly over the four Rigamajig play sessions.**
- **Boys and older children expressed higher levels of interest in STEM careers than girls and younger children.**

What Can I Do with These Findings? Implications for Teachers and Play Facilitators

1. Small group play with Rigamajig offers rich opportunities for school age children to develop and exercise a variety of 21st century skills: engineering thinking and construction; physical skills, and leadership and collaboration within a peer work group.
2. Children need adequate time, space, and freedom in order to gain the most from Rigamajig. In this study, the play spaces were found within the elementary schools in various places: maker spaces; a corner of the library; the music room when not in use; or other unused school spaces. Play can take place outdoors when weather permits. In the study we provided spaces at least 25 ft. by 25 ft. in area.
3. Adult play facilitators were encouraging, but not directive. They offered a play prompt at the beginning, which typically was a problem the group could solve by designing and building a structure or contraption. They did **not** tell the children what or how to build. When the group stalled or got stuck, the facilitator asked open-ended questions to help the children identify their problem and offer possible solutions and ways to move forward. If play became raucous or unsafe, the facilitator reminded players of the safety or courtesy rules. (See web-based project lesson plans for suggestions about non-directive play facilitation ideas <https://www.rigamajig.com/project-plans/>)
4. Having enough time to think, collaborate, and build is important. The play sessions in this study were 30 minutes, which often was not enough time for the groups to fully work out and realize their construction plans. Providing at least one hour of uninterrupted time is recommended or opportunities for children to return to their creations over the day or week to complete them.

5. Think about the optimal composition of play groups. In the study, we limited the groups to same gender children, with four students from the same grade level. This allowed us to study age-related variations in play, uncomplicated by cross-gender attitudes and interactions. Clearly, we found that girls displayed as much or more engineering, physical, and social competence skills as boys. But we encourage facilitators to experiment with groups of different sizes and composition, including mixed-age and mixed-gender groups, to see what happens.
6. Think of ways that you can integrate or blend academic objectives from different subject areas using Rigamajig materials. Hands-on science, technology, engineering, mathematics learning (STEM) opportunities abound within Rigamajig play, especially if the teacher or facilitator is alert to the possibilities. As they play, students are highly motivated to think, collaborate, experiment, and build, and the alert educator will find ways to discuss and extend these learning opportunities. (See web-based project lesson plans for connections to NGSS science and other academic standards <https://www.rigamajig.com/project-plans/>). Likewise, extended learning in language arts, creative arts, and social studies can easily happen with Rigamajig as a motivational “springboard!”