An Analysis of the Characteristics of Exploratory Behavior in 1-Year-Old Children during ‘Buoyancy Play’

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1. Introduction

Buoyancy is a force that causes water in a tank to exert an upward force on a material. Japanese children first learn formally about buoyancy in 7th-grade science. However, even without formal early childhood science education, children often encounter the phenomenon of 'sinking or floating of materials' in everyday life, such as in the pool or bathtub. A significant issue in Japanese early childhood education is the absence of programs designed to spark young children's interest and curiosity about buoyancy. Japanese preschool teachers often provide materials that float in water exclusively when young children play in the pool. This practice stems from the fact that many young children tend to favor materials that float over those that sink. Consequently, there have been limited instances of using substances that sink in water in educational practices. Additionally, there are few studies investigating how young children explore substances that sink in water.

The purpose of this study is to analyze the characteristics of exploratory behavior in one-year-old children during 'Buoyancy Play' by comparing two cases: one involving only substances that sink in water and the other involving substances that float on water. The outcome of this study will provide teachers with a perspective for selecting materials that either float or sink.

2. Methods

The overview of the program ‘buoyancy play' for one-year-old children as one of the Scientific-Educational Program ‘Kagaku’

Kotani et al. have been developing the scientific-educational program, "Kagaku" for early childhood science education (e.g., Kotani, T., 2019). "Kagaku" means "science" in Japanese. The aim of "Kagaku" is (1) to develop science process skills such as observation, classification, communication, and more, through exploratory manipulation and (2) to enhance young children's ability to think independently through scientific experiences in the fields of physics, chemistry, and mathematics. We prepared a tank filled with water and provided each child with eight substances that float on water and nine that sink in water for the 'buoyancy play' program in 'Kagaku’. The former category includes four types of vegetables (green pepper, garlic, tomato, and lemon) and four types of objects (a sponge ball, a vinyl ball, a styrene foam ball, and a wooden ball). The latter category consists of five types of vegetables (kiwifruit, onion, cherry tomato, orange, and potato) and four types of objects (a bell, a marble, a dice, and a low rebound ball).

3.The research designs

Participants

Four one-year-old children were selected as test subjects by their homeroom teachers. Two of them are girls, identified as F1 and F2, while the other two are boys, identified as M1 and M2. The girls, F1 and F2, are respectively 1 year and 9 months and 1 year and 7 months old, while the boys, M1 and M2, are respectively 1 year and 9 months and 1 year and 6 months old. The age range of the participants falls between 1 year and 6 months to 1 year and 9 months, with an average age of approximately 1 year and 8 months.

Research field

Sakuranbo nursery school is a private nursery school in Moriguchi City, Osaka, Japan. All preschool teachers have introduced the ‘Kagaku’ program into their class every year.

Procedure

The 'buoyancy play' program consists of two parts. In the first part, only a child and a preschool teacher entered a small room. The teacher showed the young children a small stone and a ping-pong ball, placing each of them in the water in front of the child to demonstrate the phenomena of 'sinking and floating'. A teacher provided a child with eight substances that float on water. The child was allowed to choose one of them and place it into the water freely for about ten minutes. The teacher gave no directions during the child’s exploration. After one week, in the second step, the teacher replaced the eight substances that floated on water with ones that sank in water. She allowed the child to explore in the same manner. The first step was conducted on January 30, 2023, and the second one on February 7, 2023.

Data collection and Data analysis techniques

The child's behavior and words were recorded using two digital video cameras. We conducted microgenetic method analysis to investigate the patterns of which objects young children chose over time, utilizing the annotation software 'ELAN ver6.3' (Siegler, R. S., 1995).

4.Results and Discussion

We obtained graphs depicting the temporal changes in the subjects of exploration for all four young children. We attempted to analyze them using these graphs. The main results of our study, conducted with four young children using microgenetic analysis, are as follows:

(1) All three young children, except for F1, attempted to verify all substances that both sink and float in water. This result demonstrates that one-year-old children possess the capacity for fundamental scientific exploration, such as experimenting with all substances in their initial exploration phase.

(2) We compared the number of vegetables and artifacts chosen by each child in the case of substances that both sank and floated. As a result, we found a significant difference between them in the case of substances that floated on water: the results of Fisher's exact test for F1, F2, M1, and M2 were, respectively, $p = 0.0005$, $p = 0.0000$, $p = 0.0000$, and $p = 0.0652$.

In contrast, we found no significant difference between vegetables and artifacts in the case of substances that sank in water for F2 and M1: the results of Fisher's exact test were, respectively, $p = 0.1180$ and $p = 0.6305$. However, we did find a significant difference between them for F1 and M2: the results of Fisher's exact test were, respectively, $p = 0.0000$ and $p = 0.0105$. In the case of substances that float, we believe that most young children chose artifacts because they are often familiar with and use artifacts, such as during play in a pool. However, in the case of substances that sink, we think that most young children selected both vegetables and artifacts equally because they have had few opportunities to interact with substances that sink before. Further investigation is needed to delve deeper into this discussion.

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[Reference]

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