From Water as a Toy to Water as a Tool: A Pilot Study on Object Play and Tool Use in Young Children

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Abstract

The "Play Ethos", a principle centred around the idea that play is beneficial, suggests the relevance of play to learning. This thesis discusses the facilitation of tool use through object play from a perspective of the "Play Ethos" and Affordance Learning Theory. A study consisting of observational, experimental, and supplementary phases was delivered to 9 children aged 3-6 years old at the Forestry Campus of the Lethbridge Montessori School. This study investigated if behaviours seen in a playful setting (observational phase) were then used to solve a problem in a task (experimental phase). Results showed that similar behaviours were conducted in both phases, however due to confounding variables and limited sample size, further research must be conducted to test the relationship between object play and tool use. Despite these results, this study identifies and explores important topics to consider when designing and facilitating experiments to young children.

Introduction

"It is through play that much of the work of childhood is done… play is one of the most important means by which a child exercises his impulse to grow… play has tremendous importance in the progress of development and in the economy of daily life" – Jersild (1955, p.501)

Play, a ubiquitous phenomenon, is present in children, elephants, monkeys, goats, and numerous other mammalians, as well as non-mammalian species. This universality provides reason for its thorough investigation through a Tinbergen's approach, including ontogenetic trajectories, causal mechanisms, functional consideration, and phylogenetic perspective (Burghardt, 2005; Wisberg et al., 2013). Holding many definitions, ranging from "any brisk activity" to "abstain from work" (Eberle, 2014), play has been linked to positive social behaviour

in animals and is even related to biological markers of brain development (Pellis & Pellis, 2009; Byers & Walker, 1995). Burghardt (1999, 2005) proposed 5 criteria to identify, define, and categorize play: play (1) appears incompletely functional in the context expressed, (2) is voluntary, rewarding, pleasurable, or done for it's own sake, (3) is in some ways modified structurally or developmentally compared to its functional counterpart, (4) is repeated in recognizable, but not invariant, form, and (5) is initiated when the animal is not under more than mild stress which could be caused by poor health, bad environmental conditions, social upheaval, or intense conflicting motivational states. There is a myriad of adaptationist hypotheses for the evolution of play, whose stronger versions include postulates such as: (1) play evolved to improve sensori-motor coordination, strength, and endurance during the development; (2) a key adaptive benefit of play consists in honing social-communicative skills; (3) the function of play is to gain information about the environment, enhance cognitive abilities, and stimulate creativity; and (4) play was designed to prepare individuals for, and help them cope with, unexpected events (see Burghardt, 2004 for a review of play theories).

The "Play Ethos" highlights the necessity for play in human development. It states that play "aids in the acquisition of cognitive, social, and emotional skills; and is the basis of math and language development" (Pollock, 2018, p.281). It developed through a general education perspective in the 1920s (Smith, 2010). However, as the Ethos continued to grow through the years, it could have warped play research, specifically in the 1970s and 80s (Smith, 1988). This perspective is supported by Lillard et al. (2013), who argue that enough experimenter bias has occurred to affect the outcomes of play research. Their definition of experimenter bias involves "experimenters who are swayed by the cultural view of play and knowledge about condition subtly and probably unconsciously influenc[ing] the children's performance (Lillard et al., 2013, p.27).

In my opinion, there is a large possibility of this "warping" of play research due to the effect of experimenter bias. I think it is hard to escape unconscious experimenter bias in play research as the majority of individuals have been exposed to play throughout their lives. This exposure and their personal relationship with play could affect how they investigate the phenomenon of play.

Play, especially in children, is thought of as a normal, expected behaviour in Western Societies (Peterson, 2015). Peterson et al. (2015) discussed the perspectives held by teachers and early childhood educators on play-based learning. Curriculum documents in Canada exhibit principles of the "Play Ethos":

"Play is a natural mode of learning and the foundation for the kindergarten program" (Saskatchewan Ministry of Education, 2009, p. 8)

"Play is a means to early learning that capitalizes on children's natural curiosity and exuberance" (Ontario Ministry of Education, 2007, p. 5)

The "Play Ethos" can also be applied to the realm of object play and tool use. Object play is defined here as a child manipulating objects, without a goal provided to them, in a playful context as clarified by the criteria above. While object play can occur in make-believe episodes (Solis et al., 2017), pretend play was not a criterion for object play in this study. Some examples of object play include: a child scooping sand and a child rolling a toy car across the ground. When discussing object play, it becomes important to create a distinction between object play and object exploration. Exploration of an object differs from object play, in various quantitative and qualitative ways. Exploration is the process in which an individual learns "what does this *object* do?" whereas play is the process in which an individual learns "what can *I* do with this

object?". Developmentally, exploration precedes play as knowledge of an object's properties is necessary prior to playing with that object (Hutt, 1966).

Tool use is defined here as use of an object to reach a goal or solve a problem (Shumaker, 2011). A spoon can be used as a tool to transfer food from a container onto a plate. Manipulating curtain strings (i.e., a tool) by pulling them can decrease the amount of sunlight entering a room. Following the example of the spoon, a study conducted by Connolly and Dalgleish (1989) on spoon use in children from 12 to 23 months provided support for object exploration facilitating the development of tool use. Through observation of spoon use, the child learns about the spoon's mechanical properties and the purpose of spoon use. Then the child attempts spoon use, gradually improving the skill until they are able to eat with the use of a spoon. What exactly is the child gaining while exploring and observing the spoon that helps them use the spoon as a tool? Steenbergen et al. (1997) also conducted a study on spoon use in children. They changed the appearance of a "typical" spoon by varying the degree of the handle in relation to the bowl of the spoon. They hypothesized that if children saw the spoon's affordances, regardless of these changes in appearance of the spoons, they would then change how they handled the spoon. Their results supported this hypothesis as children were able to perceive the function of each spoon, regardless of physical appearance differences. The "Affordance Learning" theory holds that the combination of visual and tactile perception of an object's physical and action-relevant properties, together with pressure-free opportunities for exploratory activity and behavioural tinkering, such as those enabled by object play, contribute to determining the object's potential use for the goal-oriented actions required for tool use (Lockman, 2000).

Driven by the "Play Ethos", some behavioural scientists, anthropologists, theorists, educators, and therapists have argued that the expression of object play behaviour in humans and

non-human animals promotes the development of knowledge and skills applied to the physical domain, such as tool use (Bjorklund & Gardiner, 2011; Parker & Gibson, 1977). A study conducted by Sylva et al. (1976) involved children being exposed to different environments with sticks and clamps: they could either play with unassembled sticks, watch an adult assemble the sticks, or watch an adult use the clamp in a non-functional manner (control). Children who played with the assembled sticks were shown to be more systematic with their problem-solving, in the sense that they progressed from simple to complex moves and effectively used information from failures they experienced or hints they were given (Sylva et al. 1976). However, these results were not replicated with double-blind conditions (Simon & Smith, 1983; Smith, 1988; Vandenberg, 1980). Furthermore, research conducted by Dansky and Silverman (1973, 1975) showed a positive correlation between child play and creativity. However, skepticism around these results remains as the results are not replicated when the study is replicated with double-blind procedures. This lack of replication, supports the argument that experimenter bias caused the results seen by Dansky and Silverman (Pellegrini, 2016).

The “Play Ethos” emphasizes the value of play, in fact it is centered entirely around the idea that play is beneficial. Despite the support for the “Play Ethos”, there remains a fair amount of controversy, namely that it is a meager assertation and lacks reliable research (Smith, 2010). Many researchers have highlighted the bias associated with investigating "The “Play Ethos”". Lillard et al. (2013), specifically, proposed that the “Play Ethos” occurs because of the prevailing belief held by researchers that play has value (Weisberg et al., 2013). Lillard et al. (2013) went on to address problems with methodological approaches to investigating the “Play Ethos”. These problems include correlational findings discussed as causal findings, the failure to replicate studies, and experimenter bias. Lillard et al. (2013) expressed the importance of masking

experimenters. They stressed that even undergraduate courses should teach students the importance of masked experimenters. They defined a masked experimenter as being “unaware of (a) the hypotheses being tested and (b) participants' conditions" (Lillard et al., 2013, p. 4). It is important to recognize the benefits from a masked experimenter; however this condition is not always possible in experiments, especially when conducting studies on child development. Lillard et al. (2013) attested to this by claiming that research on cognitive development does not necessarily need masked experimenters, dependent on the types of tests administered. Another solution aside from masked experimenters is for the experimenter to be an individual who does not know about the current experiment but has prior knowledge on conducting experiments. This individual would require specific instructions on how to administer the task, how to react if problems arise with task facilitation, how to respond to participants during the task, and any other possible unexpected scenarios. This would help limit variability in the experimenter’s behaviour during the experiment as they would abide by strict guidelines and instructions. Another solution, used in a visual information and speech perception study conducted on infants by Havy et al. (2017), involves the use of parents in the experiment. In this study by Havy et al. (2017) parents were able to run the experiment without knowing the purpose of the study. Aside from parents, teachers could also facilitate experiments for children with strict instructions, as described earlier. After my experience with this project, I would express that having unknown masked experimenters for child research can be an unrealistic expectation due to (1) the importance of comfortability and feeling of safety for the child and (2) financial constraints. Going with a stranger to complete a foreign task can be scary for a child and experimenters have the ethical responsibility to minimize harm for participants with harm being defined as “anything that has a negative effect on the welfare of participants, and the nature of the harm may be social, behavioural, psychological, physical or

economic" (Canadian Institutes of Health Research, 2018, p.21). Additionally, limitations on funding can prevent proper compensation for a masked experimenter who is not a lab, parent, or teacher volunteer. Aside from experimental biases, addition confounding variables the majority of research designs have failed to capture include age and sex differences, motivational processes, task characteristics, and inadequate controls (Smith, 2010).

If substantial scientific support that addresses the previously mentioned concerns with research around the "Play Ethos" emerges, it could lead to reformation of mainstream education systems in Western societies. While play is encouraged in children, as shown above in the prevalence of play in educational guides, it is not as prevalent in adults. As children become adults, work corrodes their daily life and replaces adult play (Elkind, 1988). This reduction of play in adults could be due to the lack of prioritization of play (Baptiste, 1995). Of course, this is only one possible reason for the decrease in play in adults, another reason could be that adults are simply too tired after working to engage in any play. Time constraints, physical health concerns, costs, family commitments, and lack of play opportunities were just some reasons stated as barriers to physical play in sports for adults (Jenkin, 2016). If the "Play Ethos" proves true, and play has a significant impact on the process of learning, adults may increase prioritization of play and incorporate it more into their daily and social activities. Furthermore, this change in thought-process around play may result in an increased implementation of play-based learning in higher education, namely high school and post-secondary. The "Play Ethos" must be examined in more detail to further our understanding of the intricate process of learning through play. Examining an item whose usage may turn from plaything to a tool for functional use could aid in deepening our understanding of this phenomena.

Water, an element of nature, displays characteristics of both toys and tools. Toys are defined here as objects commonly used in play activities, such as when water is used to splash or create a "hand water gun" with the intended effect to squirt water on another individual. Throughout childhood, individuals are exposed to water in both, playful contexts (e.g., water balloons and water gun fights) and instrumental/functional settings (e.g., water for cleaning, water for hydrating). Children gain experience exploring water as a play object and this exploratory and playful experience can build towards tool use.

"All human victories, all human progress, stand upon the inner force" (Montessori, 1912, p.24), this chapter title from Maria Montessori, expresses her belief that children should not be restricted and disciplined to be immobile and silent. The idea she upholds, that children already have what they need to be accomplished/ successful, can be seen through the Montessori method. "The fundamental principle of scientific pedagogy must be, indeed, the *liberty of the* pupil; -- such liberty as shall permit a development of individual, spontaneous manifestations of the child's nature (Montessori, 1912, p. 28). The Montessori pedagogy encourages exploration and play through children's engagement with the physical environment throughout their daily schedule. Montessori learning materials, wooden toys that teach children abstract concepts from subjects including language, arithmetic, physics, and geometry, are organized around the classroom in an easily accessible manner so that students are free to choose which works and objects to engage with. Creative and practical educational environments such as this system can foster affordance learning and the development of problem-solving skills at a young age via a unique set of principles and curricula which include independence, movement, intrinsic motivation, and a hands-on focus on natural elements (Ozerem & Kavaz, 2013). The Montessori pedagogy provides a sense of freedom for children as they are allowed to pick which activities to work on, but teachers are

always there to support and guide them (Lillard, 2013). Through the use of learning materials and the tenants of the Montessori method, Montessori education may contribute to the beneficial transition of knowledge and skills from object play to tool use in young children.

In preschool and kindergarten, young students at the Lethbridge Montessori School (LMS) have regular and unguided access to a water table. Playful exploration with this water table may be conducive to participants' basic learning of some hydraulic properties of water, that could be co-opted into the instrumental usage of water. Using the water table provides children with the opportunity to explore water and various objects determined by their teachers; in turn children play with water and those objects. Through this play, unknowingly or not, students are exposed to many hydraulic properties of water such as viscosity, density, compressibility, permeability, and buoyancy. Rudimentary understanding of these properties, which all play a hand in understanding water displacement, should allow children to use water as a tool in problem-solving tasks regardless of their complexity. Using the objects in the bin to play with the water affords children with knowledge on how to use the displacement of water (a manipulation of water) as a tool.

As Weisberg et al. (2013) noted, research on the relationship between play and learning should be viewed as a full picture, not a sum of its parts. I set out to investigate the intricate relationships between object play and tool use through the perspective of the "Play Ethos", in hopes to add a missing piece to the larger puzzle of the connections between play and learning.

The main purpose of my honour's thesis was to critically address the "Play Ethos" with a particular object (i.e., water) that could be used for play and tool use. I examined whether and how the learning of water affordances in a playful context could be applied to a situation of insightful problem-solving, which required water to be used as a tool through the causal understanding of water displacement. This study was conducted at the Lethbridge Montessori

School due to the school's pedagogy. I conducted this project as a pilot study with the ultimate goal that future research will set out to examine variation in the playful and instrumental use of water across differentially creative educational environments. The purpose of this pilot project was to generate and start honing a study design that could be replicated by future students and researchers in other schools. To test the effect of a creative educational environment in young children's ability to transfer their knowledge and skills from "water as a toy/plaything" to "water as a tool", it is crucial to compare the water-related knowledge and behaviours in preschool and kindergarten at the Lethbridge Montessori School (hereafter LMS, a particularly creative, practical, and play-oriented educational environment, which, among various other activities, includes regular and unguided access to a "water table") and a more "traditional" educational environment at a Lethbridge Public School (hereafter LPS), whose curriculum includes basic theoretical knowledge about water, but no water-oriented practical activities such as those experienced at the water table.

Investigating the relationships between object play, tool use, and child development is essential to understand the most effective forms of learning for students. This research could provide insights into better teaching methods, especially for children with developmental disorders who have divergent forms of communication and interactions with the world around them. Additionally, this research can further our understanding of the developmental relationships among object play and tool use.

Methods

Ethics

The ethics submission for this project was a collective effort between my supervisors, Drs. Foroud and Leca and me. We received ethics approval from the University of Alberta Research Ethics Board 2. As this was my first experience with submitting an ethics application for a human study, I gained valuable information related to data management, risk management for children, and parental consent forms. Owing to the nature of the participants (i.e., preschool children), confidentiality and protection of non-participants and participants was crucial. Additionally, this was my first time interacting with the parents of children aged 3-6 years. This posed many challenges, most notably the balance between divulging enough information about the study to make parents comfortable while adhering to ethics standards and refraining from sharing too many details about the research goals and methodology so parents would not influence their children.

Participants

My pilot study consisted of participants recruited from two classrooms, *Casa de Jaune* (9 participants) and *Casa de Bleu* (5 participants), at the Lethbridge Montessori School (LMS), Forestry Campus in Lethbridge, Alberta. To address some of the confounding variables mentioned by Smith (2010), participants of both sexes and varying ages (3-6) years were chosen for this research study. The observational phase included 14 participants (8 boys, 6 girls) while the experimental phase included 9 participants (6 boys, 3 girls). Due to this discrepancy between phases, data analysis was only conducted on the 9 participants who completed both observational and experimental phases.

Materials for the Observational and Experimental Phases

The study comprised of an observational phase followed by an experimental phase. In both phases, a water table was used. The water table was a two-tiered cart with the top shelf containing a large plastic bin filled with water and objects children could use for exploration and play with water, while the bottom shelf contained extra objects. A list of materials in the water table with their potential affordances can be found below.

Material	Examples of Potential Affordances within the Water Table
Funnel	Transfer of water and/or objects
Plastic double open ended tubes	Transfer of water and/or objects
Slotted pasta spoon	Scooping of water/ and or objects, mixing, splashing of water
Small glass pitcher	Transfer, holding, pouring, and mixing of water and/or objects
Red hearts (can be deconstructed)	Transfer, holding, pouring od water and/or objects
Bucket (no handle)	Transfer, holding, pouring of water and/or objects
Water balloon	Rolling, splashing of water
Measuring scoops (various sizes and colours)	Transfer, holding, pouring of water and/or objects
Ladle	Transfer, holding, pouring of water and/or objects
Metal pitcher (varying sizes)	Transfer, holding, pouring of water and/or objects
Plastic flattened shovels (various sizes)	Transfer, holding, pouring of water and/or objects
Whisk	Mixing of water and/or objects
Slotted spatula	Transfer, holding, pouring, mixing of water and/or objects
Water	Splashing, cooling down
Gelatinous beads	Rolling
Soapy water	Bowing bubbles
Plastic beaker	Transfer, holding, pouring or water and/or objects
Plastic scoopers (varying colours)	Transfer, holding, pouring or water and/or objects
Glass cylindrical container	Transfer, holding, pouring or water and/or objects
Pasta spoons (varying colours)	Transfer, holding, pouring or water and/or objects
Plastic rake	Moving water, pouring, transfer of water and/or objects

Before starting my study, I met with both classrooms during circle time. At this time, I introduced myself to the children, as a student from the University, showed them the recording equipment I would be using (a handheld video camera), and asked them if they were okay with me coming to their classroom and looking around. I let them know they were able to come up to me and ask me questions but that just like them, I had work to do. I also consulted with teachers and my co-supervisors to determine the best position for the water table in the classrooms, and their involvement in the study. I expressed that I did not want to interfere in the classroom routine or proceedings in anyway and that they were to act as though I was not there. Subsequently, the teachers had full control of what materials to place in and around the water table, how many students to allow at the water table, which students to allow, how long students were allowed at the water table, and any instructions to provide children when using the water table (e.g. “the water must stay in the table”).

Due to the different layouts between the two classrooms, the water table was organized differently between classes. The water table was located away from main classroom entrances but was close to tables where students would complete activities and use Montessori materials. *Casa de Bleu* (located on the first floor) has a mezzanine which overlooked the position of the water table. This is where the majority of observations were recorded from, which allowed for more of a bird’s eye view of the water table and any participants using it. Occasionally, observations were recorded from the staircase to the mezzanine in order to protect the confidentiality of non-participants. The teachers in *Casa de Bleu* chose to put towels on the ground around the water table to prevent water from spilling on the floor.

Casa de Jaune (located on the second floor) is significantly smaller than *Case de Bleu* with no mezzanine or second level. In *Casa de Jaune*, the water table was placed in the middle of

the room, away from the main entrance, by a large window. Similar to *Casa de Bleu,* the water table in *Casa de Jaune* was near student tables. Due to the lack of a second level, observations could not be recorded with the same bird's eye view as in *Casa de Bleu.* Additionally, teachers in *Casa de Jaune* chose to keep towels on the bottom self of the water table so to discourage mess.

Any replications of this study should note that as no two classrooms are exactly the same, the exact placement of the water table can not be replicated. However, the water table placement should follow these criteria: (1) be kept away from main entrances for safety reasons, (2) observable from most if not all parts of the room (i.e. students should be able to see the water table from their play and work locations), and (3) any observations of the water table should be made from the same angle in all classrooms.

Experimental Phase

The experimental phase was conducted using the same water table used for the observational phase. However, the water bin inside the water table was without water and contained materials to solve the task. The materials provided to participants were: a large plastic bowl, a graduated cylinder, a green "ball" (small Styrofoam cut out), measuring cups, a bowl of glass beads, an eyedropper, post-it notes, and a funnel. A full list of materials with their potential affordances can be found below.

Table 2 – Materials Provided to Participants in the Experimental Phase

Material	Potential Affordances
Post-its	Hold written information, folded to scoop water
Measuring Cups	Hold, transfer of water and/or objects
Funnel	Hold, transfer of water and/or objects
Eyedropper	Transfer water
Glass beads	Displace water level, roll
Bowl (small)	Hold glass beads, scoop water
Graduated cylinder	Hold water and/or objects
Bowl (large)	Hold water and/or objects, container to play and explore in
Water	Transfer object, splashing, cooling down
Styrofoam ball (object to retrieve)	Object to reach

The experimental set-up was kept the same for all participants and located on the second floor of the LMS, approximately the same distance from both classrooms however *Casa de Jaune* participants had to walk through another classroom to access this location while *Casa de Bleu* participants needed to walk up the stairs. The experiment was in a closed hallway, limiting any interference from other students or teachers. The door to an adjoining classroom was propped open for safety reasons when my supervisor was unable to oversee any experimental sessions. Foam couches were available next to the experimental set-up for the experimenter to sit in if required. Additionally, bathrooms were available directly across from the experimental set-up to allow for the experimenter to be out of sight and for smooth transition between experimental phases. The decision was made to keep the experimental location different from the observational location to provide a location that was familiar to participants but new for the water table location. Additionally, having a different experimental location allowed for participants to complete the experimental phase during school hours without intrusion or intervention from other students and teachers. Most participants were comfortable climbing to the second floor for the experimental phase however one participant did struggle with the staircase. Future studies should accommodate

for anyone unable to climb stairs or access certain areas of the building. A figure of the experimental layout can be found in Appendix A.

Research Design

This research study was divided into three main phases: observational phase, experimental phase, and a questionnaire-based phase.

Observational Phase

The observational phase, conducted by me, involved behavioural of participants at the water table. Observations for *Casa de Bleu* were conducted from the mezzanine from 8:30 to 10:30 am whereas observations for *Casa de Jaune* were conducted from 1:00 to 3:00 pm. These times varied depending on the day-to-day schedule of the classrooms; however, time blocks (i.e. morning and afternoon) were kept constant for each classroom. Students in *Casa de Bleu* were relatively unaware of my presence unless they were on the mezzanine where I was located. In *Casa de Jaune,* students were far more aware of my presence and potentially formed a connection between me and the water table. Students in *Casa de Jaune* would often ask what I was recording and why; for this reason, I did my best to hide that I was recording them or their behaviour at the water table. Consistency between classroom layouts would be beneficial in mitigating the risk of exposure around the study and purpose of the observational phase. However, that is impossible to achieve due to the nature of classrooms, especially in pre-school; so all possible measures were taken to prevent my presence from affecting participant's motivation to playing at the water table. For example, I would frequently pretend to record other parts of the room, I would set up my camera and walk away from that area, I would look away from the water table, and if asked any questions about what I was recording, I would either say I was not recording, that I was recording the classroom, or I would try to change the topic of conversation.

Teachers were not instructed on which materials to include in the water table or on consistency between water table materials throughout the observation period. Materials ranged from kitchen utensils to funnels to tubes. A full list of items can be found in Table 1. The water table occasionally contained beads with a gelatinous consistency or soap. Typically, the water table was only present when I was at the field site. All actions and behaviours of participants at the water table were recorded. While observing and filming behaviour at the water table during this phase, I focused on which materials were used, what actions were used with the materials, and any collaboration between participants. In this study, collaboration refers to (1) when two or more participants would use the same water table item simultaneously, (2) when one participant would transfer water or any material in the water table from an item, they were holding to an item being held by another participant, or (3) when participants would act towards a common object (i.e. two participants filling up the same pitcher simultaneously). Additionally, collaboration also referred to any imaginary or pretend play conducted by more than one participant simultaneously (i.e. two or more participants "making ice cream" in the water table). The layout of *Casa de Bleu* prevented audio data from being captured accurately, however audio data from *Casa de Jaune* was recorded. Due to the lack of consistency of audio data between sites, it was not included in the results or data analysis but did allude to interesting findings about pretend play.

Experimental Phase

The experimental phase is a pilot specifically used to identify how to implement the experiment designed for this study. Due to the piloting needed to properly implement the designed experiment, significant changes were made to the methodology throughout this process. The experimental phase was eventually divided into three trials, with each trial being a variation of water displacement task. This task was designed based off of Aesop's fable "The Crow and

the Pitcher" (Aesopus, 1998). Adaptations of this fable have been used in many studies including a study conducted on corvids and one on elephants (Barrett, 2020; Bird, 2009). Trials 1 and 2 were delivered to every participant; trial 3, added later, was delivered to 6 participants, with only 3 receiving the entire trial.

The first three participants were crucial to the study design as many changes were made after each session. The initial participant was presented with two trials. The first trial had the following set up: a graduated cylinder containing a "ball", taped down so participants were unable to flip the cylinder upside down, a large bowl filled with water, measuring cups, a bowl of marbles, an eyedropper, and post-it notes. The eyedropper and post-it notes served as distractors from the "conventional" items (measuring cups, funnel, water bowl filled with water, and glass beads) that should allow participants to reach the solution to the task. In trial one, the "conventional" solution was for the participant to use a measuring cup to move water from the large bowl to the graduated cylinder, raising the Styrofoam ball until the participant could use their hands to retrieve it.

The second trial had the following set up: a graduated cylinder containing 60mL of water and the "ball", taped down so participants were unable to flip the cylinder upside down, a large bowl without any water, measuring cups, a bowl of marbles, an eyedropper, and post-it notes. In this trial, the "conventional" solution was for the participant to add marbles to the graduated cylinder, thus raising the water level and the Styrofoam ball until the participant could use their hands to retrieve it.

The order of trials one and two was decided as such to limit the possibility of the trial materials influencing participants. If the first trial had a graduated cylinder containing water, it could potentially have provided a clue for participants with solving the other trials. Participant's success in any trial was defined by considering (1) completion of the task (i.e., successful retrieval

of the floating object), (2) time to complete or give up on the task, and 3) if any solution aside from the "conventional" solution was used. To control for any social influence, participants completed all trials alone.

The experimental phase was planned as being clinical to limit variation in experiment delivery across participants; however, that stoic environment was not conducive to facilitating experimental tasks for children. The environment was clinical and stoic in the sense that (1) there was limited interaction between experimenter and participant, (2) the participant was not provided a reason for retrieving the ball, and (3) the experimental materials were organized in an unfamiliar way. After delivering the experimental phase to the first participant, changes in script and location were made for me as the experimenter. These changes were designed to facilitate a comfortable environment for learning and play without providing direct information about task completion.

The first participant was asked to perform the experimental phase on a desk, instead of the water table, with all of the materials laid out in front of them. They were then instructed to keep their hands by their sides and told two rules (1) this container (the graduated cylinder) needs to stay attached to the table here and (2) this container (bowl of water) needs to stay attached to the table here. They were told "other than that you can use anything on the table here. Can you please get the ball out?" During this initial session, the participant seemed uncomfortable and reluctant to explore the materials as they frequently looked away from the experimental set up and repeated the phrase "I don't know what to do". The first participant was presented with only trials 1 and 2.

At the end of each experimental trial, a post-task interview was conducted to better understand their thought process throughout the "water displacement" tasks. The post-task interview consisted of a series of questions designed to analyze their specific behavioural approach during the task. The questions were: (1) Can you tell me how you did what you did? (2) How

come? (3) If you did this again, what would you do differently? (4) Which game did you like the most? (5) Which game was the easiest?

I had originally planned for participants to stay in another classroom with a teacher between trials but many participants were reluctant to spend time in a different classroom. As such, participants were offered the choice between returning to their own classroom and going to the other classroom. Needing participants to stay in a classroom in between trials presented many problems namely distraction for the other students and increased time between trials. When in the classroom between trials, participants sometimes began working with the classroom materials. The LMS values a child's education and as such they allow students to complete their current task or activity before asking them to move on to another activity. This resulted in increased time between trials which not only lengthened the total experimental time but also caused slight variation across participant treatments. After each trial, the first participant was asked to not share any information about the task with other students. However, this was changed for future participants based off advice provided to me by my co-supervisor Dr. Foroud. She advised me that through her experience working with children in research and educational settings, using phrases such as "do not run" or "do not talk", results in children attending to the last word of the phrase, thus being more likely to run or talk. Additionally, asking a child to keep the task a secret, or not tell anyone about the task presents many challenges when working with young children as they are specifically taught to share information with their parents or teachers if anyone tells them to keep an activity a secret.

After the first participant, the decision was made to hold all experimental trials in the water table to provide familiarity and comfort to participants. The first participant seemed reluctant to explore any of the experimental materials on the desk, so the decision was made to transfer

materials to a location they were familiar with, the water table. By viewing and recognizing the water table in the experimental phase, participants may have been more enthusiastic to interact with the task and tinker with experimental materials. Tinkering is a crucial component to exploration and play as it marries play and inquiry (Banzi 2008, vi-vii). This decision was made to increase the likelihood of participants interacting with the task, and to increase the comfortability of the environment for participants.

Each subsequent participant was presented with the problem: the experimenter was unable to get their ball and needed the participant's help, often phrased as "I can't get my ball, do you think you could help me? Can you get my ball for me please?". This problem was introduced as a game and participants were asked if they wanted to come play a game with me. This prompt of helping me was used for each trial in the experimental phase. Studies provide support for the idea that children like to help (Aknin 2012; Hamlin, 2010, 2011) A. Young children have been shown to exhibit happiness when giving and prefer prosocial behaviour (Aknin 2012; Hamlin, 2010, 2011). This game was chosen to provide the participants with a specific motivation, to help someone they know, whether that was me or my co-supervisor, Dr. Foroud. This motivation was included to provide a reason for completing the task and to address another cofounding variable mentioned by Smith (2010). At this point in the study, the majority of the participants knew me and had somewhat of a relationship with me, so asking them directly to help me was also a form of positive encouragement. A few participants completed the experimental phase with my co-supervisor Dr. Foroud if they were not familiar with me. Dr. Foroud also facilitated the experimental phase for the second, third, and fourth participants due to the significant changes made after the first, second, and third participants. Depending on the participant, instructions were rephrased and repeated, light conversation around the task and materials was conducted. This

conversation, on the experimenter's side, ranged from questions such as "what do you think this does?" to "how do you think we can do that?" in response to questions from participants around functions of materials and solutions for the task. Additionally, the phrase "can you get the ball for me please?" was rephrased and repeated if the participant seemed distracted (i.e. walked away from the water table). The experimenter's location also varied between participants as some participants were comfortable with the experimenter supervising from a slight distance while others required the experimenter to be at the experiment side (water table) with them. It was important to create an experimental environment in which young child participants felt safe and comfortable to engage with the task. Individual differences between children called for differences in experimenter dialogue and location for each experimenter session. It was important to pilot different aspects of the experimental environment (i.e experimenter. location, dialogue, experiment site), for the premise of this experimental design, can the participant solve the task?

Before conducting trials 1 and 2 with the second participant, the decision was made to include another situation in which participants were presented with a modified experimental set-up of trials 1 and 2, in which the graduated cylinder and large bowl both contained water, here referred to as double water situation. This was implemented to offer another chance to participants who were unable to solve trials 1 or 2. The second participant did not leave for the double water situation and water was just added by me at the request of Dr. Foroud in front of the participant. Running the experimental phase with the second participant made us aware of a complication with the experimental materials, the ball was too big for the graduated cylinder and if manipulated in a specific way, would be stuck at the bottom of the graduated cylinder, unable to be dislodged. Additionally, the second participant was given the post-task questions at the end of the

experimental phase, not after each trial. After conducting this session, the size of the ball was reduced.

Conducting the experimental phase with the third participant led to more significant changes in my methodology, including the introduction of the third trial in which the double water situation was presented as another game. Trial three was added for two purposes: to see if participants favoured one solution over the other and to offer another chance to participants who were unable to solve trials one or two. It was important to have this as it is a separate trial to gain a complete sense of whether the participants were able to solve the game. By introducing water in both the graduated cylinder and water bowl in front of the participant, there was the risk that participants were made aware that water could be used as a solution to the problem. The direct addition of another material, the water, by the experimenter in front of the participant could have provided participants with the clue that water was needed to solve the problem.

The third trial had the following set up: a graduated cylinder containing 60mL of water and the green "ball", taped down so participants were unable to flip the cylinder upside down, a large bowl filled with water, measuring cups, a bowl of marbles, an eyedropper, and post-it notes. Either conventional solution from trials one or two would have adequately solved the task in trial three. The ball was painted green to be more visible to participants, especially after the size reduction.

Supplementary Information Phase

Aside from the post-task interview/ questionnaire described above, two additional questionnaires were created for the purposes of this study, one designed for parents to describe their child's interactions and relationship with water and another designed for teachers to describe their teaching techniques. These questionnaires can be found in Appendices B and C. Parents were asked to provide answers within a week of their child's experiment. Unfortunately, due to timing

concerns with the end of the semester, not all parental questionnaires were returned, and the ones that were completed were returned to me a couple of months after the experiment, so they were not included in the results or analysis. While these questionnaires still contain valuable information, there was not enough time to properly conduct analysis and answers would have portrayed participants' current knowledge on water, not the knowledge they had while the experiment was being conducted. While some teacher questionnaires were returned, the original purpose of the questionnaires was to compare the creative environments of the two classrooms. Due to the limited sample size (2 participants from *Casa de Bleu* and 7 participants from *Casa de Jaune),* a statistical comparison of creative educational environments could not be conducted. Therefore, the teacher questionnaires were no longer relevant to, and included in, this study.

Data Analysis

Data from the experimental phase were evaluated first and then data from the observational phase were examined to identify any behaviours that occurred into both phases and understand the potential relationship between any tool use actions (seen in the experimental phase) and object play actions (seen in the observational phase). Due to the extent of play behaviours conducted in the observational phase, initial analysis was narrowed to include only the actions *directly* involved for solving the task in the experimental phase (raising the ball through the addition of water in trials 1 and 3). Those actions were the scooping and pouring of water. Trial 2 was not included at this stage as the conventional solution (adding glass beads) did not consist of a specific action that could be looked at in the observational phase. To correctly examine trial 2, analysis of all behaviours related to water displacement must be conducted. However experimental results for this trial were included in case any reader was curious.

Experimental

Experimental data were scored according to 7 measures: (1) Did the participant solve the trial? (2) How long did the trial last? (3) Did they use the conventional solutions (as defined in the methods experimental phase, trial 1- adding water, trial 2- adding glass beads, trial 3- adding water and/or glass beads)? (4) Did they have another solution to the problem? Conveyed to the experimenter verbally or by the participant's actions (5) How much time was spent directly solving the trial? (6) How much time was spent doing other actions (exploring materials in the water table that could not be used to solve the task)? (7) How much time was spent away from the water table?

Measure 1- Participants were scored on if they were able to solve the trial, i.e. retrieve the ball. As between-participant analysis was not conducted, the results indicated a yes or no depending on success in the trial.

Measure 2- All trials were intended to be 10 minutes; however, participants were allowed to end the trial anytime they wanted and if the participant was directly solving the task when the 10 minutes were up, the participant was allowed to continue that action. The time spent on the trial was noted.

Measure 3- The solution participants used to retrieve the ball was taken into consideration. The conventional solution for trial 1 was adding water to the graduated cylinder to raise the water level. The conventional solution for trial 2 was adding glass beads to raise the water level. The conventional solution for trial 3 was adding water and/ or glass beads to raise the water level. As between-participant analysis was not conducted, the results indicated a yes if the conventional solution was used. At this stage, it was noted if participants used the conventional solution.

Measure 4- The solution participants used to retrieve the ball was taken into consideration. Attention was paid to any solution other than the conventional solution used to complete the task.

Future analysis should make note of any other solutions proposed by participants which should be scored depending on how creative the solution is. This would allow for a comparison between participants.

Measure 5- Time spent directly solving the trial was defined as time spent on actions that were conducted around or in relation to the object of interest, the ball. Examples of such actions include: participants using measuring cups to cover the graduated cylinder that housed the ball, participants looking into the graduated cylinder, and participants pouring water into the graduated cylinder. The time spent on these actions was noted.

Measure 6- Time spent doing other actions was defined as time spent engaging with materials inside the water bin, aside from the graduated cylinder or object of interest, the ball. Examples of such actions include: participants dropping glass beads into the water bowl, participants picking up and examining a measuring cup by turning it around and looking at it, and participants picking up the eyedropper, pulling the rubber bulb off of the glass pipette, and putting the rubber bulb back. The time spent on these actions was noted.

Measure 7- Time spent away from the water table is defined as time participants spent stepping away, walking away, looking away from the water table, in general not interacting with the water table, or extra interaction with the experimenter. This measure was primarily included to investigate if any participants felt uncomfortable during any of the experimental trials, so that changes to the methodology could be made to facilitate the experimental trials in a more efficient and preferable manner. The time spent on these actions was noted.

For future replication studies with larger sample sizes, these measures should be scored as indicated below and should allow for comparison between participants. Please note the proposed scale indicates that participants with a higher score were more successful in the trial.

Measure 1- Future studies with larger sample sizes should score this measure appropriately (e.g. use of 1 for success of task, use of 0 for failure of task) to provide a comparison between participants.

Measure 2- Duration of trial should be kept more consistent between participants when possible. Additionally participants who spent less time on the trial, should receive a higher score. For example, if a participant is given 10 minutes for a trial but only spent 1 minute on the trial, they should receive a score of 9, 10-1.

Measure 3- Use of conventional solution should be scored depending on the premise of replicated studies. If studies aim to compare creative educational environment, as described in the introduction, no solution should receive a score of 0, the conventional solution should receive a score of 1, and a non-conventional solution should receive a score of 2.

Measure 4- Solutions other than conventional solutions should be score depending on how creative the solution is. Future studies should define a criterion of creativity to use for this measure.

Measure 5- For time spent on direct actions, the same scoring method as measure 2 should be used. For example, if a participant is given 10 minutes for a trial and spent 3 minutes on direct actions, they should receive a score of 7, 10-3.

Measure 6- For time spent on other actions, the opposite scoring method as measures 2 and 5 should be used. For example, if a participant is given 10 minutes for a trial and spent 6 minutes on other actions, they should receive a score of 4, 10-6.

Measure 7- For time spent away, the same scoring method as measures 6 should be used. For example, if a participant is given 10 minutes for a trial and spent 7 minutes away from the experiment, they should receive a score of 3, 10-7.

Additionally, results from the post-task interview questions were not included due to variations in how they were administered.

Observational Phase

Many forms of play were seen in the observational play including object play, pretend play, and constructive play. In addition to this, many repetitive actions were also seen during the observational phase such as scooping and pouring, whisking, shaking, and pushing down on objects to submerge them into the water. As stated above, trial 2 was not involved in this initial stage of analysis.

Results

Experimental Phase

For trial 1, 22% of participants (2/9) were successful in retrieving the ball. During trial 2, 50% of participants (4/8) were successful in retrieving the ball with the 2 successful participants from trial 1 remaining successful in trial 2. Lastly, in trial 3, 100% of participants (3/3) were successful in retrieving the ball. Results for trial 3 were only involved if the full trial was conducted. Instances where participants watched the set up for trial 3 or were directly provided water (i.e. the water bowl was filled in front of them) were not included in the data analysis. This was to control for any hints the participants may have received by the experimenter directly providing them with water. However, these experiences were very valuable in developing the methodology. Results around successfulness of trial, solution use, and measures 1,2, 3, 5, 6, and 7 for trials 1, 2, and 3 can be found in tables 3.1, 3.2, and 3.3, respectively. As analysis was tailored

to examine only the scooping and pouring behaviours and creativity was not taken into account, measure 4 was no longer appropriate for this stage of the study.

Table 3.1 – Results for Trial 1

Participant	Solved	Solution used	Trial time	Time direct	Time other	Time away
J1	No	N/A	9 min 52 sec	48 sec	2 min 47 sec	6 min 17 sec
B1	No	N/A	12 min 13 sec	1 min 38 sec	8 min 27 sec	2 min 8 sec
J2	No	N/A	13 min 33 sec	10 sec	6 min 33sec	6 min 50 sec
B2*	No	N/A	7 min 16 sec	18 sec	11 sec	4 min 15 sec
J3	No	N/A	9 min 45 sec	9 min 45 sec		
J4	Yes	Filled with water and then added glass bead	5 min 24 sec	5 min 8 sec		16 sec
J5	No	N/A	10 min 12 sec	9 sec	7 min 50 sec	2 min 13 sec
J6	No	N/A	11 min 59 sec	1 min 52 sec	8 min 12 sec	1 min 55 sec
J7	Yes	Conventional	39 sec	26 sec		13 sec

*Participant MN9HS15 spent time telling the experimenter of different possible solutions during the trial

Table 3. 3 – Results for Trial 2

Participant	Solved	Solution used	Trial time	Time direct	Time other	Time away
J1*	No	N/A	11 min 21 sec	5 min 12 sec	2 min 3 sec	4 min 6 sec
B1	Yes**	Conventional	8 min 31 sec	2 min 21 sec	6 min 4 sec	6 sec
J2***	No	N/A	10 min	23 sec	3 min 53 sec	1 min 10 sec
B2****	Yes	Conventional	8 min 51 sec	5 min 27 sec	1 min 2 sec	2 min 24 sec
J3	No	N/A	4 min 54 sec	3 min 23 sec	2 sec	1 min 29 sec
J4	Yes	Conventional	1 min 31 sec	1 min 11 sec	2 sec	18 sec
J5	No	N/A	8 min 43 sec	31 sec	34 sec	7 min 38 sec
J6	N/A	N/A	N/A	N/A	N/A	N/A
J7	Yes	Conventional	39 sec	16 sec		23 sec

*Participant AN7WC20 knocked over the graduated cylinder so the experiment had to be re-set up.

**Participant NN8DG10 verbalized and performed the conventional solution for trial 2; however problems with the materials (size of ball) prevented the participant from getting the ball.

***Participant HG8HC9 moved to the other side of the water table in a manner than prevented any activity within the water table to be recoded.

****Participant MN9HS15 performed the conventional solution for trial 2; however problems with the materials (size of ball) prevented the participant from getting the ball. Additionally, it is important to note that this participant provided another solution (digging with the glass bead and spent time pursuing that solution)

Table 3.3 – Results for Trial 3

Participant	Solved	Solution used	Trial time	Time direct	Time other	Time away
J1	N/A					
B1	N/A					
J2	N/A					
B2	Yes	Conventional-added water	2 min 40 sec	2 min 40 sec		
J3	N/A					
J4	Yes	Conventional-added water	22 sec	21 sec		1 sec
J5	N/A					
J6	N/A					
J7	Yes	Glass beads & water	1 min 8 sec	37 sec	7 sec	24 sec

Observational Phase

The results of which participants engaged in scooping or pouring behaviours in both phases can be seen in the tables below. Table 4.1 illustrates the relation between experimental and observational phases for trial 1. It shows if participants solved trial 1, if any pouring or scooping actions were seen in the trial, which objects were involved in those scooping and pouring actions, if any scooping or pouring was seen in the observational phase, the duration of those actions, and the objects included in them. The first participant was not included in this table due to the differences in methodology.

Table 4.1 – Results for Trial 1

Participant	**Trial Solved?**	**Any Scooping or Pouring Seen? (Experimental)**	**Objects Involved**	**Any Scooping or Pouring of water Seen? (Observational)**	**Duration of action**	**Objects Involved**

B1	No	Yes	Measuring cups, funnel	Yes	14 min 5 sec	- tube, funnel, measuring cup, pitchers, bucket (no handle), ladle, slotted spoon, scoop
B2	No	No	N/A	No	N/A	N/A
J5	No	Yes	Measuring cup, glass beads, funnel	No	N/A	N/A
J4	Yes	Yes	Measuring cup	Yes	7 min 1 sec	- Measuring cups, pitchers, beaker, cylindrical container, bucket (no handle), ladle, heart,
J3	No	No	N/A	Yes	12 min 2 sec	- Pitcher, ladle, scoop, beaker, heart, measuring cups, shovel, kitchen spoon, rake, cylindrical container,

J6	No	Yes	Measuring cup	Yes	21 min 53 sec	- Measuring cup, pitcher, bucket (no handle), beaker, cylindrical container, slotted spoon, scoop, ladle
J2	No	Yes	Measuring cup	Yes	54 min 54 sec	- Measuring cup, pitchers, ladle, hearts, cylindrical container, bucket (no handle), beaker, scoop, shovel,
J7	Yes	Yes	Measuring cup	Yes	5 min 38 sec	- Measuring cup, pitchers, heart, beaker, cylindrical container, ladle,

Table 4.2 illustrates the relation between experimental and observational phases for trial 3. It shows if participants solved trial 3, if any pouring or scooping actions were seen in the trial, which objects were involved in those scooping and pouring actions, if any scooping or pouring

was seen in the observational phase, the duration of those actions, and the objects included in them.

Table 4.2 – Results for Trial 3

Participant	**Trial Solved?**	**Any Scooping or Pouring Seen? (Experimental)**	**Objects Involved**	**Any Scooping or Pouring Seen? (Observational)**	**Duration of action (sec)**	**Objects Involved**
B2	Yes	Yes	Measuring cup	No	N/A	N/A
J4	Yes	Yes	Measuring cup	Yes	7 min 1 sec	Measuring cups, pitchers, beaker, cylindrical container, bucket (no handle), ladle, heart,
J7	Yes	Yes	Measuring cup	Yes	5 min 38 sec	Measuring cup, pitchers, heart, beaker, cylindrical container, ladle,

Discussion

These results do not directly support the hypothesis that object play facilitates tool use in young children, nor do they provide direct support against the hypothesis. Participants who performed scooping and pouring behaviours in the observational phase were not necessarily successful in the experimental phase, even if they performed scooping and pouring behaviours in both phases. Additionally, a participant who did not perform scooping and pouring behaviours in the observational phase was still successful in the experimental phase.

There are many possible reasons for the results seen in this study. First, participants may have been exposed to pouring and scooping water outside of the playful context of the water table in the observational phase. They may engage in those behaviours outside of their school environment or even within in their school environment but in different areas of their classrooms, such as the practical life section. Perhaps that prior exposure is where they learned scooping and pouring which led them to be successful in the experiment.

Secondly, the scooping and pouring actions were not isolated within the play setting, participants could have been scooping or pouring water in the play setting as part of pretend of imaginary play. One definition of pretend play, proposed by Matthews (1977) states that children transform or substitute a specific object or action for another object or action that is not necessarily present. Using this definition, it is possible that instead of pouring water, the participant was actually pouring “concrete” to build a road, essentially pretending the water is concrete. This form of pretend play, instead of object play, could have led to increased engagement in the play setting but lack of success in the experimental setting.

Third, looking at only scooping and pouring behaviours in the play setting negates other experiences and actions that could have taught participants of hydraulic properties, such as water displacement. It is entirely possible that some participants learned about water displacement through their scooping and pouring actions in the observational setting which gave them the knowledge necessary to solve the experimental trials. However, it is also possible that participants gained the relevant knowledge around water displacement in some aspect of their lives, completely unrelated to the observational setting.

Fourth, due to the similarities between trials 2 and 3 (the ball floating on water at the beginning of the task), participants may have recognized the need to add more water into trial 3 to retrieve the ball.

Fifth, despite the methodological changes to facilitate a more comfortable and familiar environment, participants may still have felt uncomfortable when completing the task. Results from measure 7, time spent away from water table, show that some participants were still reluctant to interact with the experimental materials. Lastly, the motivation of helping the experimenter retrieve their ball may not have been reason enough for participants to engage with the task.

It is important to note that participants were able to use objects in the experimental phase that were similar to those they were exposed to in the observational phase such as the different measuring cups, ladles, and kitchen spoons. Despite the differences between those objects provided to participants in the observational phase and experimental phase, participants mostly used the objects in the same manner, grasping by the handle to scoop and pour. Through the Affordance Learning theory, play with an object that had a handle such as a kitchen spoon may have helped the participant recognize that object's affordances and aided in their decision to

scoop and pour water with the measuring cup, another object with a handle, to solve the task at hand. However, there are a multitude of variables to consider when looking at this data, such as different forms of play, age and sex differences, therefore a direct conclusion about the participants learning tool use through object play by the principles of the Affordance Learning theory cannot be made.

Conclusions

Although definite conclusions about object play and tool use cannot be made through this phase of the study, this pilot study did refine an experimental methodology used to test the relationship between object play and tool use in young children. The importance of participant comfort and familiarity, especially in young children, the need to expand participant observations, and the materials necessary to best conduct the experimental trials were identified and addressed when possible. Experimenter location and dialogue were modified, experiment site was changed from desk to water table, and ball size and colour were modified.

Limitations of this Study

The limited sample size in this study prevented me from conducted any statistical analyses pertaining to the relationship between object play and tool-assisted problem-solving. The observational phase focused on participant behaviour in the water table, thereby ignoring other behaviours potentially relevant to solving the experimental trials that participants could have performed/honed in other parts of the classroom. For a full analysis of object play and tool use, all interactions with water in both playful and tool-use contexts should be examined. Additionally, the development of the experimental phase methodology hindered the ability to do between-participant analysis as not all experimental trials were delivered to participants in the

same manner. However, developing the experimental phase methodology was necessary to identify the best way to implement this water-displacement experiment in future studies. Furthermore, different classroom layouts limited the possibility to capture all participant behaviours in the water table.

Next Steps/Future Directions

This study should be replicated in a larger sample, preferably with preschool students in different learning environments. Educational environments that value play differently could be beneficial when examining the benefits of play with relation to problem-solving. Additionally, expanding the observational phase to other parts of the classroom, aside from the water table could provide other reasons and examples of object play that facilitated tool use. Moreover, deeper analysis of observational videos should be done with additional scoring measures of: facial expression analysis, body language, teacher interruption, other social interruption, and audio data pertaining to pretend play and collaboration between participants. The pilot study lays the groundwork for how to implement an experiment using the tasks developed in this pilot, and for future object play and tool use research with water in young children. It highlights information around child studies such as comfortability in environment for children, the necessity for a familiar and friendly experimenter who interacts with the child when needed, and the value of examining an object used for play and tool-use such as water.

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Appendix

Appendix A. Original vs Developed Experimental Layout

Figure 1: Original Layout

Figure 2: Developed Layout

Appendix B. Parental Questionnaire

Parent/Guardian Questionnaire

Participant ID:

Hygiene

1. How many times a DAY does your child brush their teeth?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

2. How many times a DAY do YOU brush your child's teeth?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

3. How many times a WEEK do YOU brush your child's teeth?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

4. How many times a DAY does your child brush their hair?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

5. How many times a DAY does your child wash their face?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

6. How many times a DAY do YOU wash your child's face?

Mark only one oval.

0	1	2	3	4
◯	◯	◯	◯	◯

7. How many times a WEEK does your child shower?

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

8. How many times a WEEK does your child bathe?

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

Household Tasks

9. Please select all of the ways your child helps with laundry

Tick all that apply.

- [ ] Putting their dirty clothes in the laundry basket
- [ ] Putting away their clean clothes
- [ ] Putting clothes into the washing machine
- [ ] Moving clothes into the dryer
- [ ] Turning on the washer
- [ ] Turning on the dryer
- [ ] Putting soap into the washing machine
- [ ] None of the above
- [ ] Other: _____

10. Please select how often your child helps with laundry-related tasks per WEEK

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

11. Please select all of the ways your child helps with doing the dishes

Tick all that apply.

- [ ] Washing dishes by hand
- [ ] Drying dishes by hand
- [ ] Loading a dishwasher
- [ ] Unloading a dishwasher
- [ ] Putting soap in the dishwasher
- [ ] N/A
- [ ] Other: _____

12. Please select how often your child helps with dishwashing related tasks per WEEK

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

13. Please select all of the ways your child helps with cleaning

Tick all that apply.

- [ ] Vacumming
- [ ] Dusting
- [ ] Putting away toys
- [ ] Putting away their books
- [ ] N/A
- [ ] Other: _____

14. Please select how often your child helps with other cleaning related tasks per WEEK

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

15. Please select all of the ways your child helps with cooking

Tick all that apply.

- [ ] Washing produce
- [ ] Cutting produce
- [ ] Peeling produce
- [ ] Mixing
- [ ] Rolling
- [ ] Shredding
- [ ] Boiling water
- [ ] Packing meals
- [ ] N/A
- [ ] Other: _____

16. Please select how often your child helps with cooking related tasks per WEEK

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

17. Please select all of the ways your child helps with gardening

Tick all that apply.

- [ ] Picking out what to plant
- [ ] Potting plants
- [ ] Watering plants
- [ ] Planting seeds
- [ ] Transferring plants
- [ ] N/A
- [ ] Other: _____

18. Please select how often your child helps with gardening related tasks per WEEK

Mark only one oval.

0	1	2	3	4	5	6	7
◯	◯	◯	◯	◯	◯	◯	◯

19. If there are any household tasks not listed above that your child helps with, please state them below with how often your child does the task per WEEK

_____

_____

_____

_____

_____

Nature

20. On a scale of 0-5 how experienced is your child with hiking?

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Hikes regularly

21. On a scale of 0-5 how experienced is your child with skiing?

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Skis regularly, goes to the slopes with family

22. On a scale of 0-5 how experienced is your child with canoeing

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Canoes regularly, spends time in a canoe

23. On a scale of 0-5 how experienced is your child with snowboarding?

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Snowboards regularly, goes to the slopes with family

24. On a scale of 0-5 how experienced is your child with swimming?

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Swims regularly, needs minimal supervision

25. On a scale of 0-5 how experienced is your child with boating?

Mark only one oval.

	0	1	2	3	4	5	
No experience	◯	◯	◯	◯	◯	◯	Is regularly on a boat

26. On a scale of 0-5 how much experience does your child have with beaches?

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
No experience	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	regularly visit the beach

27. On a scale of 0-5 how much experience does your child have with rivers, lakes, oceans?

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
No experience	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	regularly visit rivers, lakes, oceans

28. On a scale of 0-5 how much experience does your child have with mountains?

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
No experience	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	regularly visit the mountains

Exercise/ Toys

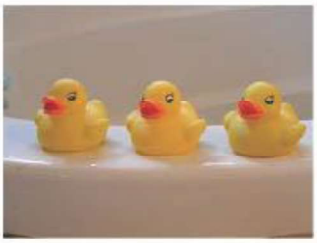
29. Please select forms of exercise your child does on a regular basis

Tick all that apply.

- [ ] gymnastics
- [ ] football
- [ ] dance
- [ ] swimming
- [ ] hockey
- [ ] soccer
- [ ] baseball
- [ ] volleyball
- [ ] Other: _____

30. Please select all toys your child plays with

Tick all that apply.



☐ Floatable bath toys

☐ Tubes/ pipes

☐ Pipettes

☐ Magnifying Glass

☐ Stuffed animals

☐ Dolls

☐ Action Figures

☐ Water guns

☐ Colander

☐ Pipe cleaners

☐ Microscope

☐ Stickers

☐ Toy Car

☐ Books

☐ Mini cars

☐ water balloons

☐ Other: _____

31. Please select all mixed materials you child plays with or in

Tick all that apply.

- [ ] soil
- [ ] sand
- [ ] slime
- [ ] water
- [ ] playdough
- [ ] mulch
- [ ] N/A
- [ ] Other: _____

Activity-Based knowledge

32. On a scale of 1- 10 how much do you think your child has a knowledge on how to dig?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
no knowledge	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	proficient

33. On a scale of 1- 10 how much do you think your child has a knowledge on how things float?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
no knowledge	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	proficient

34. On a scale of 1- 10 how much do you think your child has a knowledge on how things fly?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
no knowledge	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	proficient

35. On a scale of 1- 10 how much do you think your child has a knowledge on how things sink?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
no knowledge	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	proficient

Appendix c. Teacher Questionnaire

University of Lethbridge

Department of Psychology
University of Lethbridge
4401 University Drive
Lethbridge, Alberta, T1K3M4, CANADA

Teacher/Educator Information Letter (Survey) Implied Consent

May 6, 2022

Title of the study: **Movement, Play and Learning in Young Children**

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University of Lethbridge
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Invitation to Participate: You are invited to participate in this research study 1) about how children play and work with objects 2) because you are a teacher/educator in a classroom where some of your students may have participated in our study "Movement, Play and Learning in Young Children."

Purpose of the Study: From this research we wish to learn how children play with toys, work with learning materials, and how they learn to use tools (such as spoons and tweezers) early in life. The purpose of this research is to characterize the motor differences in how children play and work with objects and, to identify what may distinguish play from work. This study may help us understand the role of play in learning and could potentially lead to enhancing teaching and therapeutic tools.

Participation: If you wish to participate in this study, please complete the attached survey. The survey should take you approximately 15-20 minutes to complete. You do not have to answer any questions that you do not want to answer. Once you have completed the survey, please return it by placing it in the drop-off box "*Creative Education Environment Study*" at your school.

We would appreciate receiving it before *June 30, 2022.* If we do not receive it by said date, We will send a notice of reminder to everyone in two weeks from today. We may send up to two more notices of reminder between the first notice and July 31, 2022.

Benefits: A potential long-term benefit of the present research may include a deepening in the current state of knowledge on how young children play and learn; such findings may benefit early childhood programs in general.

Risks: There are no risks for participation in this survey.

Confidentiality and Anonymity: The information that you will share will remain strictly confidential and will be used solely for the purposes of this research. The only people who will have access to the research data are the student researcher and her supervisors. Your answers to open-ended questions may be used verbatim in presentations and publications but neither you (nor your organization name) will be identified. Results will be published in pooled (aggregate) format. Anonymity is guaranteed since you are not being asked to provide your name or any personal information.

Data Storage: Paper surveys will be kept in a locked filing cabinet in the office of the supervisors at the University of Lethbridge for a minimum period of *5* years.

Compensation (or Reimbursement): There is no compensation for completing this survey.

Voluntary Participation: You are under no obligation to participate and if you choose to participate, you may refuse to answer questions that you do not want to answer. Should you choose to withdraw midway through the survey simply shred the entire survey. Given the anonymous nature of the survey, once you have submitted your responses it will no longer be possible to withdraw them from the study.

Information about the Study Results: Research findings will be available at the completion of this study. Arrangements can be made for the researcher to present research findings at your school once the study is complete.

Contact Information: If you have any questions or require more information about the study itself, you may contact the researcher (or her supervisors) at the numbers mentioned herein.

The plan for this study has been reviewed by a *Research Ethics Board 2* at the University of Alberta for research conducted at the University of Lethbridge. If you have any questions regarding your rights as a research participant or how the research is being conducted you may contact the Research Ethics Office at 780-492-2615.

Please keep this form for your records, and if you wish to participate, please return the attached survey by placing it in the drop-off box "*Creative Education Environment Study*" at your school.

By submitting the survey your consent to participate is implied.

Teacher/Educator Survey
(*Movement, Play & Learning in Young Children* Study)

Water Curriculum Questions:

1) What is your primary method of teaching?

2) What properties of water have your students been exposed to during this current school year?

3) Are there time periods during the school year when students learn about the properties of water? If so, when?

4) Are there hands-on activities for students to learn about water?

    a. What are these activities?

5) What materials are used to learn about water? (e.g. water tables, books, videos, etc.)