Chapter 13
Supporting Early Mathematics Learning: Building Mathematical Capital Through Participating in Early Years Swimming

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Abstract Much has been written about out of school contexts and their importance and relevance to learning mathematics. This chapter explores the swim environment for under 5s and its potential for learning mathematics. The findings are drawn from a much larger, international study on the potential impact of early years swimming to add capital to young children. The focus here is on adding mathematical capital to under-5s. It was found the there is a very strong case for early years swimming to be of significant benefit to young children. Drawing on both internationally and nationally accredited and recognised psychological testing and observations of lessons, the chapter explores specific results and then offers a potential explanation for how such results may have been achieved by drawing on lesson observations. The results provide interesting and valuable insights into the potential of non-school contexts to add mathematical capital to young children.

Keywords Early years · Swimming · Out-of-school contexts · Mathematical capital · Bourdieu

Introduction

As part of a much larger project that explores the potential of participating in early-years swimming to add capital to under-5s, this chapter discusses the affordances of the early years swimming context for the development of mathematical learning. Drawing on data generated through the project, this chapter initially compares the achievement of young children on an internationally recognised child testing program. The children in this study performed significantly better than the normal population of the standardised testing program. Observations of swimming lessons are offered to help explain these data.

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Within the Australian context, there is a considerable fascination and affinity for water and swimming. Most Australians live within 1 h drive from a body of water—the ocean, river, or lake. From census figures, it is estimated that there are more than 1.1 million pools in Australian homes and there are approximately 7.0 million homes in the nation, thus making for approximately 15 % of homes having their own pool. Each year, another 24,000 pools are built in homes (Smith 2015). In this context, water activities are a major recreational activity—with swimming, boating, fishing and diving some of favourite pastimes. Swimming is a major recreational as well as sporting activity across the nation. In 2009, over half a million children, aged 5–14 participated in swimming as an organized sport. It was, in fact, the most popular sport across all children of school age, beating dancing, soccer, Australian Rules and netball (ABS 2009). Most primary schools offer swimming lessons as part of the standard curriculum offerings. As an organised sport, the nation has a major fascination in swimming in international events such as the Olympics.

While swimming is part of the cultural identity of the nation, it is also a major activity for children under 5. In this age group, the activities are largely focused on water safety, as death by accidental drowning was the largest cause of death in under-5s. While there are no firm figures on how many children participate in early years swimming, the peak body for Australian swimming coaches and Teachers (ASCTA) estimated that approximately 20 % of under-5s participate in swimming lessons, thus making for quite a large number of young Australians who participate in swimming prior to school. The interest in early-years swimming has grown with Australia now boasting 934 swim schools nationwide (RLSA and AustSwim 2010), over 600 of which are registered with Swim Australia. Almost 80 % of swim schools are privately owned and a little less than a quarter are operated by local councils. The remaining swim schools operate under a management group, through a school, are community based or a combination of these, along with many backyard operators whose businesses are not registered.

While largely unregulated, the industry has a number of organizations that contribute to its management, regulation and education. These include ASCTA, Swim Australia,[1] AustSwim and the Royal Life Saving Society—Australia (RLSSA). Even the Australian Taxation Office influences the participation and credentialing of teachers in the industry. The CEO of ASCTA estimated that there are approximately 800 registered swim schools catering for under-5s in Australia and that these schools would represent approximately 550 of the 600 members of ACSTA. These figures, however, do not account for the many swim schools that operate out of back yards that may not have council permits, or are not members of ACSTA. The figures, however, do give some insight into the breadth of uptake across Australia of early years swimming.

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[1] Not to be confused with Swimming Australia, the national sporting body responsible for the promotion and development of competitive swimming in Australia at all levels. Swimming Australia has almost 100,000 members and just over 1100 swimming clubs nationwide (www.swimming.org.au).

Different swim schools emphasise different aspects of learn-to-swim. Some may elect to offer the “Swim-and-Survive” program from RLSSA, some adapt this program to incorporate other aspects of swimming. Almost all baby classes emphasise water familiarisation and survival skills. Beyond one year of age, however, swim schools offer any number of a variety of approaches to learn-to-swim. Most swim schools advocate that they invoke in children a respect for the water and aquatic survival skills. Beyond this, the primary focus of some schools is be on the development of technique in young swimmers with the ultimate aim of producing (future) competitive swimmers. Others adopt more of a “general education” approach which incorporates other aspects of learning. What is taught in learn-to-swim and how it is taught may impact on what children take away from their learn-to-swim classes to use in their everyday lives. Children may have very different learning experiences from the types of programs offered by the swim schools. Each of these schools offers new learnings—swimming and other—that may help children in contexts outside swimming.

There have been few studies of the impacts of participating in learn-to-swim for young children. Naturally, the focus on the limited research undertaken has been on how early swimming can enhance some motor abilities such as balance and reaching (Sigmundsson and Hopkins 2010) and motor development in neonatal babies including head holding, steady sitting, and holding items (Jun et al. 2005). Others have looked at the impact of swimming on children suffering respiratory difficulties such as asthma (Wang 2009; Font-Ribera et al. 2011). There has also been some considerable research on how water activities can enhance mobility and aerobic strength for children with physical disabilities (for example, Fragala-Pinkham et al. 2008; Hutzler et al. 2008). However, there has been little research into the impact of swimming lessons on able-bodied students other than a large German study in the late 1970s (Diem 1982) when the learn-to-swim industry was in its infancy. Not only are the conditions in Australia different from those experienced in Europe, but in the three decades ago or so.

It is in this context, where many young children are taking swimming lessons, often from the age of 6 months, and with strong parental involvement, that the potential for swimming to add to the repertoire of skills was researched. This is the first international study of its kind to be undertaken and hence represents a significant analysis of the early years swim context. Many aspects of the potential of swimming to add to young children were investigated including intellectual capital, physical capital, social capital and emotional capital. Using nationally and internationally recognised tests, cohorts of children were researched to monitor their well-being against various milestones. This chapter focuses on the swimming environment for children to add to the mathematical learning of children under 5 years of age.

Adding Mathematical Capital Through Early-Years Swimming

The overall project is framed using Bourdieu's (1983) notion of capital, where through the exchange economy, the learnings from one context can be converted into a capacity to do well in a different context and thus become embodied by the learner as part of their habitus. In this case, the learning from the swim context becomes part of the habitus of the learner. A problem for early childhood education is the fact that habitus, or the dispositions, skills and ways of being a family member assimilated as schemata for learning acquired at home do not always transfer well into the school situation. Some children, as described above, can make effective transitions from home to school when they possess pre-existing schemes for thinking about number, colour, shape and so on, others do not. This study, then, explores the possibility of swimming to add to such schemata that learners may be exchange as capital in other fields, namely schooling. It is argued that early swimming has a part to play in this process. Unlike other activities undertaken by under-5s, swimming can be commenced from a very early age. Some advocates of early years swimming (e.g., Laurie Lawrence, the creator of the Kids Alive learn to swim initiative) advocate that swimming can commence as early as birth. Lawrence has worked with the Australian Government to provide all Australian mothers with a DVD on water familiarisation upon the birth of their child. Part of this initiative is based on the fact that the largest cause of death in under-5s is accidental drowning. In a nation where water activities constitute a significant part of the national Australian identity and recreational activities, water safety is strongly endorsed. As such, not only can it be commenced at a young age, but the possibilities for young children to gain in other areas of learning are being explored in this study.

The study is exploring the possibility that early years swimming may add forms of capital to under-5s that may be of value in other contexts, particularly schooling. Jorgensen (2012) has argued elsewhere that the forms of capital building that are possible through early years swimming could include physical capital, social capital, intellectual (or cognitive) capital and linguistic capital. This chapter draws on two of these capitals—intellectual capital and linguistic capital—to constitute mathematical capital. Mathematical capital, or an aptitude to apply concepts in situations requiring understanding of a mathematical discourse, in the context of this chapter, refers to those aspects of school mathematics that are made possible within the early-years swimming context. Being exposed to aspects of school mathematics in the swim environment may support learning of constructs that become embodied by the learner and that can be then exchanged within the school context. These learnings help to support success within the formal school environment. This may be particularly poignant for learners whose social conditions have traditionally excluded them from many aspects of the mathematical discourse and discursive practices.

Method: Child Testing and Lesson Observations

Three key forms of data collection constitute this study. A large-scale survey was developed with over 3000 responses. This survey has been analysed using a number of techniques and the analysis suggest that parents report their swimming children are performing many of the milestones significantly earlier than would be anticipated on developmental expectations. However, while these data are pleasing in terms of the potential for swimming to enhance the mathematical capital building of young children, it is also a limited methodology due to the potential bias of the parents and the limitations of broad parameters of each milestones. To further clarify any potential capital building made possible through participating in early years swimming, intense child testing was undertaken—some tests were for the physical capital building while others were related to cognition and another for socio-emotional capital. Of interest to this chapter are the outcomes of the cognitive tests related to mathematical capital building.

Child Testing

Drawing on widely-used child testing protocols, a series of tests was selected to be administered to children. It was planned that approximately 200 children would be tested. As the tests require considerable input from the child, language skills needed to be well developed, and an attention span commensurate with the time of the test was required. To this end, children only of 3, 4 and 5 years were tested. Within the sampling profile, consideration was also made of gender (boys and girls), socio-economic status (high, mid and low socio-economic backgrounds) and the swim experience of the participants. The tests employed by the Early Years Swimming (EYS) Project were specifically selected to meet a number of criteria:

- Suitable for our purpose—to assess the physical, cognitive and linguistic development of children.
- Age-appropriate—for assessing 3–5 year olds.
- Could be utilised in one session of 1–2 h per child.
- Mostly administered directly to the child without requiring input from a caregiver (or teacher).
- Could be administered by qualified teachers, but not requiring specialist qualifications (psychology, physiotherapy, occupational therapy, etc.).
- Standardised and norm-based: tests have been administered widely with a pool of previous respondents against which we could assess our participants.
- Provide "age-equivalent" measures.
- Not designed for screening purposes (e.g. for identification of autism)—these tend to focus on deficits and not the achievement of milestones and beyond.

The instruments were selected in order to quickly and accurately determine each child's progress across a number of cognitive and language areas. Of interest to this chapter is the Woodcock-Johnson III test that was used to assess "range of cognitive areas, including: oral language, listening comprehension, maths reasoning, verbal ability, cognitive efficiency" (Jorgensen 2013). Each assessment took approximately 90 min to implement by trained teachers. Parents were usually present but were asked not to contribute to/influence the child's responses. Assessments were conducted on campus or within quiet rooms in swim schools.

Woodcock-Johnson III (WJ III)

The Woodcock-Johnson III (WJ-III) Tests of Achievement is a comprehensive system for measuring general intellectual ability, scholastic aptitude, oral language and achievement. It allows the assessment of a wide range of ages, reportedly 2–90 years. First developed in the United States in the late 1970s, it has been extensively tested, with a wide normative sample in 2001 of over 8000 in the United States. It has since been re-normed with an Australian sample of over 1300 in 2006–2007. Sub-tests from the WJ-III have been used in other large-scale Australian studies, for example, the Child Care Choices Study (Bowes et al. 2009).

At ages 3–5 years, it is difficult to assess cognitive and language skill in one brief sitting. The WJ-III allowed for quick and accurate assessment of each child's progress. Eight test items were selected from the WJ-III Tests of Achievement battery based on appropriateness for the purpose of the study (in assessing cognitive and linguistic levels), suitability for the age group and ease of implementation. Two of these items specifically related to mathematics and are described in Table 13.1.

The results from each of these sub-tests are recorded as "Age Equivalent" scores, sub-test scores can also be amalgamated to allow the formation of five "clusters": Oral Language, Oral Expression, Brief Achievement, Brief Reading and Maths Reasoning. Each of these clusters is designed to provide a highly reliable prediction of future achievement in a minimum amount of testing time. As composites of individual tests, they are more reliable than individual test items (Table 13.2).

Table 13.1 Items selected from Woodcock-Johnson III tests of achievement for EYS child assessments in mathematics

Sub-test item	Brief description
Item 10: applied problems	Mathematics problems need to be solved by the child by listening to the problem and performing simple calculations, eliminating any extraneous information presented. Calculations become increasingly complex
Item 18: quantitative concepts	Understanding of maths concepts and symbols is assessed through counting and identifying numbers, shapes, and sequences. The child may also progress to items where they have to identify a missing number from a series

Table 13.2 Woodcock-Johnson III tests of achievement clusters assessed for EYS

Tests of achievement/clusters	Brief reading	Oral language	Oral expression	Maths reasoning	Brief achievement
Applied problems				●	●
Quantitative concepts				●	

Table 13.3 Overview of ages and gender of swimming children assessed

Age	F	M	Total
Group 1: mean age 40.5 months	30	30	60
Group 2: mean age 48.8 months	36	26	62
Group 3: mean age 60.2 months	29	25	54
Total	95	81	176

As the WJ-III provided age equivalent scores for each item, this standardised test permitted comparison of the child's actual age with the performance on each item and each cluster with a wider population of children. It also provided "Z" scores for each item and cluster.

The data collected for this part of the study were compared against larger populations—the tests were selected on the basis that normative data were available to which comparisons could be made with our swimming children. In most cases, these were Australian norm-referenced populations making it possible to undertake comparisons between the swimming children and a normal population.

One hundred and seventy-seven (n = 177) children were assessed, 95 were female and 82 male. They were aged between 36 and 71 months with the mean age of 49.46 months. For the purposes of our analysis, the children were split into three groups, based on tercile age. The ages were converted to years by taking age in months at time of testing and dividing by 12 and then rounding to the nearest year. The rounding is very important because it means that 0.5 is rounded up and 0.4 is rounded down. The result is a group of years that will be based on children around the whole year but might average slightly lower or higher. The alternative—to select those children aged between 3 and 4 years—would provide an analysis of a mean age closer to half-years (e.g. 3.5 years), making comparisons difficult. Once split into the three terciles, the gender groupings per age were then identified (Table 13.3).

All of the children who took part in child assessments are actively engaged in learn-to-swim classes. They have participated in varying lengths of time, from 6 to 61 months.

The children represent a variety of socioeconomic backgrounds. Parents were asked for the postcode of their residential suburb and data was analysed using the Australian Bureau of Statistics Index of Relative Socio-economic Disadvantage (IRSD). This is a general socio-economic index that summarises a range of information about the economic and social conditions of people and households within an area. A low score indicates relatively greater disadvantage in general, a high score indicates a relative lack of disadvantage.

Of the children assessed for this project, 82 represent residential areas that score in the lowest half of areas on the ABS's Index of Relative Socio-economic Disadvantage (Table 13.4).

The basis for this aspect of the child testing was the Woodcock-Johnson III tests. Using a two-tailed t-test, a number of factors were found to be very highly significant. The Woodcock-Johnson III battery assesses children on a number of items,

Table 13.4 Overview of ages, gender and socioeconomic status of swimming children

Age group	Female				Male			
	Low SES	Med SES	High SES	Total	Low SES	Med SES	High SES	Total
Group 1: mean age 40.5 months	3	14	13	30	11	10	9	30
Group 2: mean age 48.8 months	10	12	14	36	6	10	10	26
Group 3: mean age 60.2 months	10	10	8	28	12	7	6	25
Total	23	36	35	94	29	27	25	81

Table 13.5 Mathematical reasoning cluster

Cluster	Indicative items included in general skill	Mean	Significance	Mean difference
Mathematics reasoning	Simple mathematical calculations and counting and identifying numbers, shapes, and sequences	56.06	0.000	6.597

some of which can be aggregated into clusters which provide quick and accurate measures of performance for general skills.

The mathematical reasoning skills had statistical significance can be seen in Table 13.5.

As a group they were particularly strong in Mathematical Reasoning. They also scored more than 6 months ahead of the normal population on the cluster for mathematical reasoning. These results will now be closer examined by looking an individual subtests and by breaking down the cohort into a number of subgroups (by age, gender and socioeconomic status).

Age Groupings

The 177 children assessed for this research has been broken down into terciles according to age. Sixty children are in the youngest group (Table 13.6).

With a mean age of 40.5 months, they are excelling over the normal population in a number of areas including Applied Problems and Quantitative Concepts at 9

Table 13.6 Performance of the swimming tercile age group 1 on WJIII assessments

Sub-test	Mean	Sig. (2-tailed)	Mean
Applied problems	49.58	0.000**	9.083
Quantitative concepts	44.73	0.001**	4.233

$*p < 0.05$, $**p < 0.01$

Table 13.7 Performance of the swimming tercile age group 2 on WJIII assessments

Sub-test	Mean	Sig. (2-tailed)	Mean difference
Applied problems	57.13	0.000**	8.327
Quantitative concepts	56.57	0.000**	7.771

** $p < 0.01$

Table 13.8 Performance of the swimming tercile age group 3 on WJIII assessments

Sub-test	Mean	Sig. (2-tailed)	Mean difference
Applied problems	65.85	0.000**	5.646
Quantitative concepts	64.10	0.001**	3.896

* $p < 0.05$, ** $p < 0.01$

and 4 months ahead of their same age peers. These results are statistically significant.

Similar results were recorded for the middle tercile. There were 63 children in this group (Table 13.7).

With a mean age of 48.8 months, this group also outperformed the normal population in many statistically significant ways with considerable differences ahead of their same aged peers in the normal population—Applied problems (8.3 months), Quantitative Concepts (7.7 months).

The 54 children in the oldest tercile have a mean age of 60.2 months. Their results are reported as follows (Table 13.8).

The oldest tercile also performed well on both mathematical measures—Applied Problems (5.6) and Quantitative Concepts (3.9). It is noted the differences are not as great in this group, and it is thought that there may be a ceiling effect coming into the data since the selected tests were only for young children (Table 13.9).

These data suggest that young children participating in swimming lessons appear to be achieving better in mathematical domains than the normal population. One of the questions that these data raise is related why the swim environment may be enhancing mathematics learning. In order to better understand the potentialities of the swim environment, the project also included observations of lessons across four different states in Australia.

Table 13.9 Overview of the performance of the swimming cohort by tercile age groups on WJIII maths assessments

Sub-test item	Group 1 mean age: 40.5 months	Group 2 mean age: 48.8 months	Group 3 mean age: 60.2 months
Quantitative concepts	7.398**	3.613*	5.46**
Applied problems	9.083**	8.327**	3.896**

* $p < 0.05$, ** $p < 0.01$

Swim Pedagogy: Fostering a Rich Language of Mathematics

As part of the project, there has been a concurrent investigation of the pedagogical environment in order to understand the ways in which the teaching may, or may not, enhance learning. Not only are the learners being exposed to practices that help build a capacity to swim, but there are hidden aspects to the pedagogic discourse that build other forms of capital. While some of the pedagogic discourse relays convey mathematical concepts and processes, they also may assist in inducting young learners into the ways of schooling. The potential to build forms of capital through the swim pedagogy has been observed across a number of lessons. The research team has been involved in observing many lessons across Australia. Over 12 months, an observations tool has been developed to profile the pedagogy of the swim schools. In developing this tool, a considerable number of lessons were videotaped to ensure the development reliability of the tool, and focus groups conducted with the swim industry to trail and validate the tool. For this chapter, I am not focusing on the specifics of the lesson observation tool, but rather the observations of lessons where it became clear that the pedagogic discourse used by the teachers had considerable potential for enhancing the mathematical capital of the learners.

Zevenbergen (2001) has noted the disjunction between the home and school discourses around the mathematical register. The instructional discourse of the learn-to-swim programs uses the rich language of shape, location, colour, number so that young children are exposed to this language from a very early age. Terms such as “get the red ball”, “swim under the rope”, “push through the hoop” are commonplace in the discursive practices employed by the teachers. This enrichment of vocabulary exposes the children to many aspects of the mathematical register but also links the constructs with physical actions so that the children have greater opportunities to learn the school discourse and embed it within a physical-cognitive experience. In this way, there is every chance that the students may have greater success in schools due to their exposure to the patterns of signification (concepts/language) within the learn-to-swim program that augers well with school knowledge. This may be particularly so for those children whose home language is restricted in the use of such terms. Through the instructional discourse, students are exposed to rich iterations of language thus offering potential to extend their linguistic (and mathematical) capital. In this context, the swim environment offers the potential for young children to add to their repertoire of skills, knowledge and dispositions that ultimately may position them favourably for formal schooling. This is now discussed with reference to learning mathematics.

Pedagogic Discourse in Learning Mathematics

Bernstein (1990) pioneered the work on pedagogic discourse where he argued that classroom discourse relays more than just concepts. In this case, not only are swimming skills and dispositions being learnt, but other valuable aspects of the dominant culture are being learned. Most notably for this chapter is the mathematical ideas and processes that are integral parts of Western culture are being embedded implicitly in the discursive practices of the swim pedagogy. Also, other aspects of culture are being relayed—such as turn taking, paying attention to the teacher, not talking while the teacher elicits instructions, or walking in single file to the teaching space. Many of these cultural norms of the swim environment will transition to the formal school context, which will also act as a form of capital for the students.

Of interest in this chapter then, are the possibilities for mathematical learning that is being made possible via pedagogic discourse. This discourse is one that has particular regulatory rules and protocols that are part of discourses to do with engagement and preparation for instruction. For example, as the teacher encourages kicking skill, he/she moves the babies' legs counting one, two, three, four and with each count the leg is moved. This protocol of counting to each kick not only encourages the development of the auditory phenomenon of counting but also the one-to-one correspondence of count-to-kick pattern. Students are exposed to the discourse as they inserted into the teaching/learning environment. As the swim environment is one where there is a high emphasis on safety, teachers work in small classes and are focused on ensuring all children are engaged with the lesson. The engaging environment is one aimed at maximum learning in the time allocated so that students learn important skills regarding attention to the teacher and on-task behaviours.

The protocols associated with the learning environment can be illustrated in the following extract where the teacher is relaying a number of important aspects of the teaching/learning environment. In this extract, the important social skill of turn-taking is being elucidated. At this same time, the importance of waiting until it is the student's turn to undertake an activity, is being learned. By waiting, the teacher is then able to work with, and assess the student's behaviour and undertake any necessary corrections. The importance of being able to take turns is embedded in the interactions.

> Teacher: Jack,[2] go back to the wall, start from the wall and wait your turn, buddy.[3]
>
> This was also noted in an interview:
>
> Teacher: You need to have eyes in the back of your head. As soon as you hear a splash or yell, your immediate reaction is to see what has happened, to see if it is one of your kids.

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[2] Pseudonyms are used in this paper to protect the identity of participants and sites.

[3] A term of affection often used by teachers, particularly for young boys.

> You don’t get much a chance if they fall over: you have to make sure you know where each of them are at any point in time.

The importance of the pedagogic discourse in coming to learn more than just swimming was observed across a range of patterns and structures within the swim environments. Within the Bourdieuian framework used in this project, what can be seen is that the swim environment is adding new forms of knowing, behaving and communicating (or capitals) to children that, in turn, is internalised into their habitus. These dispositions to the learning environment are likely to position them more favourably with teachers as they display these new learnings. The displays of learning that can be observed in the children need to align with the practices valued in the field if the child is to be seen as displaying valued knowledge. Such displays, in turn, can then be exchanged for other rewards in the learning environment. In the swim environment, these are often certificates that acknowledge what has been learned, and as a consequence, progression into a different class. While the swim environment primarily focuses on skill development leading towards independent swimming, what is of value is the incidental learning that can be readily observed. There were many practices that created potential for mathematics learning that would prepare students for their mathematics learning but also support them in their transition into formal schooling. It is this aspect of the swim environment that is the focus of the remainder of this chapter.

Mathematical Discourse

Jorgensen and Grootenboer (2011) have shown that the pedagogical discourse of the swim context is rich with mathematical signifiers. Throughout the observation of many lessons we found that there were often times when swimming teachers used mathematical language and ideas in their instructions. Most lessons links counting exercises with bodily mechanisms for familiarisation or propulsion through the water, so that the children are exposed to regular counting in threes or up to ten in the very early years. Water familiarisation, which can commence at birth, is a cueing process where the parent pours water of the child’s head so that it runs over the face. To cue the child, the parent says “one, two, three, ready”. At the cue of ‘ready’, a very young child, even 3 months of age, will close her/his eyes in anticipation of the water coming over the face. This very early exposure to counting and number brings about a familiarity with the counting patterns. In the lessons, teachers constantly use counting patterns to cue the children for various activities—such as kicking, submersion or floating.

Drawing on the data from Jorgensen and Grootenboer (2011), it can be seen that the pedagogic discourse employs a rich mathematical language. Many terms are used that relate to various aspects of the mathematics curriculum. These include number (one, two three), to measurement (big, fast, slow), to space in the areas of geometry (circle, straight, line, edge) and positions (up, down, underneath, side-by-side, together, backwards, edge). For example:

> *T: After one-two-three, we are going to push off with our hands like a rocket.*
>
> *T: I need to see really big arms, big and slow.*
>
> *T: Clinton, can you follow the big line on the roof” [points to the line painted on the ceiling]?*
>
> *T: Okay watch me, I am going to have my hands on the edge, toes on the wall, head backwards, looking up at the line on the roof. Watching me, push off the wall, eyes up, glide, like a ferry boat [teacher demonstrates]. Alex, hair in the water first, and push and glide. Hold your body nice and straight and long.*

The routine instructions employed by the teachers and constitute a significant component of the lessons observed over the 3 years of data collection and lesson observation. There is much mathematical language and concepts embedded in these interactions. What was also observed was of the strong link between the auditory learning of the words and that the words/concepts are linked with physical actions. There is a strong push in early years learning, through perceptual-motor programs (Stephenson), to link kinaesthetic experiences with linguistic experiences with the view that this partnering of physical actions with concepts further strengthens learning. A growing body of contemporary brain research suggests that there is a linking between the physical embodiment of words and cognition. This research indicates that the physical movement associated with swimming may be helping young children with many of the concepts found in mathematics. If this is indeed the case, then the body movements associated with number, or body movement and position or even colour sorting may enhance the potential for learning and retaining these concepts.

While there is an emphasis on the mathematical signifiers that are integral to learning school mathematics, there is also a need to recognise the role of the ‘little’ words (e.g., prepositions, adverbs) are important as these often have important meanings in mathematics (e.g., off, up, out). These are often neglected in the study of language and mathematics but are an integral part of learning (and success) in school mathematics. There is a considerable difference between 25 % of 200 and 25 % off 200. Similarly, the enrichment of spatial language terms of near, next, on, below is integral across the spectrum of mathematical experiences. In these cases, the little words have a big influence on mathematical learning. Being exposed to mathematical discourses where prepositions have been used is integral to learning, and it has been found that when students are not able to grasp the use of prepositions, there is considerable scope for error (Zevenbergen et al. 2001). The swim environment offered a range of experiences, with concomitant physical actions, with these signifiers. In the extracts below, the use of these little words can be observed:

> *T: Sitting on the edge of the pool, rockets up in the air, now on one, two, three, slide in and push off the wall swimming out to me using big arms.*

> *T: Alex, put your rockets up like Benjamin. No, not hands side-by-side, hands one on top of the other. Keep your toes underneath the water, nice long legs, no spaghetti legs, nice long straight legs.*
>
> *T: Climbing up out of the pool, using your muscles, tummies, hands and one knee. Standing on the edge now. Now, using your hand making a circle with your arm. Going up past your ear and around to your leg, up past your ear and around down to your leg. Big circles, I want big straight arms [teacher manipulates the child's arm to demonstrate].*

These extracts are representative of the instructional discourse of the lessons that have been observed consistently throughout this study. The ones used here have come from one lesson and are used here to illustrate the potential of the swim pedagogy to build a rich experience of the mathematical discourse, but to also create strong practical experiences that link action with words. This partnering of action and words may offer richer experiences for learning (and understanding) the mathematical discourse. The swim environment seems to afford particular experiences—both cognitive and physical—that extend and consolidate the learning of a rich mathematical discourse. Furthermore, it was clear during the observations that the children's responses to the mathematical terms were demonstrated their understanding by performing the appropriate action or behaviour.

Conclusion

The findings reported in this chapter indicate that there is considerable potential for the early years swimming context to provide affordances for building mathematical capital among young swimmers. This capital comes in the forms of early number, comparatives (same/different), colour recognition which is an integral part of many of the early sorting and classifying activities that are foundational to number concepts. What is of interest to the early childhood sector, to parents and caregivers, and educational researchers is that the swim environment is one that is not traditionally associated with formal learning, particularly in matters related to education per se. However, what I have shown in this chapter is that participating in early years swimming may offer much more than physical capital and water safety for young children. The data in this project have shown that even for young children from low SES families, there have been achievements in mathematics learning (and other areas) that are significantly better than for the normal population.

In terms of the early years learning of mathematics, it may be prudent to consider avenues for learning that are outside those usually associated with school or formal learning contexts. While this study was focused on swimming, there has been feedback from other sport areas—can ballet enhance learning or fencing? This is difficult to answer. However, what is also clear from this study, is that unlike other activities that young children undertake, swimming can be started at a very early age. Water familiarisation, as advocated by Laurie Lawrence and cited in the beginning of this chapter, can commence as early as the first bath. Formal swimming lessons can commence at times nominated by the swim school but are often between 3 and 6 months. As such, children can start swimming much earlier than any other activity. Unlike other sport or recreational activities where the child's motor skills are considerably advanced, the swim environment supports the child—so even with floppy necks, the water acts as a support (along with the parents' grasp). To this end, the child is often participating in swimming nearly 2 years before they can commence most other physical activities.

What has emerged from this study is that participating in early years swimming has the possibility to enhance young children's mathematical understandings. As noted in the earlier sections of this chapter, there are many differences in schools in what is a largely deregulated industry. Parents have the choice to opt in or out of early years swimming. For those who do, there is a need to be mindful of what constitutes a quality swim environment, and how that environment may (or may not) contribute more broadly to a young child's learning. What has emerged from the study is that much more is learned than just swimming. Quality swim schools have the potential to significantly enhance the mathematical learning of children under 5 years.

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