Early-Years Swimming: Creating Opportunities for Adding Mathematical Capital to Under 5s

Robyn Jorgensen (Zevenbergen)
Griffith University
<r.jorgensen@griffith.edu.au>

Drawing on survey data from over 2000 parents, this paper explores the possibility of early-years swimming to add mathematical capital to young children. U sing developmental milestones as the basis, it was found that parents reported significantly earlier achievement on many of these milestones. Such data suggest that the early years swim environment may offer enhanced opportunities for learning skills that help transition young children into formal schooling. This paper explores those milestones that are related to early mathematics.

Drawing on data from a large international survey, this paper explores the possibilities of participating in a non-school environment to add capital to young learners. In particular, this paper explores the possibilities of adding mathematical capital to children before they commence formal schooling. Using Bourdieu's (1983) theoretical construct of capital where he argues cultural goods can be exchanged for other goods in another context. In this exchange process, the newly acquired goods are of benefit to the beholder. This paper is framed using the notion of capital to explain how young children may be positioned in terms of advantage in their transition to school (Jorgensen, 2012). The capital-adding that is made possible through participating in early-years swimming includes mathematical capital. Within Bourdieu's exchange economy, it is shown that participating in formal swimming, young children gain experiences outside swimming, including mathematical skills and knowledge, that will have value within the school system. As such, their learnings from the swim context have value in another context, thus becoming forms of capital that can be exchanged for goods to advantage the learner.

Mathematical Experiences Prior to School

Early childhood education, particularly mathematics education, has become the focus of increased attention in the past decade (Perry, Young-Loveridge, Dockett, & Doig, 2008) in part due to the recognition that intervention in the early years can alleviated many of the challenges of education in the later years of schooling. The importance of early years learning in mathematics was aptly summed up in the Position by the Australian Association of Mathematics Teachers and Early Childhood Australia (2006, p. 2):

> The Australian Association of Mathematics Teachers and Early Childhood Australia believe that all children in their early childhood years are capable of accessing powerful mathematical ideas that are both relevant to their current lives and form a critical foundation for their future mathematical and other learning. Children should be given the opportunity to access these ideas through high quality child-centred activities in their homes, communities, prior-to-school settings and schools.

Young children in the years prior to school are able to engage with meaningful and rich mathematical concepts and ideas and in so doing develop a strong foundation in their mathematical understandings that will position them well for later in life (Clarke, Clarke, & Cheeseman, 2006; Kilpatrick, Swafford, & Findell, 2001). Within the parameters of this paper, this is conceived of as a p rocess where the exposure to rich mathematical

In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia). Melbourne, VIC: MERGA.

experiences will help to build a strong mathematical habitus. For Bourdieu, the habitus is, in its simplest form, the embodiment of culture including knowledges and dispostions. This habitus is then recognised and legitimated in the formal school context. Those children with a strong mathematical habitus are more likely to be recognised as 'good learners' of school mathematics and have accolades bestowed upon them – such as high grades, certificates etc. Therefore, it is important that children are able to access mathematical concepts and ideas through a range of activities prior to school settings (Perry & Dockett, 2005) in order to be best prepared for the experiences of schooling.

In examining the possibilities of prior-to-school experiences, there are two main contexts to consider – those that can be broadly conceived of as educational settings such as preschool settings (e.g., Fox, 2005; Mitchelmore, Papic, & Muligan, 2011) and informal, out-of-school, everyday settings (e.g., Clarke & Robbins, 2004). Arguably, the informal settings are more likely to be considered playful and hence not explicitly focused on the learning of mathematics. However, in these contexts, there is still the possibility for learning (Clarke, et al., 2006; Goos & Jolly, 1994). In her work where she observed toddlers at play in outside settings, Lee (2010) noted activities related to a range of mathematical categories including (in descending frequency): spatial concepts, number, measurement, patterning and shape. She noted that not only were the children engaged in activities that were mathematically rich, but that they were also using and learning mathematical ideas and problem solving. Similarly, in her work on measurement in out-of-school contexts, Macdonald (2012) found that children engaged in a wide range of activities. The overall project reported in this paper is not primarily concerned with mathematics per se, but rather the overall experiences of young swimmers as they are exposed to the pedagogical discourse of the swim environment and the affordances made possible through that environment for learning beyond swimming. What has become clear as the project has evolved is that the under-5s swim environment offers strong possibilities for mathematics learning.

Adding Mathematical Capital through Early-Years Swimming

As noted earlier, the 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 his or her 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. Other children are less successful in the transition to school as they do not possess those skills and dispositions (habitus) that is valued within the school context. That is to say, where there is alignment between the home habitus and school practices, there is a greater chance of success for that child. As such, making the transition to school for many young children is about building a habitus that aligns with the structuring practices of formal schooling.

In a nation where water activities constitute a significant part of the national Australian identity and recreational activities, water safety is strongly endorsed. At the same time, and different from other physical activities, formal swimming can be commenced from a very early age. Some advocates of early-years swimming (e.g. Lawrence, 2012) argue that swimming can commence as early as birth but generally formal lessons begin at six months with some schools commencing at three months. As a field of activity that can commence early in life and with significant physical and safety benefits, the study explores the possibility of swimming to create opportunities for learning that may extend beyond swimming. In so doing these other skills, it is theorized that these skills and dispositions can become forms of capital that can be exchanged in other fields, namely schooling. The project is thus an exploration of the ways in which early-years swimming may create opportunities for capital building among young children. There are various forms of capital that are possible – social, linguistic, cognitive and physical – but this paper is limited to the cognitive capital that emphasizes mathematical capital.

Surveying the Field

Over a period of three years, a survey has been implemented across Australia, New Zealand and the USA. A total of over 7000 responses have been received. The surveys have been administered over a six-month period between September and March, due to the interest in swimming over the warmer months. In its first year of the study (2010/2011), the survey was administered via pencil-and-paper but in the second and third years was implemented via Lime Survey – an online survey tool. The first iteration of the survey tool was modified in subsequent years. The data presented here are those from the second year of the study as the third (and final year) has recently been completed and removed from the on-line environment. The data presented in this paper draws on over 2000 parental responses.

The questionnaire was created around internationally-recognised developmental milestones. Initially established using Ericson's seminal work, the instrument was refined using the work of the Centre for Disease Control's (CDC) (2012) milestones. These more contemporary measures were used to reflect recent changes in environmental factors contributing to changes in development. The CDC milestones are organised chronologically for 2 months, 4 months, 6 months, 9 months, 1 year, 18 months, 2 years, 3 years, 4 years, and 5 years. Each chronological group is then divided into a number of key areas – social and emotional; language/communication; cognitive (learning, thinking, problem solving); and movement/physical development. Of relevance to this paper are the cognitive milestones which are described as thinking, learning and problem solving. Some of these are clearly related to early mathematical ideas and processes. Typically the mathematically-orientated milestones appear at two years and older. The milestones that have a mathematical orientation have been highlighted in Table 1.

The focus of these milestones is to promote awareness among parents as to their child's development so that if the child is not achieving such milestones by nominated ages that there is a need to 'act early'. As such, milestones are presented as diagnostic tools for child development. They provide a benchmark for 'normal development' of children and so were useful in providing a benchmark to describe the age that children usually achieve particular behaviours. Using internationally-recognised criteria as the basis for the survey, it was possible to see if participating in early-years swimming may progress learning in key areas of children's growth.

Table 1

Cognitive milestones for children two years and older

Age	Cognitive Milestones
2 years	• Finds things even when hidden under two or three covers • *Begins to sort shapes and colors* • Completes sentences and rhymes in familiar books • Plays simple make-believe games • *Builds towers of 4 or more blocks* • Might use one hand more than the other • *Follows two-step instructions such as "Pick up your shoes and put them in the closet."* • Names items in a picture book such as a cat, bird, or dog
3 years	• Can work toys with buttons, levers, and moving parts • Plays make-believe with dolls, animals, and people • *Does puzzles with 3 or 4 pieces* • *Understands what "two" means* • *Copies a circle with pencil or crayon* • Turns book pages one at a time • *Builds towers of more than 6 blocks* • Screws and unscrews jar lids or turns door handle
4 years	• *Names some colors and some numbers* • *Understands the idea of counting* • *Starts to understand time* • Remembers parts of a story • *Understands the idea of "same" and "different"* • Draws a person with 2 to 4 body parts • Uses scissors • Starts to copy some capital letters • Plays board or card games • Tells you what he thinks is going to happen next in a book
5 years	• *Counts 10 or more things* • Can draw a person with at least 6 body parts • *Can print some letters or numbers* • *Copies a triangle and other geometric shapes* • Knows about things used every day, like money and food

Source: CDC, 2012, http://www.cdc.gov/ncbddd/actearly/milestones.html

Rasch Modelling

While there are quite high levels of expected variation in the achievement of the milestones assessed there also were challenges in the data available with some items clearly non-discriminatory. For example, items that typically were achieved by children of all ages (e.g. early milestones such as "brings hands within range of eyes and mouth" or "imitates some movements and facial expressions") did not provide any discrimination. Rasch modelling was employed to facilitate the identification of items appropriate for inclusion in scales assessing each of the four aspects of the milestone areas.

WINSTEPS (2012) software was used to undertake this analysis. For each item, fit statistics were calculated (i.e. infit value, with this transformed as a standardised t value). Additionally data were analysed indicating the level of difficulty of each item, thus suggesting the relative sequence of development of the milestones included. Using this approach the data could be more clearly reported within the limitations of the model.

Each test item that was accepted in the final analysis was mapped for each age group and plotted against the CDC milestones. Refer to Figure 1 for an illustration of the process through which motor skills were mapped against the milestone "Climbs well" as assessed by parents. In this milestone, the international benchmark for this skill is 3 years – as indicated by the downward arrow between columns 2-3 and 3-4. What is seen in this figure is that parents indicated that their child could complete this task. All children above four years of age were able to "climb well". What is of interest to this research is the percentage of children younger than the benchmark who were able to complete the skill. More than 90% of children between 2 and 3 years were able to complete the task as were 87% of 1-2 year olds. Also notable was the small percentage of parents reporting that their 6month-12month old child was able to undertake this activity. This latter reporting, observed on many items, is a limitation of the method due to the possible (mis)interpretation of the milestone. The Rasch Modelling process eliminated those items where there was statistically considerable variation within an item, thus rendering it invalid for this process. As the hypothesis foundational to the research was that participating in early-years swimming would add capital to young children, the most significant interest in the data were those achievements prior to the nominated age for the particular milestone. Those children who met the milestone prior to the nominated age could be achieving this milestone as a consequence of their involvement in early-years swimming. That is, within the project's theoretical framework, early-years swimming may be adding various forms of capital to young swimmers.

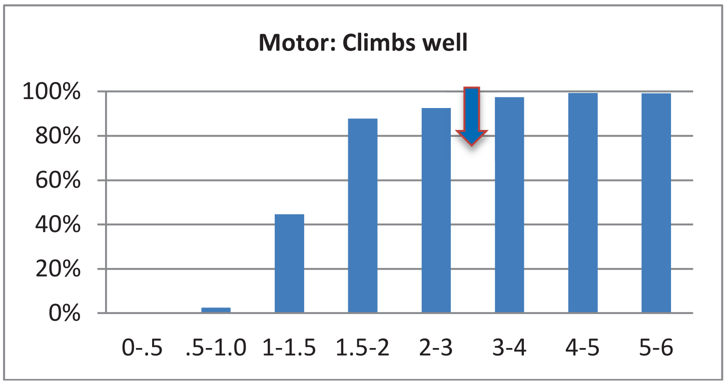

Figure 1. Percentage of children reported to "Climbs Well".

Each item was represented in the following way so that it could be easily seen as to the percentage of participants who were achieving milestones at what reported age. In considering the example – Counting Patterns – in Figure 2, it can be seen that the expected age for the milestone is 4 years with nearly 100% of the children achieving this immediately prior to this age cutoff but also more than 80% achieving it between the age of 2-3 years.

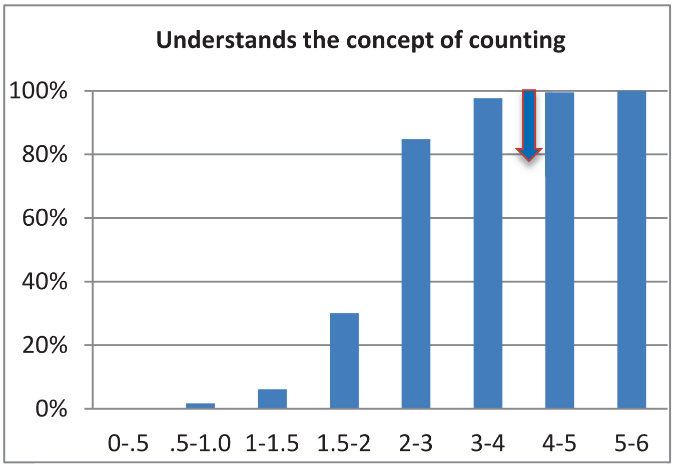

Figure 2. Understand the concept of counting.

Counting Patterns

Counting is a core skill of early-years mathematics. The skill is made up of a number of skills such as the counting pattern, one-to-one correspondence, counting on and so forth. For this cohort of swimmers, the parental reporting of children's capacity to understand the counting concept appears much earlier than what has been nominated by the CDC. This suggests that the children may be acquiring this skill much earlier than the normal population. The swim environment offers a rich context for counting, particularly for the numbers up to 10 and often to 20 depending on the age cohort. This occurs within the context of kicking patterns, breath holding, or stroke techniques where the children are counting for particular time lengths.

Using the outlined process for each milestone, it was observed that children should be achieving the milestone immediately before the nominated cutoff. What was of interest to this project were those items where they were being achieved at least two indicators prior to the milestone as this suggested early acquirement of that milestone, probably earlier than anticipated for normal developmental sequencing. These are summarised in the table 2 below. Here it can be seen that on many milestones related to mathematics children were achieving at least two age groups before the nominated time. In the case of counting to 10, this was achieved three age groups prior to the nominated time.

Table 2
Achieving developmental milestones

Milestone	< 6 mths	6 mths -1yr	1yr – 18mth	18 mths-2yr	2yr-3yr	3yr-4yr	yr4-5yr	5yr-6yr
Correctly names some colours								
Understands the concept of counting								
Begins to have a sense of time								
Understands the concept of same/different								
***Can count 10 or more objects*								
Correctly names at least four colours								
Understands physical relationships (in, on under)								

What these data indicate is that the parents of swimming children are reporting that their children are reaching many developmental milestones ahead of the "normal" or expected time. The above figure shows those milestones that appear to be acquired considerably ahead of the expected time for that particular milestone. One milestone (marked with 2 asterisks) appears to be acquired considerably earlier than would be anticipated. Similarly, there were some milestones (for example, "understands physical relationships") that were just outside our nominal cutoff point of 50%, marked here by the percentage points.

Creating Opportunities for Mathematical Capital

The data presented here indicate that there are substantial differences between the normal expectations for achieving developmental milestones and the reports of over 2000 parents of children who swim. Similar trends have been observed in the annual survey data prior and post this survey thus suggesting consistency in the data. Further analysis will be undertaken on these data but is beyond the scope of this paper.

Observations of lessons reported elsewhere (Jorgensen & Grootenboer, 2011) showed that the swim environment is rich in considerable spatial vocabulary, counting activities, and activities that foster one-to-one correspondence between counts and kicking actions. Similarly, the teachers' actions in lessons foster many of the skills that have been observed and reported here. Children are asked to kick 'through', 'under', 'over', 'left', 'right' of objects thus creating significant opportunities to link language with action thereby consolidating many spatial concepts. Similarly, there are many opportunities for counting in terms of the actions that are taken when swimming. Further, many swim schools that were observed also had 'crying policies' whereby an unhappy or scared child would be removed from the class so that they would not get upset, nor upset the other children. This fostered very happy learning environments and ones where teachers could focus on maximising time on task for those who remained in the lessons. Collectively these experiences provide a rich learning environment for many mathematical concepts.

Limitations of the Model

Two key limitations to this model are acknowledged. First, a control group would have enabled a much more robust analysis to be undertaken. However, over the past two years, every attempt has been made to create a sample large enough to provide a comparative base for the study. This has not been possible. In part, this limits the claims that can be made from the survey. However, to access a large enough number of parents who do not take their children to swimming meant that the project would have tapped into quite biased samples – including a disproportionate number of families from low SES families who for financial reasons were unable to access swimming, migrant families for whom swimming is not part of their culture or rural/remote families who were geographically unable to access pool facilities. The inclusion of a disproportionate numbers of such families would have compromised the findings of the study. To address this factor, the study specifically targeted low socioeconomic (SES) families in low SES areas and/or in schools that offered subsidized lessons for low income families.

A second key consideration of the project was the parental bias that is possible when using this tool. To ameliorate for this factor, extensive testing using internationally renowned child development tests were implemented with a careful selection of children. It was found from these tests (a topic for an extended paper) that there were significant differences between the normal populations and the early-years swimming children. This confirmed that there were differences between the two populations and, in most cases, the early-years children were achieving better/earlier than the normal populations, thus confirming the trends noted by the parents. These were carefully matched against SES and confirmed positive differences between the swimming cohort and the normal populations irrespective of SES.

Conclusion: Interesting Trends

The survey results have indicated that many young swimmers are achieving developmental milestones considerably earlier than the normal expectations. While parental bias may be a factor, intensive one-on-one testing using internationally-recognized tests have confirmed the overall trends observed in the data reported here. Thus, it is with confidence that the data are reported here. Notwithstanding the limitations of the original model of developmental milestones, the survey data suggest that there are many mathematically-related milestones that parents report their children achieving earlier than would be anticipated.

References

Australian Association of Mathematics Teachers and Early Childhood Australia. (2006). *Position paper on early childhood mathematics*. Retrieved March 1, 2011, on-line from http://www.aamt.edu.au/content/download/721/19509/file/earlymaths_a3.pdf

Bourdieu, P. (1983) Forms of capital. In J.G. Richardson (Ed.) *Handbooks of theory and research of the sociology of education*. New York Greenwood Press.

Centre for Disease Control, (2012).*Developmental Milestones,* http://www.cdc.gov/ncbddd/actearly/milestones.html Accessed May, 15, 2012.

Clarke, B., Clarke, D., & Cheeseman, J. (2006). The mathematical knowledge and understanding young children bring to school. *Mathematics Education Research Journal, 18*(1), 78–103.

Clarke, B., & Robbins, J. (2004). Numeracy enacted: Preschool families' conceptions of their children's engagement with numeracy. In I. Putt, R. Faragher, & M. McLean (Eds.), *Mathematics education for the third milennium: Towards 2010. Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia* (pp. 175–182). Sydney: MERGA

Fox, J. (2005). Child-initiated mathematical patterning in the pre-compulsory years. In H. L. Chick & J. L. Vincent (Eds*.), Proceedings of the 29th conference of the Iternational Group for the Psychology of Mathematics Education* (Vol. 2, pp. 313–320). Melbourne: University of Melbourne.

Goos, M. E., & Jolly, L. (2004). Building partnerships with families and communities to support children's numeracy learning. In I. Putt, R. Faragher, & M. McLean (Eds.), Mathematics education for the third milennium: Towards 2010. *Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia* (pp. 279–286). Sydney: MERGA.

Jorgensen, R. & Grootenboer, P. (2011). Early years swimming as new sites for early mathematical learning. In *Proceedings of the Annual Mathematics Education Research Group of Australasia Conference*. Alice Springs: MERGA.

Jorgensen, R. (2012). Engaging Learning Environments: Under-5s swimming as a site for capital building. *Australian Journal of Early Childhood, 37* (2), 127-131.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.) (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Laurence, L. (2012) *Kids Alive*. http://www.kidsalive.com.au/ Accessed 10/7/2012

Lee, S. (2010). Mathematical outdoor play: Toddler's experiences. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), Shaping the future of mathematics education. *Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia* (pp. 723–726). Fremantle: MERGA.

Macdonald, A. (2012) Young children's photographs of measurement in the home. Early Years: An International Journal of Research and Development, 32 (1), 71-85

Mitchlemore, M., Papic, M.M., & Mulligan, J.T. (2011). Assessing the development of pre-schoolers mathematical patterning. *Journal for Research in Mathematics Education, 42*(3) 237-268.

Perry, B., & Dockett, S. (2005a). "I know that you don't have to work hard": Mathematics learning in the first year of primary school. In H. L. Chick & J. L. Vincent (Eds.), *Proceedings of the 29th conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 65–72). Melbourne: University of Melbourne.

Perry, B., Young-Loveridge, J., Dockett, S., & Doig, B. (2008). The development of young children's mathematical understanding. In In H. Forgasz, A. Barkatsas, A. Bishop, B. Clarke, S. Keast, W. T. Seah & P. Sullivan (Eds.), *Research in mathematics education in Australasia 2004-2007* (pp. 17–40). Amsterdam: Sense.

Winsteps (2012). *WINSTEPS & Facets Rasch* Software http://www.winsteps.com/index.htm Accessed 27/6/2012.

Acknowledgements: I would like to thank Patricia Funnell for her work as research assistant on this project and Dr Helen Klieve for her statistical advice.