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Water competence development in young children: common methodological approaches and their effects on aquatic skill acquisition and on gross motor development

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Dedication

"I may have defects, live eager and get angry sometimes, but do not forget that my life is the greatest company in the world. And I can prevent it from going bankrupt. Being happy is to recognize that life is worth living, despite all the challenges, misunderstandings and periods of crisis. Being happy is to stop being a victim of the problems and become an author of history itself. It is to cross deserts outside ourselves, but being able to find an oasis deep in our soul. It is to thank God every morning for the miracle of life. Being happy is to be unafraid of our own feelings. It is to talk about ourselves. Is to have the courage to hear a 'no'. Is to be strong enough to listen to a criticism, even if unfair... Stones on the path? I keep them all, one day I will build a castle." (Fernando Pessoa).

I dedicate my thesis to my beloved daughter Beatriz that, unfortunately, became an angel in Heaven too earlier.

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And last by not least, a very special thanks to **my little daughter**, that passed away too early. It is for her that I keep working and teaching babies and kids. You will always be my inspiration.

Resumo

Objetivo: Esta tese inclui três estudos relacionados com o ensino da natação, procurando cumprir com os seguintes objetivos: (i) descrever a organização e metodologia de ensino da natação desenvolvida em Portugal, em contexto educativo (primeiro ciclo do ensino básico); (ii) analisar as diferenças na competência aquática adquirida entre dois programas de ensino da natação, em contextos de profundidade distintos (água rasa e profunda); (iii) analisar as mudanças longitudinais no desenvolvimento motor global de crianças, após cinco, dez e 30 meses de prática de natação e de futebol. **Métodos:** Para o primeiro estudo, a amostra incluiu 89 coordenadores pedagógicos de escolas de natação e 100 professores de natação. Em ambos os grupos amostrais foram aplicados questionários para apurar a organização e metodologia de ensino da natação. Para o segundo estudo, a amostra foi constituída por 21 crianças (4,70 ± 0,51 anos), de ambos os géneros e sem qualquer experiência em programas de ensino da natação. A amostra foi dividida em dois grupos experimentais, que foram sujeitos a um programa similar de ensino da natação, durante seis meses, mas variável na profundidade do espaço aquático (piscina de água rasa; piscina de água profunda). Para o terceiro estudo, a amostra foi composta por 33 crianças (4,8 ± 0,5 anos). A amostra foi dividida em três grupos: grupo de controlo; grupo praticante de futebol; grupo praticante de natação. Foi utilizado o *Test Gross Motor Development - 2nd Edition* para avaliar o desenvolvimento motor global em três momentos distintos: após cinco, dez e trinta meses de prática desportiva. **Resultados:** Os resultados do primeiro estudo sugerem que a natação no primeiro ciclo do ensino básico rege-se, sobretudo, pelas orientações do Ministério da Educação. Os principais objetivos das aulas estão relacionados com a adaptação ao meio aquático, privilegiando-se as habilidades aquáticas básicas (81,4%), num ensino pouco suportado em material pedagógico. No segundo estudo, os resultados sugerem que o ensino em piscina rasa permite adquirir um nível superior de competência aquática, em particular em cinco habilidades aquáticas básicas. No terceiro estudo, os dados apontam, em ambos os grupos (futebol e natação), para uma melhoria significativa do quociente motor bruto e dos scores padrão, na locomoção e controlo de objetos entre T5 e T10. Os praticantes de futebol atingem um quociente máximo de desenvolvimento motor após 10 meses de prática. Os praticantes de natação apresentaram um desenvolvimento motor (entre T10 e T30) gradual, particularmente em habilidades de controlo de objetos. **Conclusões:** Os dados descritos no primeiro estudo permitiram-nos identificar algumas insuficiências no enquadramento da natação no primeiro ciclo do ensino básico, provavelmente por condicionantes da eficiência do processo de ensino-aprendizagem, ao nível da aquisição de habilidades aquáticas mais complexas. Para além disso, os resultados sugerem que as sessões de natação em baixa profundidade parecem facilitar o desenvolvimento da competência aquática em crianças, após seis meses de prática. Foi também concluído que a prática desportiva (natação e futebol) durante a infância pode contribuir para um maior desenvolvimento motor.

Resumo Alargado

Objetivos: Esta tese encontra-se dividida em três propósitos principais, consubstanciados em três estudos relacionados com o ensino da natação: (i) descrever a organização e metodologia de ensino da natação desenvolvida em Portugal, no âmbito da disciplina de Expressão e Educação Física, no primeiro ciclo do ensino básico; (ii) analisar as diferenças na competência aquática adquirida entre dois programas similares de ensino da natação, orientados em contextos de profundidade distintos (água rasa e profunda); (iii) analisar as mudanças longitudinais no desenvolvimento motor global de crianças, após cinco, dez e 30 meses de prática de natação e de futebol.

Métodos: Para o primeiro estudo, a amostra incluiu 89 coordenadores pedagógicos de escolas de natação e 100 professores de natação. Em ambos os grupos amostrais, foram aplicados questionários com vista a apurar a organização e metodologia de ensino da natação, no contexto particular do primeiro ciclo do ensino básico. O questionário aos coordenadores incluiu os seguintes itens: (i) caracterização geral dos coordenadores com e sem natação no primeiro ciclo do ensino básico e professores; (ii) caracterização da organização institucional das escolas de natação em estudo; (iii) enquadramento do ensino da natação no primeiro ciclo do ensino básico (quando existe). O questionário aos professores que ministravam aulas de natação a crianças do primeiro ciclo do ensino básico (em contexto escolar) incluiu os seguintes itens: (i) caracterização geral dos inquiridos; (ii) enquadramento / finalidade do ensino da natação em crianças no 1º CEB; (iii) enquadramento do ensino da natação no primeiro ciclo do ensino básico, conhecimento das diretrizes para o ensino da natação dadas pelo Ministério da Educação de Portugal; (iv) organização metodológica do ensino da natação, no primeiro ciclo do ensino básico. Tratando-se de uma pesquisa de campo, foi utilizada estatística descritiva para a análise dos dados, em particular o cálculo das frequências das respostas.

Para o segundo estudo, foi recrutada uma amostra de 21 crianças portuguesas (4,70 ± 0,51 anos), de ambos os géneros e sem qualquer experiência em programas de ensino da natação. As crianças foram divididas em dois grupos experimentais, que foram sujeitos a um programa similar de ensino da natação, mas variável na profundidade do espaço aquático (n=10, programa aquático em água rasa; n=11, programa aquático em água profunda). Cada participante foi avaliado duas vezes na sua prontidão aquática, utilizando um formulário de observação de 17 habilidades motoras aquáticas: durante a primeira sessão (T0) e após seis meses de prática – duas sessões por semana, no total de 48 sessões - (T1). Recorreu-se ao *test t* para comparar a proficiência aquática de cada habilidade entre os grupos e a uma análise discriminante dos registos de proficiência aquática, para construir um modelo preditivo de ambos os contextos de prática.

Para o terceiro estudo, a amostra foi composta por 33 crianças (4,8 ± 0,5 anos.): 11 crianças constituíram o grupo de controlo (5,3 ± 0,2 anos); 11 crianças eram praticantes de futebol com

cinco meses de experiência; 11 crianças eram praticantes de natação (4,6 ± 0,4 anos) com cinco meses de experiência. Foi utilizado o *Test Gross Motor Development - 2nd Edition* (TGMD-2) para avaliar o desenvolvimento motor global e a proficiência motora, em 12 habilidades motoras fundamentais [habilidades de locomoção e de controlo de objetos], em três momentos distintos: após cinco (T5), dez (T10) e trinta (T30) meses de prática desportiva. Os testes foram gravados em vídeo e, à posterior, foram analisados e avaliados de acordo com o desempenho individual para cada habilidade motora, de acordo com os critérios previamente validados. Em todos os estudos, os dados foram agrupados e analisados estatisticamente, tendo sido considerado significativo um valor de $p \leq 0,05$.

Resultados: Os resultados do primeiro estudo sugerem que a natação no primeiro ciclo do ensino básico rege-se sobretudo pelas orientações do Ministério da Educação. A restrição orçamental (60,0%) e a dificuldade no transporte dos alunos da escola para a piscina (54,0%) são as razões mais apontadas para a supressão da natação do plano de ensino escolar. O ensino é dirigido fundamentalmente para o terceiro e o quarto anos (80,1%), com aulas de frequência semanal (64,4%), em classes com um elevado número de alunos (13 a 16 alunos). Os principais objetivos das aulas estão relacionados com a adaptação ao meio aquático, privilegiando-se as habilidades aquáticas básicas (81,4%), num ensino pouco suportado em material pedagógico. No segundo estudo, os resultados sugerem que o ensino em baixa profundidade permite adquirir um maior grau de competência aquática, em particular nas seguintes habilidades aquáticas básicas ($p < 0,05$): *controlo respiratório, imersão da face e abertura dos olhos; flutuação horizontal; posição corporal (equilíbrio) no deslize ventral; posição corporal (equilíbrio) no deslize dorsal; batimento de pernas ventral com controlo respiratório, sem apoio de material flutuador*. A função discriminante revelou uma associação significativa entre os dois grupos e em quatro fatores (habilidades aquáticas) ($p < 0,001$), representando (0,938) ^ 2 = 88% entre variabilidade do grupo. A *posição corporal no deslize* foi o principal preditor relevante ($r = 0,535$). No terceiro estudo, os resultados sugerem que ambos os grupos (futebol e natação) melhoraram significativamente no seu quociente motor bruto e nos seus scores padrão, na locomoção e controlo de objetos entre T5 e T10. Em T10, todos os praticantes de futebol alcançaram a classificação máxima descritiva para o quociente motor bruto. Entre T10 e T30, os praticantes de natação melhoraram os scores padrão no controlo de objetos. Após 30 meses de prática desportiva, não foram encontradas diferenças significativas ($p > 0,05$) entre ambos os grupos experimentais.

Conclusões: Os dados relatados no primeiro estudo permitiram-nos identificar algumas insuficiências no enquadramento da natação, no primeiro ciclo do ensino básico, provavelmente por condicionantes da eficiência do processo de ensino-aprendizagem, ao nível da aquisição de habilidades aquáticas mais complexas. No segundo estudo, os resultados demonstram que as sessões de natação em água rasa parecem permitir um desenvolvimento superior da competência aquática em crianças, após um período de seis meses de prática. No último estudo, os dados sugerem que a prática desportiva (natação e futebol), durante a infância,

pode contribuir para um maior desenvolvimento motor. Apesar da prática de futebol parecer induzir um desenvolvimento motor acelerado e superior (a curto e longo prazo), em comparação com a prática de natação, os praticantes de natação apresentaram um desenvolvimento motor gradual, particularmente em habilidades de controlo de objeto.

Abstract

Objective: This thesis includes three studies related to the teaching of swimming, with the following objectives: (i) to describe the organization and methodology of swimming teaching in Portugal, in the context of school education (elementary school); (ii) to analyze and compare the efficiency between the two program types of swimming teaching (practice in shallow water and practice in deep water); (iii) to analyze the longitudinal changes in the gross motor development of children, after five, ten and 30 months practicing swimming and soccer in parallel. **Methods:** For the first study, the sample included 89 pedagogical coordinators of swimming schools and 100 swimming teachers. We have done a survey with both groups to assess the level of organization and methodology of swimming teaching. For the second study, the sample was composed by 21 children (4.70 ± 0.51years), of both genders and with no experience with swimming learning programs. The sample was organized in two experimental groups, which have followed a similar swimming learning program during six months, but using different water depths (one using shallow water, the other using deep water). For the third study, the sample was composed by 33 children (4.8 ± 0.5 years). The sample was organized in three groups: control group, soccer group, swimming group. We have used the *Test Gross Motor Development – 2nd Edition* to evaluate the gross motor development in three different moments: after five, ten and 30 months of practice of both sports. **Results:** the results of the first study indicate that the swimming practice in the elementary school is conducted following the orientations from the Portuguese Ministry of Education. At this level, the swimming practice is focused on the aquatic readiness, giving more attention to basic aquatic skills (81.4%), where the teaching model rarely includes pedagogical material. In the second study, the results indicate that we can achieve a better performance (higher level of aquatic competence) in shallow water than in deep water, especially with acquiring the five basic aquatic skills. In the third study, the results indicate that, in both groups (soccer and swimming), there's a significant improvement of the gross motor coefficient and the standard scores in the locomotion and control of objects, between T5 and T10. The soccer practitioners have reached the higher motor development coefficient, after 10 months of practice. The swimming practitioners have a gradual motor development (between T10 and T30), especially with regards to object control skills. **Conclusions:** with the data of the first study, we could find some deficiencies in the integration of swimming practice in the elementary school's program and probably those are limitations of the efficiency of the teaching method adopted, in respect to the acquisition of more complex aquatic skills. By the results of the second study, the development of aquatic skills, by children after six months of practice, seems to be easier in shallow water that in deep water. The data collected with the last study indicate that sports (both swimming and soccer) during childhood can contribute for a higher gross motor development of children.

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Chapter I: Problem definition and thesis structure

1.1 Introduction

The underlying theoretical foundation of this thesis is based on, at least, the following two context levels:

- The clarification of the paradigm subjacent to the swimming teaching, recognizing the current methodological principals accepted among the scientific community, that can be the guidance to both the subsequent development of scientific research and to the pedagogical intervention and organization;
- The recognition of the importance of the psychomotor stimulation during childhood, emphasizing the importance of swimming practice in the global development of children.

Over the next sections, we will briefly frame out the key information about these topics and will finish by presenting the relevant implications on the overall structure of this thesis.

1.1.1 Theoretical concepts related to the swimming teaching

Theoretical knowledge of swimming teaching requires the correct understanding of the concepts "aquatic competence" and "learn to swim", which are, in fact, conceptually different, although they are traditionally considered to be the same or related things. Therefore, we should start a swimming teaching program by assuming the individual has a total inability in the aquatic environment, or is not capable at all of performing any oriented action in the water (Canossa, Fernandes, Carmo, Andrade, & Soares, 2007). Indeed, the movement in the aquatic environment is peculiar and unfriendly: the water affects and modifies the person's motor control because it generates permanent lack of balance and comfort (eyes, nose, ears and mouth). In fact, this impact is caused by the physical and chemical properties of the water and its intrinsic mechanism, which are shaping the interaction of this environment with bodies in contact with or moving through it. Considering such differences when comparing the aquatic environment with the terrestrial environment, it is mandatory to develop specific skills to overcome the constraint we find in this particular environment, with respect to balance, propulsion and breathing in the water. Thus, the main objective of the adaptation to the aquatic environment, while an elementary step of the swimming learning, is to achieve a gradual acquisition of competences in the water, which represents the starting point and is a

specific motor pre-requirement (i.e., basic movement skills in the water) for the practice of several water activities, such as swimming.

According to Campaniço (1989), we use the control of the body in the water, based on a behavioral differentiation in five areas: balance, breathing, immersion, propulsion and jump. This way, the ability of swimming cannot be a natural skill (Langendorfer, 2014). There's no doubt this is an ability the individual has to acquire by himself, to allow him/her to perform the proper actions towards achieving the required balance, breathing and propulsion (Barbosa, 2005). According to several authors (Campaniço & Silva, 1998; Carvalho, 1994; Catteau & Garoff, 1990; Crespo & Sanchez, 1998; Navarro, 1995; Moreno & Sanmartín, 1998), the ability of swimming, besides representing a specific movement skill in the water, requires a previous condition of autonomy, confidence and satisfaction in the new environment. Therefore, and regardless of the use given to the swimming practice (educational or merely utilitarian purpose), it is very important that the priority of the didactic and pedagogical organization model of the swimming teaching should not be the immediate achievement of formal strokes, but, instead, the achievement of confidence by the child in the new environment. It is essential that researchers and teachers assume a developing and holistic approach of swimming learning. It seems that this guidance is presented on the proposal by Langendorfer and Bruya (1995), which is used as reference along this thesis. These authors recommend that the swimming learning should be based on a progressive behavioral change of children, resulting from the sequential learning of basic movement patterns (skills), based on three underlying cornerstones: hierarchy, differentiation and individualization of basic aquatic skills. This way, the aquatic skills must be considered a dynamic process that depends on the interaction of each individual with the water. This has relevant implications, including the prevention of drowning (Langendorfer, 2014).

1.1.2 Developing aquatic competence in young children

A well-succeeded learning of complex motor behaviors depends on the understanding of the pedagogical theory related to the sport movement education (in particular, swimming), on the organization and hierarchy of educational content and also on the correct teaching of it, which is, at the same, an importance level of the rest.

With respect to the conceptual pedagogical understanding, the previous section has already addressed some of the key aspects that sustain the consequent didactics. In fact, we previously insisted on the importance of the aquatic competence that reflects the individual's readiness to move in the water. Nevertheless, it's also important to take into account other kind of understanding the teacher may have, as a person with his/her own perspective, someone who takes decisions, makes his/her own judgments and holds a certain guidance he/she believes to be appropriated to his/her professional activity (Carreiro da Costa, 1996). What objective do the teachers give to the training of the adaptation to the water? This is a concern which arises

from the known paradigm "teacher's thought" (Clark & Lampert, 1986), which has great impact to the didactics of physical education, including, of course, the teaching of swimming. In fact, it is our perception that the technical community tends, sometimes, to disregard the basic aquatic skills as a bio-behavioral requirement to learn more complex and specialized aquatic skills (including the traditional four swimming strokes). This empirical sense seems to be reflected on the results presented by Costa et al. (2012), when they inquired swimming teachers about the main objective of teaching the adaptation to the water. The results revealed that the purpose "learn to swim" inevitably emerges as the most important goal of aquatic programs developed in deep water. However, we must highlight the alarming fact of the goal "don't be afraid of water" doesn't collect a 100% acceptance, although the "pleasure of practice" is seen as a consensual point. Several unstudied individual and institutional constraints will converge together to this conceptual misrepresentation.

"How to teach aquatic skills and swimming?" This is another pedagogical issue we consider to be fundamental to the didactics of swimming, eventually delimited and included in a study category of the theoretical-implicit type, pre-conceptual and linked to the believing of teachers and their relationship with the teaching activity (Carreiro da Costa, 1996). The literature related to the teaching of swimming is poor in this topic. However, and assuming that is only accepted systematized teaching methods, we globally consider two pedagogical perspectives: the analytical perspective and the synthetic perspective (Catteau & Garrof, 1990; Machado, 1978). The validity of both perspectives to the teaching of swimming is undeniable, which makes difficult to define the limits of the application of each one (Marques & Gallardo, 2009). According to the authors, it is possible to speculate a bigger analytical tendency to the teaching of students already familiar with the water, more mature and wishing to learn swimming in a more efficient way, since it allows the rationalization and fragmentation of the swimming technique and make it closer to the biomechanical model of reference. The syntactic perspective, based on psychological approach of Gestalt (Greco, 1998), appears to be more appropriate in the process of adaptation to water, for beginner students of young age, since it puts such exercise in a certain context, getting the student's attention to solve adaptation issues.

This logic allows us to understand the reason of certain behaviors in the teaching of swimming and, consequently, explain the swimming teaching-learning process. This leads us to several issues related to teacher's planning (Carreiro da Costa, 1996), mainly the following ones: what's the teacher's thought when is making the plan and what are the differences of planning between teachers and in different contexts of learning? So, let's drawn our attention to the teacher's reflections when he/she is building up the teaching model – the set of specific strategies that come up when the sequence of the important aquatic skills is defined (Campaniço & Silva, 1998).

The balance between the planning, teacher's behavior and student's characteristics is another important concern to the teaching paradigm. This issue has a special importance in adapting

children to the aquatic environment, given the fact that is necessary to adjust the teaching model according to the child's global development, especially in the cognitive, social and motor domains (Langerdorfer & Bruya, 1995). Only this way can provide relevant experiences for a gradual acquisition of movement skills in the water, adjusted to the age and suitable to a certain level of technical proficiency. This topic is discussed in more detail along the next section.

Finally, it is important to highlight there are several variables involved in the swimming teaching-learning process, most of them related to the particular characteristics of the water environment. In line with the process-product paradigm of Piéron (1988) (figure 1), we assume that the final stage of the student's learning depends directly from the process's variables, which are in turn influenced by the variables of the presage, context and program.

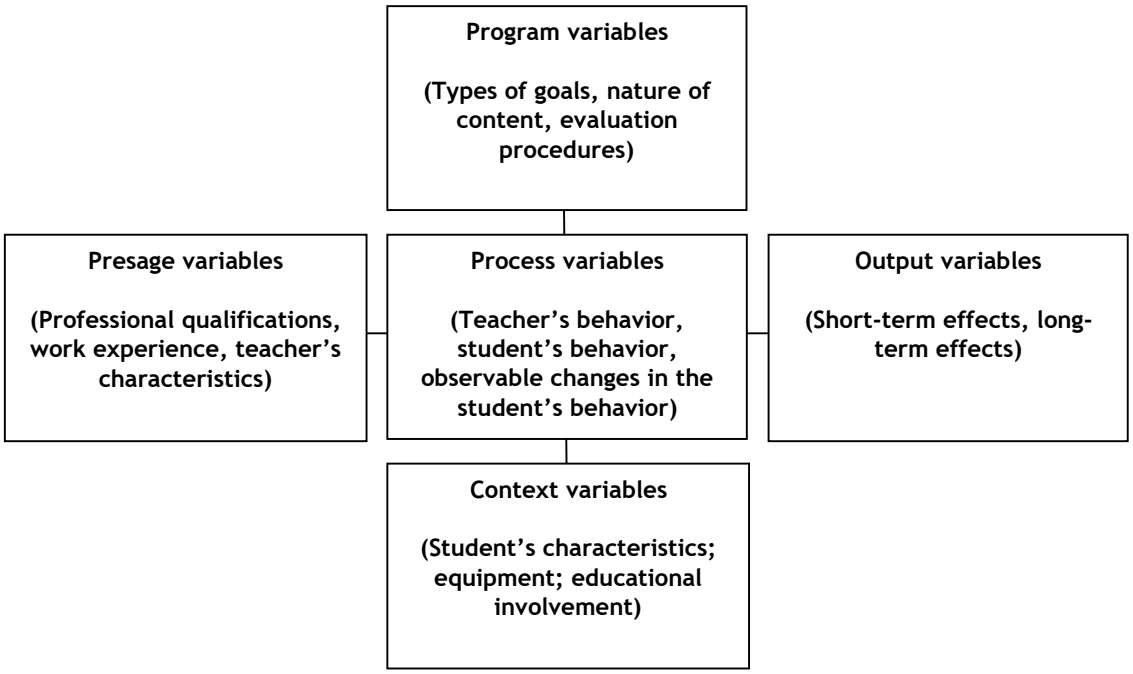

Figure 1: Process-product paradigm (according to Piéron, 1988).

We are interested, in particular, in the context variables that affect the teacher's behavior, teaching organization and, as such, that determine the effectiveness of learning (Zuo, 2004). In fact, beyond the constraints imposed directly to the child by the characteristics of the aquatic environment (mentioned earlier), the teaching quality depends on the conditions available for teaching, the space allocated to the group of students and their learning capacity (Carvalho, 1994). According to several authors (Langendorfer, 2010; Murray, 1980 cited by Costa et al, 2012) these factors are: (i) the number of students in the class; (ii) the available equipment; (iii) the water temperature; (iv) the weekly frequency of classes and (v) the depth of the swimming pool.

Despite of the lack of studies on this subject, the effect of some of these factors in the effectiveness of swimming teaching-learning process can be deduced based on the literature of educational sciences (Vickers, 1990). Indeed, a number of excessive class size affects undoubtedly the safety, effectiveness and quality of teaching, especially because the teacher has to give attention to more students. Regarding the weekly frequency of classes, it is well known that systematization of learning-teaching process (and also for successful sporting performance) is a basic requirement for behavioral modifications – in this context, it's expect to have a bigger effect (both in the short and long term) on the acquisition of aquatic skills, with a program composed by three weekly sessions, comparing with a program with just one or two sessions per week.

There isn't much information about studies done on the effectiveness of didactic equipment to use in the swimming learning, including floating devices (Erbaugh, 1986). One of the few studies in this domain has demonstrated the importance of the use of these devices in the horizontal dynamic balance. However, other authors (Blanksby, Parker, Bradley, & Ong, 1995; Langendorfer, 1987) advise not to use these devices in the learning of fluctuation and hydrodynamic positioning. The main reason seems to be the reasonable use of auxiliary devices (Barbosa, 2004; Langendorfer & Bruya, 1995; Moreno & Sanmartin, 1998; Navarro, 1995), avoiding student's dependence on a false perception of autonomy, which leads to the development of artificial aquatic skills (Soares, 2000). This appears to be the same understanding of the teachers of some Portuguese swimming schools that have a moderate use of didactic material in the adaptation to the water environment, where boards are the favorite equipment (Costa et al., 2012).

With regards to the water temperature, both the international recommendations (Water & World Health Organization, 2006) and the national recommendations (Normative 23/93 CNQ) suggest values between 30 ºC and 32ºC. To our knowledge there are no studies demonstrating the effectiveness of the swimming teaching-learning process, in difference levels of temperature. Such studies should have to consider the characteristics of the students and the teaching program, which tends to be more "active" with lower temperatures. According to McArdle, Katch and Katch (2014), the ideal water temperature in competition should range from 28ºC to 30ºC, since the metabolic heat generated is easily transferred to the water without significant increases in the energy spending or reduction of the body's temperature.

From all context factors, the depth of the swimming pool seems to be the less studied factor. The recent study from Costa et al. (2012), one of few existing studies in this matter, analyzes the effects on the development of aquatic skills in two depth scenarios (shallow water and deep water), after six, 12 and 18 months of practice. Although the study design is cross-sectional, the results seem to indicate that children with up to 12 months of practice in shallow water have better results.

1.1.3 Motor development and aquatic experience

Motor development, as part of the overall development of the human being, changes during person's life. Although being frequently associated with childhood, we can see qualitative and quantitative changes in the proficiency of these motor actions from the conception of the human being to his death (Connolly, 2000; Santos, Dantas, & Oliveira, 2004). Despite this absolute point of view, childhood is assumed as a crucial period for the development of physical skills and basic psychomotor learning, which allow the acquisition of a diverse set of motor capabilities that will help the child to gradually develop more complex movements. It should be understood this is a sequential process, sustained in the child's experiences that contribute to a solid and wide set of motor capabilities (Gallahue & Ozmun 2005; Le boulch, 1987; Piaget, 1975; Vygotsky, 1978).

The motor development refers to changes in general categories of motor behavior (locomotion, manipulation and stabilization) conditioned by stimulation received and by the predisposition of the child to interact with the environment (Gallahue & Ozmun, 2005). In this context, the lack of motor stimulation and wrong orientation of them may have a negative impact in the motor development expected to happen in that age (Gallahue & Ozmun, 2005; Le Boulch, 1987; Piaget, 1975; Vygotsky, 1978), besides affecting the functional autonomy of the child in the daily life. Therefore, it's extremely important to take good care of children's motor literacy, looking for having good levels of development of fundamental movement skills suitable for that age. These are considered to be building blocks of an appropriate level of physical fitness in the health perspective, and of the learning of specific motor skills required for sports modalities.

The category of locomotor movements refers to the changing of body's position in respect to a fixed point on the surface. It involves the projection of the human body on an external area, by changing body's position in respect to a fixed point on the surface (e.g.: walking, running, jumping or skipping). In turn, the manipulative movements involve an individual's relationship with objects and is characterized by the force applied on them, as well as the strength received from them. The actions of "launch", "catch", "kick" and "intercept" objects are considered thick manipulative movements; movements like cutting with scissors are fine motor movements. The stabilization movements are those that allow the body to assume a posture in the space, in relation to the force of gravity. In this category, the child is involved in continuous efforts against the force of gravity, in an attempt to obtain and maintain bipedal posture.

It is well known that, during the typical child's development, he/she goes through several stages (Gallahue & Ozmun, 2005), where there are periods of greater physical and cognitive willingness to assimilate and improve motor skills (Peres, Serrano, & Cunha, 2009). In fact, the theoretical model of Gallahue and Ozmun (2005) seems to be the consensus in terms of existing literature, suggesting four major phases of stable behavior, or, at least, relatively consistent: reflex movements, rudimentary movements, basic movements and specialized movements. For

each phase of the process are indicated stages with corresponding (presumed) chronological ages. This phase-stage process was conceptualized in the form of a heuristic hourglass (Gallahue & Ozmun, 2005), as shown in Figure 2; this framework is the typical motor development throughout lifetime, where the inverted triangle is a schematic representation of the transactional processes that affect the motor development (task, individual and environment).

Most children have a great potential for development of fundamental movement skills, that allows the child to start his/her transaction to the phase of specialized movements, around the age of 6 years old (Gallahue, 2005). The development of fundamental movement follows a sequence of stages, characterized by gradual proficiency levels, reflecting the quality of one's motor control (Carvalhal, 2000; Gallahue & Ozmun, 2005):

Initial stage: in this stage, children try their first movements, which are incomplete and uncoordinated, with no rhythmic coordination. In a nutshell, these movements have a poor space-time integration;

Elementary stage: during this stage, children have greater control of their movements and have better rhythmic and space-time coordination. However, there is still a lack of spontaneity at this stage. Most adults remain at this stage, since they progress up to it just because of the influence of the maturity;

Mature stage: most fundamental motor skills can be reached at the age of six or seven years old, but some kids may reach this stage earlier. This stage is characterized as being more effective and revealing coordinated and controlled movements.

According to Gallahue (2005), the anatomical, physiological and neural characteristics are enough developed towards operating in a mature stage for the majority of fundamental movement skills. The exceptions are mainly a result of limited opportunities to practice. For all this, the coordinated practice of sports can play a catalytic role, because it gives the opportunity of performing important motor experiences that include stimulation to develop fundamental motor skills (Martins, Silva, Marinho, & Costa, 2015; Pereira, 1990) and its subsequent optimization to the specific context of each sport. These are considered an essential part to both appropriate physical capability, in a health perspective, and to the learning of specific movement skills necessary to the practice of the sport modalities (Flinchum, 1982; Gallahue, 2006; Harrow, 1983; Tani, 2011). It is clearly a key period to contact with new sports and different contexts of practice, including swimming (Martins et al., 2015).

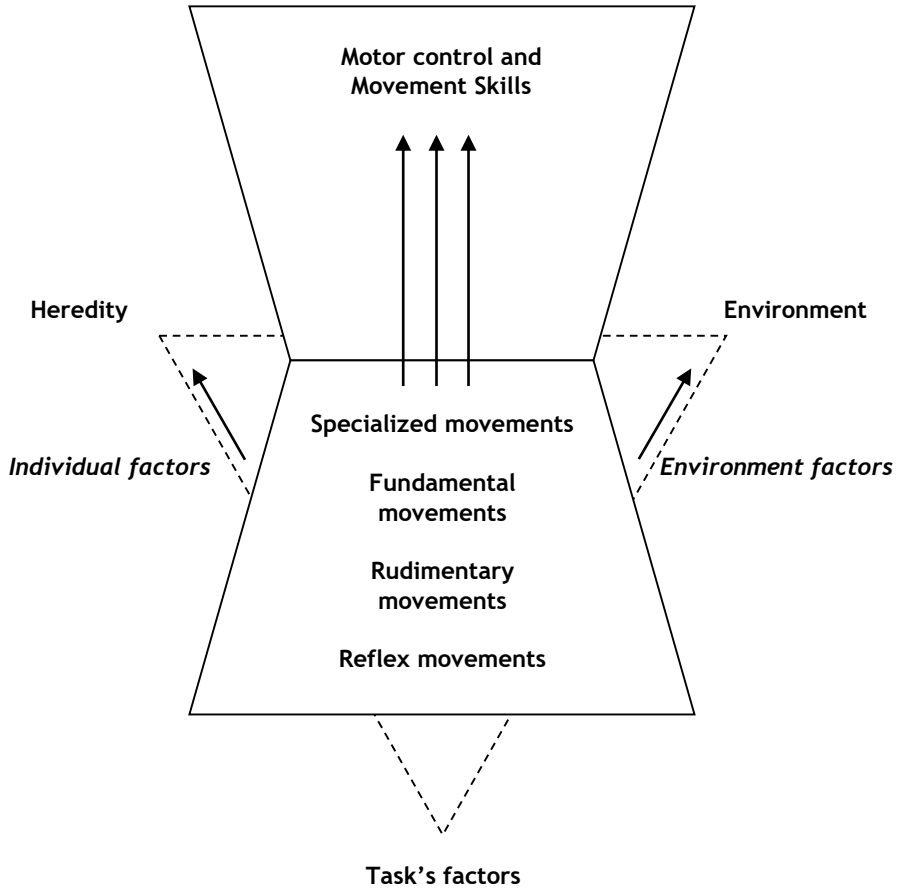

Figure 2: Descriptive model (heuristic hourglass) of a motor development during lifetime (Gallahue & Ozmun, 2006; adapted from Gallahue, 2005).

Swimming is one of the few guided physical activities that can be practiced starting from the six months of age (Moreno, Pena, Castillo, & Vegué, 2004) and about which is believed to contribute to the harmonious development of the child (Gallahue, 1993). However, the studies in this area are particularly rare, focusing especially on children with disabilities (Beckung, Carlsson, Carlsdotter, & Uvebrant, 2007; Bredekamp, & Copple, 1997; Haywood & Getchell, 2004). We highlight the work from Fragala-Pinkham, Haley, & O'Neil (2008) and Hutzler, Chacham, Bergman, and Szeinberg (1998), which demonstrates the effects of water activities in the increase of mobility and muscle strength in children with physical disabilities. In respect to babies, early aquatic experience seems to improve some motor skills, such as balance, and achieve motor development of newborn babies, including the head control. The studies are even rarer in respect to the childhood phase. Even so, it is expected to have a positive effect on the gross and fine motor capability of children between seven and nine years old (Paula & Belo, 2009). In the school context, the aquatic experience seems to lead to an optimal state of motor development in various skills, particularly in the manipulation of objects (Martins et al., 2015). Other studies have found effects on the neuromuscular development and on the performance of the cardiovascular and respiratory system (Zhao et al., 2005). Bernard (2010); Font-Ribera et al., (2011) ;Wang and Hung (2009) demonstrates a positive impact of swimming in children with cardiorespiratory diseases (e.g.: asthma). Other authors (Gorter & Currie, 2011;

Kemp & Roberts, 2005; McManus & Kotelchuck 2007; Wicher, et al., 2010) refer to supporting effects at different levels: reduction of behavior and sleep disorders; anorexia; neuro-psychomotor development deficits; hypotonia; orthopedic, neurological and respiratory disorders. More recently (Jorgensen, 2012), studies have demonstrated the positive and significant effect of swimming (comparing with the population in general) on the intellectual development, particularly language.

1.2 Problem definition and objective of this thesis

The previous theoretical framework put us under three main concerns that made us do this work.

The first concern is closely related to the swimming in the elementary school, which was formally established by decision of the Minister of Education of Portugal (Despacho nº 12591/2006 – DR nº 115, Series II, 2006-06-16), in which the physical activities are included in the education offer. This program aimed to guarantee all students access to a set of activities that would add value to their school program, in the elementary school, with the objective of developing the child's capacity in several domains (e.g.: psychomotor, social-affective and cognitive) (Fialho et al., 2013). With respect to physical activities and sports, the available program guidelines (Maria & Nunes, 2006) define the objectives and the program's generic operationalization, while giving great flexibility to extend the field of physical and motor experience of children. In this context, swimming is considered optional, although this activity was appointed as an activity "never or rarely" introduced (77.3%), despite being a favorite activity for the students (47.9%) (Fialho et al., 2013). However, we couldn't find any study about neither the way the contents are implemented or supervised, nor the effectiveness of the implemented programs. It's therefore important to know how the swimming teaching is organized and the existing teaching methodologies. This need has triggered the following question: *How is the swimming teaching included in the Physical and Motor Education program, during elementary education in Portugal?*

Our second concern is related to the fact there are almost no studies about the influence of several context factors that are linked to the acquisition of aquatic skills by small kids. One of the key factors seems to be the variation of water's depth, very common in swimming schools in Portugal, both in the educational and non-educational offers. Excluding the cases where there's no infrastructural alternative, we believe the reasons the adaptation to aquatic environment is done in deep water are the following: technical decision or merely commercial management. The reason for the first situation is mainly empirical, because there are almost no studies about this topic and the existing ones – as far as we know – follow a basic approach and with no control of the educational program used. Regarding the second situation, technical-scientific arguments are excluded but also the regulatory ones, given the fact there's no specific legislation about the swimming teaching, especially with regards to the safety rules

(size of classes, water's depth adjusted to the leaning level). Therefore, we make the following question: *Does the depth of water, during aquatic competence lessons, bring any impact to the acquisition of basic water skills by children?*

The third concern of this dissertation is about the dependency of the motor development from sport practices (Kambas et al., 2012). In the same reason a reduced or inadequate physical stimulation may affect the child's motor development (Gallahue & Ozmun, 2005; Williams et al., 2008), an inadequate motor development will be inhibitory for the practice of physical activity (e.g. Stodden et al., 2008; Williams et al., 2008). In the long run, it will create a higher probability of the child to be sedentary when he/she becomes adult (Huotari, Nupponen, Mikkelsson, Laakso & Kujala, 2011). Therefore, we must consider the childhood is not just a critical age to develop motor capabilities, but to enable the child to practice sport (Barnett, Beurden, Morgan, Brooks, & Beard, 2009; Stodden et al., 2008).

Like we mentioned before, achieving a mature stage of these capabilities is closely dependent on the opportunities to practice physical activities (Gallahue & Ozmun, 2005). Normally, the studies address the effects the community's intervention has on this matter, choosing experimental designs with isolated groups (with no control group) and during small periods of time (less than six months) (Smith et al., 2014). The catalytic role of the formal sport practice in the gross motor development is, therefore, very little known. We consider this lack of literature of special importance mainly because several kids don't benefit from a structured sport practice at school, especially during the preschool. The motor experiences during the childhood (especially at the age of six) result quite often from the practice of sports by the initiative of the child and his/her family and not necessarily from an official program (for instance at school). In this context, swimming is one of the most favorite sports. By itself, the water seems to provide important stimulations to the body's perception, giving a positive effect over prehension and balance (Sigmundsson & Hopkins, 2010). Besides that, the games and several other fun activities are an appropriate methodology to achieve the aquatic readiness at that age levels. Thus, it's important to evaluate the following: *which effects can we expect from the oriented practice of sports and in particular from swimming, in the gross motor development of child?*

Considering that the study's problem is defined, and aiming to bring a contribution to the state of art of this scientific domain, the study has the following objectives:

To analyze the implementation of a swimming program included in the scope of the Expression and Physical Motor Education, in the elementary school, in Portugal, specifically describing: (a) the methodological organization of swimming teaching; (b) the methodologies of teaching swimming actually used; (c) the application of the teaching-learning process, especially by identifying the privileged aquatic skills; (d) the reason to have a swimming program.

To analyze the improvements of the aquatic skills of the kids, after they have accomplished the aquatic competence program, conducted in different depth levels (shallow water and deep water), during six months.

To analyze the longitudinal changes in the gross motor development of children, after five, ten and 30 months practicing swimming and football.

1.3 Structure of the thesis

Considering the assumptions above, this document is organized in chapters, based on the North European model (normally known as the Scandinavian model), that results from the compilation of three experimental studies.

The text body of this dissertation is divided in five chapters. The “chapter I” has the overview, including the formal justification, the problem definition, the objectives and the presentation of the document’s structure. The following three chapters (II, III and IV) result each one from the three main points of this dissertation: the “chapter II” analyzes the organization and methodology of the swimming teaching, in the elementary school in Portugal; the “chapter III” presents the analysis of the aquatic skills acquired during two equivalent programs, one conducted in shallow water and the other in deep water; the “chapter IV” presents the analysis of the short term, midterm and long term effects in the child’s global motor development brought by the practice of swimming and football, during childhood. The articles are written in English, following the standards proposed by the University of Beira Interior, notwithstanding the fact they have been published under a different format by specialized journals and some of them written in Portuguese. The “chapter V” has the final conclusions, the limitations of the dissertation as well as questions/suggestions for future research.

1.4 References

1. Barbosa, T. (2001). *As Habilidades Motoras Aquáticas Básicas*. Revista Digital - Buenos Aires – Year 6 - n° 33 March of 2001. Available at: http://www.efdeportes.com
2. Barbosa, T. M. (2004). Ensino da natação: vantagens e desvantagens dos materiais auxiliares na adaptação ao meio aquático. Conferência apresentada no 27º Congresso Técnico-Científico da Associação Portuguesa de Técnicos de Natação. Lisboa. http://hdl.handle.net/10198/4057
3. Barbosa, T. M. (2005). *As habilidades motoras aquáticas básicas*. Cruz Quebrada: Federação Portuguesa de Natação.
4. Barbosa, T. M., & Queirós, T. M. G. (2004). Ensino da natação: uma perspectiva metodológica para a abordagem das habilidades motoras aquáticas básicas. Lisboa: Xistarca.
5. Barnett, L. M., Beurden, E. V., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescent Health, 44*, 252-259.
6. Beckung, E., Carlsson, G., Carlsdotter, S., & Uvebrant, P. (2007). The natural history of gross motor development in children with cerebral palsy aged 1 to 15 years. *Developmental Medicine & Child Neurology*, *49*(10), 751-756.
7. Bernard, A. (2010). Asthma and swimming: weighing the benefits and the risks. *Jornal de pediatria*, *86* (5), 350-351. doi:10.2223/JPED.2029
8. Blanksby, B. A., Parker, H. E., Bradley, S., & Ong, V. (1995). Children's readiness for learning front crawl swimming. *Australian journal of science and medicine in sport*, *27* (2), 34-37.
9. Bredekamp, S., & Copple, C. (1997). *Developmentally Appropriate Practice in Early Childhood Programs.(Revised Edition)*. National Association for the Education of Young Children, 1509 16th Street, NW, Washington, DC 20036-1426.
10. Campaniço J., & Silva A. (1998). *Observação qualitativa do erro técnico em Natação*. In Silva, A. & Campaniço, J. (eds.). Seminário Internacional de Natação,47-92. Edições da Universidade Trás-os-Montes e Alto Douro: Vila Real.
11. Campaniço, J. (1989). *A escola de natação: 1ª fase*. Lisboa: Ministério da Educação/Direcção Geral dos Desportos.
12. Canossa, S., Fernandes, R. J., Carmo, C., Andrade, A., & Soares, S. M. (2007). Ensino multidisciplinar em natação: reflexão metodológica e proposta de lista de verificação. *Motricidade*, 3(4), 82-99.

13. Carreiro da Costa, F. (1996). Condições e factores de ensino-aprendizagem e condutas motoras significativas: uma análise a partir da investigação realizada em Portugal. *Boletim da Sociedade Portuguesa de Educação Física*, 14, 7-32.

14. Carvalhal, I. (2000). Efeito da interacção das variáveis sócio-culturais, biológicas e motoras na prestação das habilidades corrida, lançamento, salto e pontapé em crianças de 7 e 8 anos de idade. (Doctoral dissertation, Tese de Doutoramento. Universidade Trás-os-Montes e Alto Douro: Vila Real).

15. Carvalho, C. (1994) Natação. Contributo para o sucesso do ensino-aprendizagem. Edição do Autor.

16. Catteau, R., & Garoff, G. (1990*). O ensino da natação* (3ª Edição). São Paulo, Brasil: Editora Manole.

17. Clark, C., & Lampert, M. (1986). The study of teacher thinking: Implications for teacher education. *Journal of Teacher Education*, *37*(5), 27-31.

18. Connolly, K. (2000). Desenvolvimento motor: passado, presente e futuro. *Revista Paulista de Educação Física*, *3*, 6-15.

19. Costa, A., Marinho, D., Rocha, H., Silva, A., Barbosa, T., Ferreira, S., & Martins, M. (2012). Deep and shallow water effects on developing preschoolers' aquatic skills. *Journal of human kinetics*, *32*, 211-219.doi: 10.2478/v10078-012-0037-1

20. Crespo, I., & Sanchez, I. (1998). *Didáctica da natação utilitária e educativa.* In Conferência apresentada no XXI Congresso Técnico-Científico da Associação Portuguesa de Técnicos de Natação. Porto.

21. Despacho nº 12591/2006 de 16 de Junho (Cria e regulamenta as Actividades de Enriquecimento Curricular para o 1º Ciclo do Ensino Básico das escolas genéricas).

22. Directiva, C. N. Q. N. º 23/93. A qualidade nas Piscinas de Uso Público.

23. Erbaugh, S. J. (1986). Effects of aquatic training on swimming skill development of preschool children. *Perceptual and motor skills*, *62* (2), 439-446.

24. Fernandes, R., & Soares, S. (2005). *Adaptação ao meio aquático: base do processo ensino-aprendizagem em natação*. Vila Real: Associação Portuguesa de Técnicos de Natação.

25. Fialho, I., Verdasca, J., Moreira, L., Chaleta, E., Grácio, L., Magalhães, O., Saragoça, J., Cid, M., & Tobias, A. (2013). Avaliação externa do programa de atividades de enriquecimento curricular no 1º ciclo do ensino básico – relatório final. Direcção Geral de Educação. Évora: Centro de Investigação em Educação e Psicologia da Universidade de Évora. Available at: http://dspace.uevora.pt/rdpc/handle/10174/12487.

26. Flinchum, B. M. (1975). Motor Development in Early Childhood: A Guide for Movement Education with Ages 2 to 6. St Louis Mosby.

27. Font-Ribera, L., Villanueva, C.M., Nieuwenhuijsen, M.J., Zock, J.P., Kogevinas, M. & Henderson J. (2011). Swimming pool attendance, asthma, allergies and lung function in the ALSPAC child cohort. American Journal of Respiratory and Critical Care Medicine. 183,582–588. doi: 10.1164

28. Fragala-Pinkham, M., Haley, S. M., & O'Neil, M. E. (2008). Group aquatic aerobic exercise for children with disabilities. *Developmental Medicine & Child Neurology*, *50* (11), 822-827. doi: 10.1111/j.1469-8749.2008.03086.x

29. Gallahue, D. (2005). Conceitos para maximixar o desenvolvimento da habilidade de movimento especializado. Revista da Educação Física / UEM, 16(2), 197-202.

30. Gallahue, D. L. (1993). Motor development and movement skill acquisition in early childhood education. *Handbook of research on the education of young children*, 24-41. London: Maccmilan.

31. Gallahue, D. L., & Ozmun, J. C. (2006). Understanding motor development: Infants, children, adolescents and adults (6ª ed.). Boston: McGraw Hill.

32. Gallahue, D., & Ozmun, J. (2005). Compreendendo o Desenvolvimento Motor – Bebês, Crianças, Adolescente e Adultos. Brasil: Phorte Editora Ltda.

33. Gorter, J. W., & Currie, S. J. (2011). Aquatic exercise programs for children and adolescents with Cerebral Palsy: what do we know and where do we go? *International journal of pediatrics*, vol. *2011*. doi:10.1155/2011/712165

34. Greco, P. J. (1998). Iniciação esportiva universal: Metodologia da iniciação na escola e no clube. Belo Horizonte: UFMG.

35. Harrow, A. J. (1983). Taxionomia do domínio psicomotor: manual para a elaboração de objetivos comportamentais em educação física. Porto Alegre: Globo.

36. Haywood, K. & Getchell, N. (2004) *Desenvolvimento Motor ao Longo da Vida*. Porto Alegre: Artmed Editora SA.

37. Huotari, P., Nupponen, H., Mikkelsson, L., Laakso, L., & Kujala, U. (2011) Adolescent physical fitness and activity as predictors of adulthood activity. *Journal of Sports Sciences*, 29 (11), 1135-1141. doi: 10.1080/02640414.2011.585166

38. Hutzler, Y., Chacham, A., Bergman, U., & Szeinberg, A. (1998). Effects of a movement and swimming program on vital capacity and water orientation skills of children with cerebral palsy. *Developmental Medicine & Child Neurology*, *40*(3), 176-181.

39. Jorgensen, R. (2012) Under-5s Swimming as a Site for Capital Building: Supporting and Enhancing the Transitions. *Australian Journal of Early Childhood*, 37 (2), 127-131.

40. Kambas, A., Michalopoulou, M., Fatouros, I. G., Christoforidis, C., Manthou, E., Giannakidou, D., & Zimmer, R. (2012). The relationship between motor proficiency and

pedometer-determined physical activity in young children. *Pediatric exercise science*, *24* (1), 34.

41. Kemp, J. G., & Roberts, R. G. (2005). Effects of physical conditioning on children and adolescents with asthma. *Sports Medicine*, 35 (2), 127- 141.

42. Langendorfer, S. (2014). *Swimming Learning Standards: An International Perspective*. *In* Proceedings of the XXXIV Congreso Internacional de la Asociación Española de Técnicos de Natación - Swimming Science Seminar II, Granada, October, Spain.

43. Langendorfer, S. (2010). Applying a developmental perspective to aquatics and swimming. In P. L. Kjendlie, R. K. Stallman, J. Cabri (Eds). *Biomec Med Swimming XI*, 20-22. Oslo: Norwegian School of Sport Sciences.

44. Langerdorfer, S. (1987). Children's Movement in the Water: a developmental and environmental perspective. *Children Environ Quart*, 4, 25-32.

45. Langerdorfer, S., & Bruya, L. (1995). Aquatic Readniss: Developing Water Competence in Young Children. Champaign, Illinois: Human Kinetics.

46. Le Boulch, J. (1987). *Educação psicomotora: Psicocinética na idade escolar*. Porto Alegre: Artes Médicas.

47. Machado, D. C. (1978). *Metodologia da natação*. São Paulo: E.P.U.

48. Maria, A., & Nunes, M. M., (2006). Actividade física e desportiva no 1º Ciclo do Ensino Básico. *Orientações Programáticas*. Associação Nacional de Municípios.

49. Marques, R., & Galhardo, E. (2009). *Estudo comparativo entre conceções metodológicas para o ensino técnico da natação*. Efdeportes. Revista Digital,13 (128). Available at: http://www.efdeportes.com/efd128/estudo-comparativo-entre-concepcoes-metodologicas-para-o-ensino-tecnico-da-natacao.htm

50. Martins, V., Silva, A. J., Marinho, D. A. & Costa, A. M. (2015) Efeito da prática de natação em contexto educativo no desenvolvimento motor global de crianças do 1º ciclo do ensino básico. *Journal Motricidade*, (in press).

51. McArdle, W., Katch, F., & Katch, V. (2014). Exercise Physiology: Nutrition, Energy, and Human Performance (8th edition). LWW; (February 24, 2014). ISBN-13: 978-1451191554

52. McManus, B. M., & Kotelchuck, M. (2007). The effect of aquatic therapy on functional mobility of infants and toddlers in early intervention. *Pediatric Physical Therapy*, 19(4), 275-282.

53. Moreno, J. & Sanmartín, M. (1998). *Bases metodológicas para el aprendizaje de las actividades acuaticas educativas*. Barcelona: Publicações INDE.

54. Moreno, J. A., Pena, L., del Castillo, M., & Vegué, L. (2004). Manual de actividades acuáticas en la infancia: para bebés y niños de hasta seis años. Barcelona:Paidós.

55. Murray, J. L. (1980). *Infaquatics: Teaching kids to swim*. New York: Leisure.

56. Nadel, ER; Holmér, I; Bergh, U; Ästrand P-O; Stolwijk, JAJ.(1974). Energy exchange of swimming man. *Journal of Applied Physiology*, 36 (4), 465-471.

57. Navarro, F. (1995). *Hacia el dominio de la Natación.* Madrid: *Editora* Gymnos, S. A.

58. Paula, A. & Belo, C. (2009). Avaliação do desenvolvimento motor de alunos de natação e futsal através do teste de Bruininks. Efdeportes. Revista Digital, 14 (133). Available at: http://www.efdeportes.com/efd133/avaliacao-atraves-do-teste-de-bruininks.htm

59. Pereira, V. R. (1990). Estudo da influência de um programa desportivo: motor centrado no handebol sobre o desenvolvimento psicomotor das crianças em idade escolar 9 e 10 anos. (Doctoral dissertation, Tese Doutoramento. Universidade do Porto: Porto)

60. Peres, C. G., Serrano, J. J., & Cunha, A. C. (2009). *Desenvolvimento infantil e habilidades motoras: uma sistematização*. Viseu: Vislis.

61. Piaget, J. (1975). *L'équilibration des structures cognitive (Vol. 33)*. Paris: Presses Universitaire de France.

62. Piéron, M. (1988). Didáctica de las actividades físicas y deportivas. Madrid: Gymnos.

63. Santos, S., Dantas, L., & Oliveira, J. A. D. (2004). Desenvolvimento motor de crianças, de idosos e de pessoas com transtornos da coordenação. *Rev Paul Educ Fís*, *18*, 33-44.

64. Schmitt, P. (2000). *Nadar. Del descubrimiento al alto nivel*. Barcelona: Hispano Europea.

65. Sigmundsson, H., & Hopkins, B. (2010). Baby swimming: exploring the effects of early intervention on subsequent motor abilities. Child: care, health and development, 36 (3), 428-430. doi: 10.1111/j.1365-2214.2009.00990.x

66. Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human movement science*, *20* (1), 73-94.

67. Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D., & Lubans, D. R. (2014). The health benefits of muscular fitness for children and adolescents: a systematic review and meta-analysis. *Sports Medicine*, 1-15. doi: 10.1007/s40279-014-0196-4

68. Soares SM (2000). Natação. In: Paula Botelho Gomes (Ed). Educação Física no 1º Ciclo. Porto: Pelouro do Fomento Desportivo da Câmara Municipal do Porto e Faculdade de Ciências do Desporto e de Educação Física, 154-173. Porto: UP.

69. Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest, 60 (2)*, 290-306.

70. Tani, G. (2011). A Educação Física e o Esporte no contexto da universidade. Revista bras. Educ. Fís. Esporte, 25,117-126.

71. Tani, G; Manoel, E. J.; Kokubun, E. & Proença, J.E. (1988) *Educação Física Escolar: fundamentos de uma abordagem desenvolvimentista.* São Paulo: EPU.

72. Vickers, J. N. (1990). *Instructional design for teaching physical activities: A knowledge structures approach*. Human Kinetics Publishers, Inc., Box 5076, Champaign, IL 61825-5076.

73. Vygotsky, L.S. (1978). Mind in society: the development of higher psychological processes. London: Harvard University.

74. Wang, J. S., & Hung, W. P. (2009). The effects of a swimming intervention for children with asthma. *Respirology*, 14 (6), 838-842. doi: 10.1111

75. Water, S., & World Health Organization. (2006). Guidelines for safe recreational water environments. Volume 2, Swimming pools and similar environments.

76. Welsh, L., Kemp, J. G., & Roberts, R. G. (2005). Effects of physical conditioning on children and adolescents with asthma. *Sports medicine*, *35* (2), 127-141.

77. Wicher, I. B., Ribeiro, M.A, Marmo, D. B., Santos, C. I., Toro, A. A., Mendes, R. T., Cielo, F.M., & Ribeiro, J. D. (2010). Effects of swimming on spirometric parameters and bronchial hyper responsiveness in children and adolescents with moderate persistent atopic asthma. *Jornal de pediatria*, *86* (5), 384-390. doi:10.2223/JPED.2022

78. Williams, H. G., Pfeiffer, K. A., O'Neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008) Motor skill performance and physical activity in preschool children. *Obesity*, 16(6), 1421-1426. doi: 10.1038/oby.2008.214

79. Zhao, S., Xie, L., Hu, H., Xia, J., Zhang, W.,Ye, N. & Chen, B. (2005). A study of neonatal swimming (water therapy) applied in clinical obstetrics. *Journal of Maternal-Fetal and Neonatal Medicine, 17*(1), 59 - 62. doi:10.1080/14767050400028782

80. Zuo, H.(2004). Optimize swimming teaching by clearing mentality of being scared. Journal *Guangdong Communication Polytechnique*.

Chapter II: Organization and methodology of swimming teaching in the elementary school in Portugal

2.1 Content

This chapter presents the analysis of the organization and methodology of the swimming teaching in the elementary school in Portugal.

2.2 Summary

The main objective of this study was to know the organization and the swimming learning methodology developed under the Expression and Physical Motor Education in the first level basic education in Portugal. The sample included 89 pedagogical coordinators of local swimming schools and 100 swimming teachers working at those schools. Two questionnaires were used to assess the organization and teaching methodology and the results were described based on descriptive statistical analysis. The results suggest that swimming in the first level basic education is governed according to the guidelines from Ministry of Education. The budget cut (60.0% less) and the difficulty in transporting school students (54.0%) to the swimming pool are the main reasons mentioned for the suppression of swimming. Teaching is primarily directed to the third and fourth grade (80.1%), with weekly frequency (64.4%) and classes with a high number of students (13 to 16 students). The main objective of the classes is the children's adaptation to the aquatic environment, focusing on the basic aquatic skills (81.4%), with very little use of pedagogic material. With the data collected, we were able to identify some weaknesses in the framework of swimming teaching, in the 1st level of basic education, probably because of the constraints of the teaching-learning process, at the level of more complex skills.

Keywords: Swimming; teaching methods; aquatic skills; children.

2.3 Introduction

The overall development of the child is sequential and cumulative, sustained in experiences that contribute to a solid group of motor skills (Gallahue & Ozmun 2005; Le Boulch, 1987; Piaget, 1975; Vygotsky, 1978). Childhood is seen as a critical period for the development of physical skills and basic psychomotor learning, extending this period up to the age of the last year of the 1st level of basic education.

Besides that, and according to the Physical Activity Guidelines Advisory Committee (2008), the physical exercise during childhood brings a lot of benefits to children's development (social, cognitive and physical), in the mid and long term, such as reducing the fat mass, reducing the risk of cardiovascular diseases, type two diabetes and psychological benefits (psychological well-being, self-esteem, reduce anxiety and depression). A recent study (Huotari et al., 2011) shows that children and adolescents that are physically active have less probability to be sedentary when they are adults. On the other hand, we also know that the lack or bad motor stimulation can have a very negative impact in the child's development (Gallahue & Ozmun, 2005; Leboulch, 1987; Piaget, 1975; Vygotsky, 1978).

In this perspective, we consider the swimming practice during childhood a harmonious exercise that contributes to the full development of the child and, at the same time, reduces the risk of drowning. However, to our knowledge there are no solid scientific evidences that aquatic activities actually reduce the risk of drowning (Asher, Rivara, Felix, Vance & Dunne, 1995). Regarding the motor development, the study of Zhao et al. (2005) reports positive effects of the application of aquatic activity programs. Additionally, it was observed a positive impact on the neuromuscular development and on the functional capacity of the cardiovascular and respiratory systems. Other authors (Kemp & Roberts, 2005; McManus & Kotelchuk 2007 Wicher, et al, 2010; Gorter & Currie, 2011) refer supporting effects at different levels: reduction of behavior and sleep disorders; anorexia; deficit of the neuro-psychomotor development; hypotonias; orthopedic, neurological and respiratory disorders. In addition to these benefits, the practice of swimming naturally contributes to the learning of basic, specific and complex motor skills in a wider context of aquatic competence (Langendorfer & Bruya, 1995) that should be developed particularly during childhood (Blanksby et al., 1995). However, there are limitations to the swimming practice, which often requires a prior medical advice. Hearing protection should be used to prevent in the case of otitis, sinusitis and chronic rhinitis as well as appropriate water glasses to protect eye sensitivity.

The Expression and Physical Motor Education, as part of the required range of activities included in the program of the first level of basic education, which encompasses several key content to the child's development, includes swimming as one of the optional modalities of the program. Due to the unique characteristics of this sport, the need of special facilities and teachers with the right preparation, it's not always possible to include swimming in the regular school program. Besides that, the quality of the swimming teaching depends on many factors, mainly those that directly influence its organization and, therefore, determine its effectiveness.

According to Langendorfer and Bruya (1995) and Campaniço (1989), we refer particularly to the following factors: (i) the number of students – as a factor that determines the quality of education; (ii) the didactic material - that allows variability of stimulations in the class; (iii) water temperature – that should range between 30º and 32º C; (iv) the number of classes per week - usually two times in childhood (between three and ten years old); (v) the depth of the swimming pool – making use of several methodological strategies used in deep swimming pools,

when the class is small (six to twelve students). According to Carvalho (1994), the quality of education depends on the teaching conditions, the space available to the class and is related to the learning progress of the students.

Although there are guidelines about how to develop physical exercise and sports during the elementary school, currently there are no studies in Portugal about how this is done on the field and about the achievements made. Moreover, the commission that is responsible to supervise the application of the program, which presents annual pedagogical reports, has been saying that the mechanisms to collect report data are not compliant with the teaching program, besides the fact that there is relevant data that is not being considered and other data that is being collected but not always relevant for such analysis.

Therefore, in this study we have decided to describe and analyze the implementation of the swimming program in the context of the Expression and Physical Motor Education class of the elementary school in Portugal, currently conducted by the Local Administration. We aim to know the following topics: (i) the organization of teaching methodology; (ii) the methodologies applied in swimming practice; (iii) the effective implementation of the teaching-learning process (identify which basic aquatic skills are preferential); (iv) find out why swimming is not included in the school program.

2.4 Method

2.4.1 Experimental design

This study is essentially a descriptive field research, with a quantitative analysis of the data collected, which main purpose is to know the teaching of swimming, in the context of the Expression and Physical Motor Education class, in the elementary school in Portugal.

2.4.2 Sample

Data was collected during the school year of 2010/2011, in 89 Portuguese municipalities – municipal swimming pools that participated in this study, corresponding to 30.2% of the Portuguese municipalities (table 1). The 89 pedagogical coordinators of those swimming schools were divided in two groups:

Municipal swimming pools that are providing swimming classes to the local elementary school (corresponding to a total of 59 pedagogical coordinators – 47 men and 12 women);

Municipal swimming pools that are not providing swimming classes to the local elementary school (corresponding to a total of 30 pedagogical coordinators – 26 men and four women);

Additionally, 100 swimming teachers, teaching swimming in the elementary school at those locations, agreed to participate in this study (65 men and 35 women, 31.9 $\pm$ 5.5 years old, 3.19 + 0.89 years of professional experience).

2.4.3 Instruments and procedures

We submitted a questionnaire to the pedagogical coordinators of swimming schools with or without swimming practice in the elementary school of that area, with the objective to get from them the data to analyze the context of swimming practice and the factors related with teaching of swimming in the elementary school. The questionnaire was elaborated following Wilkinson and Birmingham's recommendations (2003). The majority of the questions included in this questionnaire are dichotomous questions (so, closed questions), based on Rasch's model (1960) decreasing order of concordance, or even of the Likert's type, with four levels of attribution. The final version of the questionnaire has included the following topics: (i) characterization of the respondents (gender, age, academic degree, professional experience, number of teaching hours in the elementary school); (ii) characterization of the swimming learning environment (water temperature, water depth, number of classes, weekly frequency); (iii) local learn-to-swim framework in the elementary school (if swimming exists or not in the elementary school; understanding the swimming practice guidelines from the Ministry of Education; the number of lessons of the swimming practice; the reason behind the decision of schools that have decided to remove swimming practice from their educational program) – annex 1.

In parallel, the swimming teachers at elementary schools answered to a questionnaire with the following topics: (i) characterization of the respondents (gender, age, academic degree, professional experience); (ii) objectives of the swimming practice in the elementary school; (iii) the context of the swimming practice in the elementary school's education program and the understanding of the swimming practice guidelines from the Ministry of Education; (iv) methodology of swimming practice in the elementary school (objectives, use of didactic material, didactic content application, importance of basic learning acquisition by students, application of these contents in the global learning of aquatic competences and formal strokes/techniques) – annex 2.

Both questionnaires were adapted from Costa et al. (2012). We have used a control group in four different municipalities not included in the study's sample, with the objective to have, later on, a higher clearness and objectiveness of the questions included in those questionnaires. The questionnaires were also reviewed by experts in swimming teaching.

2.4.4 Analysis of statistics

In order to describe and summarize the data collected in this study, we used the descriptive statistic, in particular the calculation of frequencies.

2.5 Results

2.5.1 General characteristics of respondents

The following tables present the percentage of gender, age and academic degree of the inquired pedagogical coordinators and swimming teachers.

Table 1

Percentage of gender, age and academic degree of the inquired swimming pool pedagogical coordinators and swimming teachers

Table 1a)

Characteristics of the inquired swimming pool pedagogical coordinators with swimming practice included in the elementary school of their area

		Count	%
Gender	Male	45	76.3
	Female	14	23.7
Age	20-25	0	0.0
	26-30	11	18.6
	31-35	19	32.2
	35+	29	49.2
Academic degree	Secondary school	2	3.4
	Bachelor degree	2	3.4
	Graduation degree	42	71.2
	Master's degree	9	15.3
	PhD	1	1.7
	Other	3	5.1

Table 1b)

Characteristics of the inquired swimming pool pedagogical coordinators without swimming practice included in the elementary school of their area

		Count	%
Gender	Male	25	83.3
	Female	5	16.7
Age	20-25	1	3.3
	26-30	7	23.3
	31-35	11	36.7
	35+	11	36.7
Academic degree	Secondary school	1	3.3
	Bachelor Degree	0	0.0
	Graduation degree	23	76.7
	Master's degree	6	20.0
	PhD	0	0.0
	Other	0	0.0

Table 1c)

Characteristics of the inquired swimming teachers at elementary school			
		Count	%
Gender	Male	65	65.0
	Female	35	35.0
Age	20-25	7	7.0
	26-30	37	37.0
	31-35	35	35.0
	35+	21	21.0
Academic degree	Secondary school	3	3.0
	Bachelor Degree	2	2.0
	Graduation degree	81	81.0
	Master's degree	12	12.0
	PhD	0	0.0
	Other	2	2.0

The data above demonstrates a significant dissimilarity of gender at the management level, in particular at the pedagogical coordination level. About 50% of the pedagogical coordinators have 35 years old or more and almost all of them are graduated.

Most of the inquired teachers have two or three years of professional experience (85%), teaching between six to ten hours of swimming practice in the elementary school (44%) and have a diverse weekly distribution of teaching hours: one to five hours a week (20%), six to ten hours a week (44%), 11 to 15 hours a week (22%).

2.5.2 Organization of swimming schools

According to the answers from the 89 pedagogical coordinators inquired, the water temperature in the context of swimming practice in the elementary school ranges from 28ºC to 31ºC. No school is using only deep water pools. 73% of inquired schools use both deep and shallow water pools and 27% use only shallow water pools.

55% of the inquired elementary schools have swimming practice included on their educational program and 36.7% have not. The number of practice sessions in the elementary school ranges from nine to 16 sessions, during the school year. Classes have 13 to 16 students, with one practice session per week in most cases (64.4%). Most of the municipalities have between one and 15 elementary schools with swimming practice, especially in the third and fourth years. No class in the first year and about 20% in the second year.

2.5.3 Context of swimming practice in the elementary school

The following table shows the percentage of inquired schools with ongoing swimming practice and with previously swimming practice in the elementary school of their area (currently closed).

Table 2

Percentage of inquired schools with ongoing swimming practice and swimming practice currently closed

Swimming practice in the elementary school	Swimming schools with ongoing swimming practice in the elementary school of their area		Swimming schools with previously swimming practice in the elementary school of their area (currently closed)	
	Count	%	Count	%
AEP (*)	43	72.9	3	10.0
Elementary school	12	20.3	4	13.3
Others	4	6.8	14	70.0
Never included	-	-	9	6.7

(*) AEP – Extracurricular Activities Program, swimming practice as additional educational activity, in the elementary school.

According to table 2, swimming practice is essentially seen as an extra/complementary activity in about 73% of inquired schools. In those municipalities where swimming practice is now out of elementary school's program, the swimming practice was provided by the municipality as extra school activity. In only a few cases, swimming practice was included in the Extracurricular Activities Program activities or was part of the elementary school's program. At elementary schools, 67.8% of swimming lessons are provided by physical education teachers. 22% of the inquired pedagogical coordinators indicated that swimming lessons have the presence of both the physical education teacher and a trainer from a specialized swimming school.

The following table shows the percentage of swimming practice in the elementary school education, where swimming practice is not included on the elementary school's program. 30% of inquired municipalities never had swimming practice during elementary school. 60% of inquired municipalities had to cancel swimming practice because of insufficient budget.

Table 3

Percentage of swimming practice in the elementary school education, where swimming practice is not included on the elementary school's program

Swimming practice during elementary school	Swimming schools without swimming practice in the elementary school of their area	
	Count	%
Never included	9	30.0
Unknown subject	2	6.7
No budget	18	60.0
Other reasons	1	3.3

The following table shows the percentage of inquired managers and teachers that know about the guidelines from the Ministry of Education with regards to teaching swimming during the elementary school.

Table 4

Percentage of inquired pedagogical coordinators and teachers that know about the guidelines from the Ministry of Education with regards to teaching swimming during the elementary school

Know Ministry of Education's guidelines	Swimming schools with ongoing swimming practice in elementary school of their area				Swimming schools without swimming practice in elementary school of their area	
	Pedagogical coordinators		Swimming Teachers		Pedagogical coordinators	
	Count	%	Count	%	Count	%
Yes	54	91.5	87	87.0	18	60.0
No	5	8.5	13	13.0	12	40.0

More than 80% of the inquired individuals know the guidelines from the Ministry of Education. However, 13 swimming teachers and five pedagogical coordinators seem hardly committed to these guidelines but still promote swimming practice for school aged-children.

The following table shows the opinion of the inquired swimming school managers about the sufficiency of the number of lessons generally comprised in the local swimming program (in the elementary school).

Table 5

Opinion of the inquired swimming school pedagogical coordinators about the sufficiency of the number of lessons generally comprised in the swimming practice, in the elementary school

	Pedagogical coordinators opinion							
Aquatic competence level	Swimming schools with ongoing swimming practice in elementary school of their area				Swimming schools without swimming practice in elementary school of their area			
	Agree		Disagree		Agree		Disagree	
	Count	%	Count	%	Count	%	Count	%
Basic skills (balance, floating, rotations, propulsion, jumps, breathing, …)	48	81.4	11	18.6	17	56.7	13	43.3
Autonomy in the water and start rudimentary propulsive skills	48	81.4	11	18.6	28	93.3	2	6.7
Perform rudimentary butterfly and breast strokes, including starts and turns	29	49.2	30	50.8	17	56.7	13	43.3
Perform well all the four official strokes, including starts and turns	5	8.5	54	91.5	8	26.7	22	73.3

Both inquired groups indicated that is positive to have the acquisition of basic aquatic competence at elementary school and, eventually, begin gaining rudimentary propulsive skills (namely rudimentary front crawl and backstroke).

Table 6 presents the statistics about the transportation used by elementary students to go to the swimming pool and who is taking care of them during these trips.

More than 71% of the municipalities included in this study provide this transport service. We see that about 56% of these students are going with school staff and 27% are going with the school teacher.

Table 6

Transportation used by elementary students to go to swimming pool and come back and who is watching them during these trips

Transportation and supervision of children		Swimming schools with ongoing swimming practice in elementary school of their area	
		Count	%
Transportation	Walking	3	5.1
	Bus	42	71.2
	Others	14	23.7
	N/A *	-	-
Supervision	School staff	33	55.9
	Physical educ. teacher	10	17.0
	Main teacher	16	27.1
	Others	0	0.0
	N/A *	-	-

* N/A: not applicable

2.5.4 Methodology of swimming teaching in the elementary school

The following table shows the opinion of inquired teachers about the purposes of swimming programs within the educational context (during elementary school).

The list of six different possibilities above follows Rasch's format (1960). The answers obtained indicate that the two most important objectives are "lose fear of water" and "pleasure".

Table 7

Opinion of inquired swimming teachers about the purposes of swimming programs within the educational context (during elementary school)

Swimming teaches opinion	Agree		Disagree	
	Count	%	Count	%
To survive in water	75	75.0	25	25.0
To become autonomous in the aquatic environment	97	97.0	3	3.0
Lose fear of water	100	100.0	0	0.0
For pleasure	100	100.0	0	0.0
To swim a short distance of 50 m	21	21.0	79	79.0
To train future swimmers	22	22.0	78	78.0

The following table shows the opinion of the inquired swimming teachers about the use of didactic material in the process of teaching-learning swimming in the elementary school.

Table 8

Opinion of the inquired teachers about the use of didactic material in the process of teaching-learning swimming in the elementary school

Didactic materials	Swimming teachers (use of didactic materials)							
	Always		Sometimes		Rarely		Never	
	Count	%	Count	%	Count	%	Count	%
None	4	4.0	34	34.0	28	28.0	34	34.0
Boards	35	35.0	61	61.0	4	4.0	0	0.0
Arm floats	4	4.0	17	17.0	19	19.0	60	60.0
Noodles	22	22.0	73	73.0	3	3.0	2	2.0
Non-floating arches	17	17.0	78	78.0	3	3.0	2	2.0
Others	18	18.0	65	65.0	11	11.0	6	6.0

On the previous table, we see that more than 50% of teachers never or rarely use didactic material. Nevertheless, boards seem to be the most used equipment. Also, we see that arm floats are used sometimes.

Table 9 shows the opinion of the inquired swimming teachers about the use of pedagogic contents during the teaching-learning process of swimming (adaptation to water environment and teaching basic stroke technique).

In respect to adaptation to water, one can note that more attention is given ("always" column) to "water entry" (72%), "acquiring confidence in the water" (90%), "balance" (70%), "breathing control" (86%) and "propulsion with legs" (69%). Less attention is given ("sometimes" column) to "immersion in deep water" (59%) and body rotations (61% sometimes, 13% rarely).

In respect to teaching official strokes/techniques, the most important points to the inquired swimming teachers ("always considered") are the following: "water entry" (60%), "dynamic balance" (82%), "correct propulsion with legs" (74%) and "specific technical skills" (74%). On the other hand, results suggest that the following points are less important to these swimming teachers ("only sometimes"): "symmetric rotations" (62%), "correct propulsion with arms" (63%) and "rhythmic breathing control" (53%).

Table 9

Opinion of the inquired swimming teachers about the use of pedagogic contents during the teaching-learning process of swimming

	Topic	Teachers							
		Always		Sometimes		Rarely		Never	
		Count	%	Count	%	Count	%	Count	%
Teaching adaptation to water environment	Water entry	72	72.0	25	25.0	3	3.0	0	0.0
	Tasks to acquire confident	90	90.0	10	10.0	0	0.0	0	0.0
	Submersion in apnea	46	46.0	43	43.0	10	10.0	1	1.0
	Balance	70	70.0	29	29.0	1	1.0	0	0.0
	Propulsion with legs	69	69.0	28	28.0	3	3.0	0	0.0
	Propulsion with legs and arms	34	34.0	57	57.0	8	8.0	1	1.0
	Glides	50	50.0	43	43.0	7	7.0	0	0.0
	Rotations	24	24.0	61	61.0	13	13.0	2	2.0
	Skills	58	58.0	37	37.0	5	5.0	0	0.0
	Diving	28	28.0	64	64.0	8	8.0	0	0.0
	Breathing control	86	86.0	14	14.0	0	0.0	0	0.0
	Deep water immersion	20	20.0	59	59.0	18	18.0	3	3.0
Teaching basic stroke technique	Water entry	60	60.0	29	29.0	10	10.0	1	1.0
	Dynamic balance	82	82.0	16	16.0	2	2.0	0	0.0
	Correct propulsion with legs	74	74.0	24	24.0	2	2.0	0	0.0
	Symmetric rotations	30	30.0	62	62.0	6	6.0	2	2.0
	Correct propulsion with arms	24	24.0	63	63.0	12	12.0	1	1.0
	Specific technical skills	74	74.0	23	23.0	2	2.0	1	1.0
	Rhythmic breathing control	39	39.0	53	53.0	8	8.0	0	0.0
	Starts and turns	39	39.0	47	47.0	10	10.0	4	4.0
	Complex skills	7	7.0	33	33.0	47	47.0	13	13.0

Table 10 shows the opinion of the inquired swimming teachers about the importance given to attitude and basic understanding during swimming learning.

The results shown below indicates that, in general, all listed attitudes are important to the inquired teachers. Only two of them are a bit less relevant comparing to the others: “not afraid of water” and “know how to use equipment”. In terms of basic understanding, we see that “procedures and class organization”, “safety and rescue rules” and “games and fun activities” are the most important topics (“always”) for the inquired teachers, on this part.

Table 10

Opinion of the inquired teachers about the importance given to attitude and basic understanding during swimming learning

	Topic	Teachers							
		Always		Sometimes		Rarely		Never	
		Count	%	Count	%	Count	%	Count	%
Attitudes	Not afraid of water	79	79.0	20	20.0	1	1.0	0	0.0
	Know how to use equipment	81	81.0	19	19.0	0	0.0	0	0.0
	Respect practice rules	94	94.0	6	6.0	0	0.0	0	0.0
	Respect instructions and organization	94	94.0	6	6.0	0	0.0	0	0.0
Basic understanding	Procedures and class organization	90	90.0	9	9.0	1	1.0	0	0.0
	Safety and rescue rules	83	83.0	17	17.0	0	0.0	0	0.0
	Games and fun activities	87	87.0	13	13.0	0	0.0	0	0.0
	Knowing the technical language	64	64.0	35	35.0	1	1.0	0	0.0
	Theoretical domain of mechanical movement	54	54.0	43	43.0	3	3.0	0	0.0

2.6 Discussion

2.6.1 Global description of the inquired individuals

This study has the objective to analyze the implementation of swimming practice in the context of the Expression and Physical Motor Education, in the elementary school in Portugal. As we discuss below, the obtained results demonstrate that swimming practice is included essentially on the extracurricular plan of the third and fourth school years/levels, with focus on the basic aquatic skills, in line with the orientations given by the Portuguese Ministry of Education.

In parallel, we have identified the causes of the inexistence of swimming practice in certain educational contexts and also some difficulties in putting it in the right position, probably because of some limitations of the efficiency of the teaching-learning process of swimming, in respect to learn more complex aquatic/swimming skills.

With regards to the profile of the inquired pedagogical coordinator and swimming teachers, we see that the majority of them holds an academic degree on this specific field, probably due to the fact that swimming practice is included, in most cases, in the Extracurricular Activities Program (extra or complementary school activities) – which represents about 73% on our study, which requires professionals of physical activities and sports to have a specific qualification to be entitled to teach the Physical Education discipline in the elementary school and/or holding a degree in Sport Sciences. In the study by Brandão (2010), all the teachers that have participated on the study hold a degree in Sport and Physical Education as well. However, not all the teachers working on the Extracurricular Activities Program are familiar with the guidelines and objectives defined by the Ministry of Education (Brandão, 2010). We realized that the percentage of men in this professional activity is much higher than women, in

particular in the management positions (pedagogical coordinator). This proportion is certainly similar to the percentage of men and women with a degree in physical education and sports, in Portugal, although the rate between men and women becomes higher as we go up on the position level (from swimming teacher to pedagogical coordinator).

With respect to the organization of swimming schools, we found that swimming practice is more frequent to find on the third and fourth year/level, in the elementary school. This happens probably because the guidelines of the educational programming (Maria & Nunes, 2006) only consider swimming practice in those years/levels.

Teaching conditions appear to be globally appropriate for the purposes of the aquatic activity program. According to Langendorfer and Bruya (1995) and Campaniço (1989), the main factors are the following ones: the number of student (important for the teaching's effectiveness and quality); the didactic material used (allows a wide range of activities during swimming lessons); the water temperature (shall be around 30ºC to 32ºC); and the pool depth (mostly shallow water). In fact, we found that in 40% of swimming pools the water temperature is around 28/29ºC. Although Langendorfer and Bruya (1995) and Campaniço (1989) indicate that the water temperature should be between 30ºC to 32ºC, the Quality National Council recommends a maximum water temperature of 30ºC. The swimming pools owned by the Portuguese municipalities seem to follow that recommendation. With regards to pool depth, none of the schools included in this study is using only deep water. About 73% of them are using both deep and shallow water, simultaneously. In fact, and according to Costa et al. (2012), the decision of combining aquatic activities in both types of depth can be an added value and an appropriate option for the objective of the adaptation to aquatic environment at these ages. We couldn't figure out if the few schools (only 27%) that teach swimming only in shallow water are doing it because it was a management decision, or because they cannot access or build a swimming pool with both kind of depths.

The number of students per class (between 13 to 16 students) and the low frequency of swimming lessons per week (the majority of cases studied are having one lesson per week) seem to be a less positive point found with this study. Both facts result in a lower quality and effectiveness of the swimming learning/teaching (Langendorfer & Bruya, 1995). According to Sarmento, Carvalho, Florindo and Raposo (1982), the process of acquiring skills in the aquatic environment depends on the use of appropriate instruments and methods. Therefore, the size of classes seems to have a relevant impact in the effectiveness of the swimming teaching, especially during the initial phase of adaptation to water and acquisition of basic swimming skills (Campaniço, 1991). According to that, Santos, Gonçalves and Pereira (1994) found that large classes (about 20 students per class), in a certain school, were having a negative impact in the success of swimming learning, comparing with two other schools with smaller classes (around 11 to 13 students per class). According to Carvalho (1994), the learning progress of the class has a direct impact from its size, independently of the qualification and experience of the teacher. In the long run, this brings a negative impact to the teaching quality. This author

highlights that deep water, i.e. where the student's foot cannot touch the bottom of the pool, requires the teacher to provide a direct support to students. He also says that, because of effectiveness and safety, the maximum of students per teacher should be no more than four and this is the most recommended option during the phase of adaptation to water in deep swimming pools.

The cause of the absence of swimming practice in the elementary school of 30 municipalities included in this study seems be budgetary constraints (60% of municipalities). Another difficulty found is the transportation of students to and from the swimming facilities. In our point of view, the absence of swimming practice during the childhood may create two problems. The first problem is about the lower development of motor skills, during the childhood, particularly the aquatic skills, that are key for a healthy cognitive, affective and psychomotor stimulation (Langendorfer & Bruya, 1995). This is especially important between the end of the preschool and the beginning of the elementary school (Blanksby et al., 1995; Courage, Reynolds, & Richards, 2006; Zhao et al., 2005). The second problem is the potential risk of drowning (Brenner, et al., 2009, Peden & McGee, 2003).

During this study, we have noticed that the guidelines from the Ministry of Education are globally known and followed by swimming teachers (87%). The other teachers follow other program. In the majority of studied swimming schools, the swimming teaching follows a standard didactic unit, where the swimming teacher has to strictly follow the standard program/guidelines. In fact, only 39% of swimming teachers are involved in the definition and supervision of this didactic unit.

According to our results, the two groups that participated in the survey (pedagogical coordinators and swimming teachers) consider to be positive to acquire basic aquatic skills in the elementary school and eventually to start learning basic stroke techniques, particularly front crawl and backstroke. It is also important to consider the statistics about the procedures and class organization (safety rules, rescue, games and fun activities). These topics are always taken into account, although with a lower level of importance.

2.6.2 Organization of swimming pools included on this study

One of the objectives of this study is to describe the methodology of swimming teaching for the elementary school. Swimming lessons are related to the adaptation to water and to the teaching with little didactic material. Based on the six objectives considered in this study, the result of the inquiries is in line with the study by Costa et al. (2012) and by Campaniço (1991), especially in respect to the adaptation to water, mainly in shallow water, during an initial phase. The pleasure and autonomy in the water are key aspects for the development of basic aquatic skills (Langendorfer & Bruya, 1995; Langendorfer, 2010). In fact, swimming practice in the elementary school contributes to the motor development and stimulates the practice of physical activities, specially swimming.

With this study, we found a very low usage of didactic material. Boards are the most used equipment, as also reported by Costa et al. (2012). As far as we know, there are very little scientific studies about the impact of using devices (didactic material) in aquatic readiness programs. Erbaugh (1986), one of those scarce studies, demonstrated how important is to use this equipment during the development of horizontal dynamic body balance (glides). However, more important is to understand the educational advantages of didactic equipment. For example, the fun when using such devices, associated with a certain teaching methodology that assumes the game in the water as a natural educational resource, which encompasses both the practitioner's motivation and the pedagogical effectiveness, also known as compressive method by Moreno and Guitiérrez (1998).

A few inquired teachers (even though they represent a small number) are worried with the use of arm floats. The excessive use of floating equipment (jackets and arm float) in the development of floating capability, or even body behavior in a dynamic situation, has been criticized by several authors (Barbosa, 2004; Blanksby et al., 1995; Costa et al., 2012; Langendorfer & Bruya, 1995; Soares, 2000). There are distinct opinions about using auxiliary material in swimming learning. Some authors discourage the use of floating equipment (Catteau & Garrof, 1988) due to its negative influence in floating and propulsion. Other authors consider that auxiliary equipment should only be used on moderated way (Barbosa, 2004; Langendorfer & Bruya, 1995; Moreno & Sanmartin, 1998; Navarro, 1995; Sarmento & Montenegro, 1992; Soares, 2000), avoiding the dependency of practitioners from a false perception of autonomy in the water, which develops an artificial aquatic competence, as a consequence of such (Soares, 2000). Nevertheless, the use of auxiliary equipment, according to Navarro (1995), increases safety sense, reduces tiredness and, therefore, the swimming practice can be more motivating.

2.6.3 Methodology of swimming teaching in the elementary school

In the context of adaptation to water environment, the following points were found as key aspects in the teaching methodology: entry in the water, tasks that help increasing confidence in the water, body balance and breathing control. These results seem to be in line with the opinion about the purpose of swimming practice during the elementary school (see table 7 above). In fact, the pleasure of practicing such activity and the feeling of having no fear in water are key aspects for the inquired teachers. However, the fact that the inquired teachers have demonstrated they consider less important the body rotations in different axis (61% of answers are "sometimes" and 13% are "rarely") seems to us to be inappropriate and not compliant with the opinion of several authors and publications in the domain of swimming, like for instance Langendorfer and Bruya (1995) and Barbosa and Queirós (2004), towards a good and complete acquisition of aquatic skills. In fact, several authors agree that the body rotation is an important target to learn more complex skills later on, like swimming strokes, starts and

turns (Barbosa & Queirós, 2004; Erbaugh, 1978; Langendorfer & Bruya, 1995;). The less importance given to rotations was also detected by Costa et al. (2012), in a similar study's sample.

With respect to the importance of content for the teaching of formal techniques/strokes, we can see that the most important topics for the inquired swimming teachers are the following: "water entry", "dynamic balance", "correct propulsion with legs" and "other specific technical skills". As with the adaptation to water environment, the "symmetric body rotations" are consider to be less important skills. According to the inquired teachers, also less important are the "propulsion with arms", the "rhythmic control of breathing", "starts and turns" and other "complex skills". Unfortunately, with this study we cannot determinate if the importance level given to each topic, during the teaching of swimming, has brought a positive or negative impact to the learning of the skill.

2.7 Conclusion

The results of this study indicate that the swimming practice, in the elementary school in Portugal, preferably follows the guidelines from the Ministry of Education. The absence of swimming practice in the school program of certain municipalities seems to be caused by budgetary and transportation restrictions. The methodology and supervision of swimming lessons are mainly accomplished by swimming school pedagogical coordinators. The application of defined aquatic programs are found, almost exclusively, in the third and fourth school years/levels, with only a session per week and organized in classes with inadequate size, considering the level of aquatic skills of students. Swimming education seems to be focused on the pleasure part of swimming practice, trying to make kids confidant with the water environment, drawing more attention to the acquisition of basic aquatic skills, such as the water entry, the body balance and the breathing control, with little use of didactic equipment.

We recommend that futures studies should try to clarify the impact of certain topics related to teaching methodology, like class size, number of sessions per week, the teaching approach or even the use of auxiliary/didactic equipment, on the success of swimming education. It would be also very important to know the impact of swimming practice on the global motor development of children, besides its importance in the context of child safety.

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2.8 References

1. Asher, K. N., Rivara, F. P., Felix, D., Vance, L., & Dunne, R. (1995). Water safety training as a potential means of reducing risk of young children's drowning. *Injury Prevention, 1*(4), 228-233. doi:10.1136/ip.1.4.228
2. Barbosa, T., & Queirós, T. (2003). A problemática da respiração no ensino da natação. *Lecturas: Educación Física y Deportes*, 8 (58), 25. Avaliable at: http://www.efdeportes.com/efd58/natacao.htm
3. Barbosa, T. (2004). Ensino da Natação - Vantagens e desvantagens da utilização dos materiais auxiliares na adaptação ao meio aquático. In Proceedings of the *27th Congresso Técnico-Científico da Associação Portuguesa de Técnicos de Natação*. Lisboa, Portugal. Associação Portuguesa de Técnicos de Natação.
4. Barbosa, Tiago M. & Queirós, T. (2004). *Ensino da natação: uma perspectiva metodológica para a abordagem das habilidades motoras aquáticas básicas.* Xistarca.
5. Blanksby, B. A., Parker, H. E., Bradley, S., & Ong, V. (1995). Children's readiness for learning front crawl swimming. *The Australian Journal of Science and Medicine in Sport*, 27(2), 34-37.
6. Bibeau, W. S., Moore, J. B., Mitchell, N. G., Vargas-Tonsing, T., & Bartholomew, J. B. (2010). Effects of acute resistance training of different intensities and rest periods on anxiety and affect. *The Journal of Strength & Conditioning Research*, 24 (8), 2184-2191.
7. Brandão, S. (2010). Currículo Oculto e Concepções dos Professores de Actividades de Enriquecimento Curricular – Actividade Física e Desportiva. Tese de mestrado não publicada apresentada à Faculdade de Desporto, Universidade do Porto.
8. Brenner, R.A., Taneja, G.S., Haynie, D.L., Trumble, A.C., Qian, C., Klinger, R.M., & Klebanoff, M.A. (2009). Association between swimming lessons and drowning in childhood: a case-control study. *Archives of Pediatrics & Adolescent Medicine*, 163(3), 203-10. doi: 10.1001/archpediatrics.2008.563
9. Campaniço, J. (1989). *A escola de natação – 1ª fase aprendizagem*. Edição Ministério da Educação – Desporto e Sociedade. Lisboa.
10. Campaniço, J. (1991): *Metodologia específica.* Curso de aperfeiçoamento de natação. Porto.
11. Carvalho, C. (1994). Natação. Contributo para o sucesso do ensino-aprendizagem. Edição do autor.
12. Catteau, R., & Garoff, G. (1990). *O ensino da natação (3ª Edição).* São Paulo, Brasil: Editora Manole.

13. Crespo, I. & Sanchez, I. (1998). Didáctica da natação utilitária e educativa. Conferência apresentada no XXI Congresso Técnico-Científico da Associação Portuguesa de Técnicos de Natação. Porto.

14. Courage, M. L., Reynolds, G. D., & Richards, J. E. (2006). Infants' attention to patterned stimuli: Developmental change from 3 to 12 months of age. *Child development*, 77 (3), 680-695. doi:10.1111/j.1467-8624.2006.00897.x

15. Costa, A. M., Marinho, D. A., Rocha, H., Silva, A. J., Barbosa, T. M., Ferreira, S. S., & Martins, M. (2012). Deep and Shallow Water Effects on Developing Preschoolers' Aquatic Skills. *Journal of Human Kinetics, 32*(-1), 211-219. doi: 10.2478/v10078-012-0037-1

16. Despacho n.º 8683/2011. D.R. n.º 122, Série II de 2011-06-28, do Ministério da Educação. Lisboa.

17. Directiva CNQ n.º 23/93 de 24 de Maio. *Conselho Nacional da Qualidade*. A qualidade das piscinas de uso público. Lisboa.

18. Erbaugh, S. J. (1978). Assessment of swimming performance of preschool children. *Perceptual and Motor Skill*, 47, 1179-82.

19. Erbaugh, S. J. (1986). Effects of aquatic training on swimming skill development of preschool children. *Perceptual and Motor Skills*, 62, 439-446. doi: 10.2466/pms.1986.62.2.439

20. Gallahue, D. L. & Ozmun, J.C. (2005). Compreendendo o Desenvolvimento Motor: bebês, crianças, adolescentes e adultos (3ª edição). São Paulo: Phorte.

21. Gorter, J. W., & Currie, S. J. (2011). Aquatic exercise programs for children and adolescents with Cerebral Palsy: what do we know and where do we go? *International Journal of Pediatrics*, 7, vol. 2011. doi: 10.1155/712165

22. Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H.G., & Dordel, S. (2003).Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-project). *International Journal of Obesity, (*28), 22 – 26. doi:10.1038/sj.ijo.0802428

23. Huotari, P., Nupponen, H., Mikkelsson, L., Laakso, L., & Kujala, U. (2011). Adolescent physical fitness and activity as predictors of adulthood activity. *Journal of Sports Sciences*, 29 (11), 1135-1141. doi:10.1080/02640414.2011.585166

24. Langendorfer, S. J., & Bruya, L. (1995). *Aquatic readiness. Developing water competence in young children*. Champaign, Illinois: Human Kinetics.

25. Langendorfer, S. (2010) Applying a developmental perspective to aquatics and swimming. In P. L. Kjendlie, R. K. Stallman, J., Cabri (Eds). *Biomechanics and Medicine in Swimming* XI (20-22). Oslo: Norwegian School of Sport Sciences.

26. Le Boulch, Jean (1987). *Educação psicomotora:* Psicocinética *na idade escolar*. Porto Alegre: Artes Médicas.

27. Maria, A., & Nunes, M. M., (2006). Actividade física e desportiva no 1º Ciclo do Ensino Básico. Orientações Programáticas. Associação Nacional de Municípios.

28. Marinho, D. A., Garrido, N., Barbosa, T. M., Canelas, R., Silva, A. J., Costa, A. M., Reis, V. M. & Marques, M.C. (2009). Monitoring swimming sprint performance during a training cycle. *Journal of Physical Education and Sport*, 25 (4), 33-38.

29. Moreno, J. e Sanmartín, M. (1998). Bases metodológicas para el aprendizagem de las actividades acuáticas educativas. INDE Publicaciones. Barcelona.

30. McManus, B. M., & Kotelchuck, M. (2007). The effect of aquatic therapy on functional mobility of infants and toddlers in early intervention. *Pediatric Physical Therapy*, *19* (4), 275-282.

31. Mota, J. (1990). *Aspectos metodológicos do ensino da natação.* Edição da Associação de Estudantes da Faculdade de Ciências do Desporto e de Educação Física da Universidade do Porto. Porto.

32. Navarro, F. (1995). *Hacias el dominio de la Natación.* Editorial Gymnos. Madrid.

33. Okely, A.D., Booth, M.L., & Patterson, J.W. (2001). Relationship of physical activity to fundamental movement skills among adolescents. *Journal of science and medicine in sport,* 33 (11), 1899 – 1904.

34. Pate, R.R., Dowda, M., & Ross, J.G. (1990). Association between physical activity and physical fitness in American children. *American Journal of Diseases of Children, 144,* 1123-1129.

35. Peden, M.M., & Mcgee, K. (2003). The epidemiology of drowning worldwide. *Injury Control Safety Promotion,* 10(4), 195-9.

36. Physical Activity Guidelines Advisory Committee (2008). Physical activity guidelines advisory committee report, 2008. *Washington, DC: US Department of Health and Human Services*.

37. Piaget, Jean (1975). A formação do símbolo na criança: imitação, jogo e sonho, imagem e representação. Rio de Janeiro: Zahar/INL.

38. Kemp, J. G., & Roberts, R. G. (2005). Effects of physical conditioning on children and adolescents with asthma. *Sports Medicine*, *35* (2), 127-141.

39. Raposo, A. V., Silva, T., Fernandes, A. (1982). Aspectos conceptuais da metodologia do treino de base. In: Sarmento, P., Carvalho, C., Florindo, I. & Raposo, A. V. (Eds). *Aprendizagem Motora e Natação*. Lisboa: ISEF, 67-90.

40. Rasch, G. (1960). Studies in mathematical psychology: I. Probabilistic models for some intelligence and attainment tests.

41. Sallis, J.F., Prochaska, J., Taylor, & Wendell, C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, 32 (5), 963-997.

42. Sallis, J.F., Story, M. & Lou, D. (2010). Study designs and analytic strategies for environmental and policy research on obesity, physical activity, and diet: recommendations from a meeting of experts. doi: 10.1016/j.amepre.2008.10.006

43. Sarmento, P., Carvalho, C., Florindo, I. & Raposo, V. (1982). *Aprendizagem motora e natação*. Lisboa: Edições Isef.

44. Santos, A. C., Gonçalves, J., & Pereira, R. G. (2008). Estudo comparativo da organização das escolas de natação-três casos versus três parâmetros do processo ensino-aprendizagem. *Motricidade*, *4* (3), 87-93.

45. Soares, S. M. (2000). Natação. In: Paula Botelho Gomes (Ed). Educação Física no 1º Ciclo. Porto: *Pelouro do Fomento Desportivo da Câmara Municipal do Porto e Faculdade de Ciências do Desporto e de Educação Física*, 154-173. Porto: UP.

46. Thorp, A. A. , Healy, G.N., Owen, N., Salmon, J., Ball, K., Shaw J.E., Zimmet, P.Z., & Dunstan, D.W. (2009). Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers Australian Diabetes, Obesity and Lifestyle (AusDiab) study 2004-2005. *Diabetes Care*, 33(2), 327-34. doi: 10.2337/dc09-0493

47. Vygotsky, L. (1978). *Mind and Society: The Development of Higher Mental Processes*. Londres: Englewood. doi:10.1080/14767050400028782

48. Wicher, I.B., Ribeiro, M.A., Marmo, D.B., Santos, C.I., Toro, A.A., Mendes, R.T., Cielo, F.M., & Ribeiro, J.D. (2010). Effects of swimming on spirometric parameters and bronchial hyperresponsiveness in children and adolescents with moderate persistent atopic asthma, *Jornal de Pediatria*, 86(5), 384-390. doi:10.2223/JPED.2022

49. Wilkinson, D., & Birmingham, P. (2003). *Using research instruments: A guide for researchers*. Psychology Press.

50. Wrotniak, B.H., Epstein L.H., Dorn J.M., Jones, K.E., & Kondilis, V.A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics*, 118 (6),1758 – 1765. doi: 10.1542/peds.2006-0742

51. Zhao, S., Xie, L., Hu, H., Xia, J., Zhang, W.,Ye, N. & Chen, B. (2005). A study of neonatal swimming (water therapy) applied in clinical obstetrics. *Journal of Maternal-Fetal and Neonatal Medicine, 17*(1), 59 - 62. doi:10.1080/14767050400028782

Chapter III: The acquisition of aquatic skills in preschool children

3.1 Content

This chapter presents the analysis of the aquatic skills acquired during two equivalent programs, one conducted in shallow water and the other in deep water.

3.2 Summary

This study aimed to analyze changes of basic aquatic skills after six months of swimming practice. Twenty-one Portuguese school-aged children of both genders (4.70 ± 0.51 yr), inexperienced in aquatic programs, and participated in this study. The children were divided into two groups performing a similar aquatic program but on a different water depth: shallow water (n=10) and deep water (n=11). Each participant was evaluated twice for their aquatic readiness using an observation check list of 17 aquatic motor skills: during the first session (T0) and after six months of practice (two sessions per week - 48 sessions) (T1). The aquatic proficiency on each skill was compared between the groups and a stepwise discriminant analysis was conducted to predict the conditions with higher or lower aquatic competence. Results suggested that swimming practice contributed positively to improvements on several basic aquatic skills, in both groups. Though, the results showed that shallow water group managed to acquire a higher degree of aquatic competence particularly in five basic aquatic skills ($p<0.05$): breath control - face immersion and eye opening; horizontal buoyancy; body position at ventral gliding; body position at dorsal gliding; leg kick with breath control at ventral body position, without any flutter device. The discriminant function revealed a significant association between both groups and four included factors (aquatic skills) ($p<0.001$), accounting for $(0.938)^2=88\%$ between group variability. The body position at ventral gliding was the main relevant predictor ($r=0.535$). In conclusion, our results suggested that shallow water swimming lessons seemed to allow greater aquatic competence in preschool children after a period of six months of practice.

Keywords: swimming, children, aquatic skills, shallow water, deep water

3.3 Introduction

Swimming is not considered a static personal ability (Langendorfer, 2014); instead, it implies an acquisition process, through practice and experience, which is built on a previous state of

autonomy, confidence and satisfaction in the aquatic environment. Hence, aquatic competence is considered a bio-behavioral assumption of learning more complex and specialized aquatic skills, which also includes swimming strokes (Parker & Blanksby, 1997; Warda, 2003).

This conceptual understanding of aquatic competence is perhaps the most important in recent decades with regard to swimming learning (Barbosa & Queirós, 2004; Barbosa et al., 2010; Barbosa et al., 2013; Langerdorfer & Bruya, 1995; Moreno et al., 1998). It provided a coherent pedagogical foundation to reshape the "thinking processes of teachers" and therefore on what is tough and how is tough (Clark & Peterson, 1986). However, there are still several pedagogical issues unanswered mainly related with the process of swimming teaching and its results.

The uniqueness of the practice environment makes swimming a challenge for initiation of a constructive approach to teaching (Light & Wallian, 2008). Although constructivism is not a prescription for teaching (Fosnot, 1996), it is necessary to consider the teacher's role to provide optimal opportunities for learning. Therefore, proper environment conditions in a swimming pool can be particular crucial to learning with effectiveness (Carvalho, 1994). One determinant factor seems to be the variation of the water depth (Costa et al., 2012). Indeed, aquatic readiness programs for young children can be performed in shallow water (usually from 0.65 to 1.00 meter deep), usually in the beginning of the process, or in deep water (usually from 1.00 meter to 2.00 meters deep), in the later stages. By decision of the swimming instructor or mere lack of structural alternatively, there are aquatic programs for children (for utilitarian or formal educational purposes) almost exclusively conducted in deep water. One of the few studies on this subject compared the deep and shallow water effect on developing preschooler's aquatic skills, after six, twelve and eighteen months of practice (Costa et al., 2012). Results suggested that water depth might affect the purchase of some basic aquatic skills, at least up to six months of practice. However, that was a cross-sectional study, observational, which does not provide definitive information on the cause-effect of the conditions compared.

Therefore, the purpose of our study was to analyze the differences on developing preschooler's aquatic skills between deep and shallow water aquatic programs after six months of practice. It is known that the shallow water program (while applying a controlled methodological approach) may induce an acquisition of basic aquatic skills at a higher level of proficiency.

3.4 Methods

3.4.1 Study sample

The study sample consisted on 21 Portuguese elementary school-aged children of both genders (4.70 ± 0.51 yr) with no previous experience in aquatic programs. The children were divided into two distinct classes with a similar aquatic program but performed on a different water depth environment: ten and 11 children performed all the swimming lessons in shallow water and deep water, respectively.

The local swimming school board and the Ethics Committee of the Health Sciences Faculty of the University of Beira Interior approved the experimental procedures, ensuring compliance with the declaration of Helsinki. The children's parents were informed about the study design and procedures and a written informed consent was signed. Data confidentiality was guaranteed, as well as their anonymity during the treatment process and analysis.

3.4.2 Aquatic readiness assessment

All children were evaluated twice for their aquatic readiness using an observation checklist of 17 aquatic motor skills based on Langerdorfer and Bruya (1995) and already applied by Costa et al. (2012): during the first session (T0) and after six months of practice (two sessions per week: 48 sessions; T1). The aquatic motor skills assessed were the following: water entry (Sk1); water orientation and adjustment at vertical position (Sk2); breath control - immersion of the face and eye opening (Sk3) ; horizontal buoyancy (Sk4); body position at ventral gliding (Sk5); body position at dorsal gliding (Sk6); body position at longitudinal rotation in gliding (Sk7); body position at front and back somersaults (Sk8); leg kick with breath control at ventral body position, with flutter boards (Sk9); and without any flutter device, (Sk10); leg kick with breath control at dorsal body position with flutter boards (Sk11); and without any flutter device (Sk12); feet-first entry (Sk13); head-first entry (Sk14); Autonomous in deep pool (legs and arms displacement) (Sk15); vertical buoyancy at deep water (Sk16); deep water immersion (Sk17). Each one of these skills was divided into increasing levels of complexity (three, four or five levels, depending on the categorical skill) as suggested by Langendorfer and Bruya (1995): enable to perform at stage one, rudimentary movements at stage two (or three) and fundamental movements at stage three (or even four or five) that precede the specific motor skill acquisition. The children had three attempts to achieve the proposed exercises, as conducted by Costa et al. (2012).

3.4.3 Swimming practice

At the beginning of the study all children were in a state of total inaptness to the aquatic environment. The swimming sessions took place at the same time of the day, twice a week, with 45 min duration (between 6h45 and 7h30 pm). The shallow water sessions were carried out in a 0.70 cm water depth, with the water temperature at 31 ºC, the air temperature at 29 ºC and a relative humidity of 65%. The deep water sessions occurred in a 1.30 meter water depth, with a water temperature of temperature 29ºC, air temperature of 29°C and a relative humidity was 65%.

Both aquatic programs aimed to improve children’s aquatic readiness by teaching basic aquatic skills. The number of students in each class was reduced to increase the useful time of the lesson and minimize practice waiting time among students. The swimming teacher was the

same in both groups. Therefore, the teaching methods and the skills developed in each class were similar and based on the literature guidelines (e.g., Langendorfer and Bruya, 1995 and Canossa et al. 2007).

Table 11 shows how the aquatic skills were sequenced over the six months of teaching.

Table 11

Aquatic program characteristics conducted in both water deep environment.

Month	1				2				3				4				5				6			
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Sk1	↑	↑	↑	↑	↗	↗	↗	↗	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Sk2	↑	↑	↑	↑	↗	↗	↗	↗	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Sk3	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Sk4	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↔	↔	↔	↔	↔	↔	↔	↔
Sk5	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sk6	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Sk7	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↗	↗	↗
Sk8	▫	▫	▫	▫	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗
Sk9	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗
Sk10	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↔	↔	↔	↔
Sk11	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗
Sk12	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↔	↔	↔	↔
Sk13	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↗	↗	↗	↔	↔	↔	↔	↔	↔	↔
Sk14	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↗	↔	↔	↔	↔
Sk15*	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↗	↔	↔	↔	↔
Sk16*	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗	↔	↔	↔	↔	↔	↔	↔	↔
Sk17*	▫	▫	▫	▫	▫	▫	▫	▫	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↗	↗	↗	↗

Legend: ▫, Aquatic skill not developed; ↑, Aquatic skill highly developed; ↗, Aquatic skill moderately developed; ↔, Aquatic skill not directly development but consider pre-requisite.

Water entry (Sk1); water orientation and adjustment at vertical position (Sk2); breath control - immersion of the face and eye opening (Sk3) ; horizontal buoyancy (Sk4); body position at ventral gliding (Sk5); body position at dorsal gliding (Sk6); body position at longitudinal rotation in gliding (Sk7); body position at front and back somersaults (Sk8); leg kick with breath control at ventral body position, with flutter boards (Sk9); and without any flutter device, (Sk10); leg kick with breath control at dorsal body position with flutter boards (Sk11); and without any flutter device (Sk12); feet-first entry (Sk13); head-first entry (Sk14); Autonomous in deep pool (legs and arms displacement) (Sk15); vertical buoyancy at deep water (Sk16); deep water immersion (Sk17).

Teaching style shifted from absolute control (command and task style) to more indirect teaching style, best known as guided discovery (Mosston and Ashworth, 1990). Indeed, the students mostly performed analytical tasks to development basic aquatics skills in both aquatic environments. However, ludic tasks were also included, leading the child to discover a predetermined "aquatic motor target" in response to a sequence of problems presented by the teacher. Sometimes it was necessary to adjust certain aquatic tasks due to physical embarrassment imposed by depth. As such, we had to make minor changes to the task organization (i.e., smaller groups and slight changes to certain rules of play) and use some

floating didactic material. The following didactic and floating material was used: didactic - puzzles, towers, slides, mattresses, overflow arches, rings; floating - arches, balls, small boards and noodles.

3.4.4 Statistical analysis

Standard statistical methods were used for the calculation of means and standard deviations. The t test was used to compare the differences in aquatic proficiency (on each skill) between groups. The effect size was calculated using Cohen's d (Cohen, 1988). A stepwise discriminant analysis was also conducted with Λ wilk's method to build a predictive model for group membership (aquatic competence for shallow and deep water students). Predictor variables were the 17 aquatic motor skills previously described. Box's M variance-covariance matrices were used to test the multivariate homogeneity. The level of statistical significance was set at $p \leq 0.05$.

3.5 Results

Table 12 presents the aquatic skills acquired by shallow water and deep water students during six months of practice.

At the beginning of this study (T0), no differences were found in aquatic readiness between shallow and deep water. The students were not adapted to the aquatic environment and their aquatic motor proficiency was zero in all aquatic skills. After six months of practice there were differences between the means of both groups in five aquatic skills: Sk3, Sk4, Sk5 Sk6 and Sk10.

The stepwise discriminant analysis was used to determine which aquatic skills discriminate between both groups after six months of practice. The step-by-step model of discrimination was built with four steps, including the following aquatic skills: Sk5 ($F=40.151$, $p<0.001$); Sk16 ($F=34.254$, $p<0.001$); Sk15 ($F=29.237$, $p<0.001$) and Sk13 ($F=29.489$, $p<0.001$). The canonical discriminant function analysis revealed a significant association between both groups and all included factors, accounting for (0.938)^2=88% between group variability ($\Lambda=0.119$, Qui^2=36.124, $p<0.001$).

Table 12

Aquatic skills acquired (mean ± SD) by shallow-water and deep-water students after 6 months of practice

Skill	Levels of complexity	T0 (baseline)				T1 (six months pratice)			
		Shallow Water (n=11)	Deep Water (n=10)	P-value	Cohen's d	Shallow Water (n=11)	Deep Water (n=10)	P-value	Cohen's d
Sk1	**1 to 3**	1.091±.302	1.100±.316	.947	.029	3.000±0.000	2.900±.316	.306	.448
Sk2	**1 to 3**	1.273±.467	1.000±.000	.081	.827	3.000±0.000	0.000±.000	-	-
Sk3	**1 to 5**	1.000±.000	1.000±000	-	-	4.189±.879	3.100±.137	.042*	1.73
Sk4	**1 to 4**	1.000±.000	1.000±.000	-	-	2.636±.120	1.500±.850	.018*	1.87
Sk5	**1 to 4**	1.000±.000	1.000±.000	-	-	2.727±.647	1.200±.422	.000*	2.79
Sk6	**1 to 4**	1.000±.000	1.000±.000	-	-	2.090±.831	1.100±.316	.002*	1.57
Sk7	**1 to 3**	1.000±.000	1.000±.000	-	-	1.455±.522	1.300±.483	.491	.308
Sk8	**1 to 4**	1.000±.000	1.000±.000	-	-	1.000±.000	1.000±.000	-	-
Sk9	**1 to 4**	1.000±.000	1.000±.000	-	-	2.455±522	2.100±.316	.079	.823
Sk10	**1 to 4**	1.000±.000	1.000+.000	-	-	2.000±.632	1.400±.516	.029*	1.04
Sk11	**1 to 4**	1.000±.000	1.000±.000	-	-	2.091±.701	1.700±.675	.209	.568
Sk12	**1 to 4**	1.000±.000	1.000±.000	-	-	1.818±.874	1.200±.422	.057	.900
Sk13	**1 to 3**	1.000±.000	1.000±.000	-	-	2.364±.505	1.800±.789	.064	.851
Sk14	**1 to 3**	1.000±.000	1.000±.000	-	-	1.727±.467	1.300±.675	.105	.736
Sk15	**1 to 3**	1.000±.000	1.000±.000	-	-	1.364±.505	1.500±.527	.552	.264
Sk16	**1 to 5**	1.000±.000	1.000±.000	-	-	1.364±.505	1.700±.483	.136	.680
Sk17	**1 to 4**	1.000±.000	1.000±.000	-	-	1.182±.405	1.300±.483	.549	.265

Table 13 shows the pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions.

The variables are ordered by absolute size of correlation within function; Sk5 is the main predictor with a relevant absolute size of correlation within function (r=0.535). The functions at groups' centroids shows that shallow-water students have a mean of 2.46 (±1.064) while deep-water students produce a mean of -2.71 (±0.924); 100% of students were correctly classified.

Table 13

Structure matrix for shallow-water and deep-water students after 6 months of practice

Skill	Function
S5	.535
S9[a]	.296
S6[a]	.284
S3[a]	.261
S12[a]	.227
S10[a]	-.199
S13	.166
S1[a]	-.159
S7[a]	.158
S14	.144
S16	-.132
S15[a]	.124
S4[a]	.048
S17[a]	-.032
S11[a]	-.029

Legend: a – Variable not included in the step-by-step model

3.6 Discussion

The current study aimed to analyze the development of basic aquatic skills and to compare the effect of swimming practices in two distinct swimming pool environments (deep and shallow swimming pools). Results showed positive effects of swimming practice in children's aquatic competence from both sessions' types. However, shallow water students managed to acquire greater aquatic competence in nearly all aquatic skills measured after six months of practice.

The swimming programs were more than just the simple acquisition of new motor patterns that allow moving inside the aquatic environment (Langendorfer & Bruya, 1995; Martins et al., 2010). These are based on the need to adjust the motor behavior of the child in the water, helping to understand the particularities of the aquatic environment, specifically the lower gravity and viscosity (Barbosa & Queirós, 2004; Holmér, 1974). Therefore, the enjoyment for swimming practice is associated with the notion of trust about their own security in the new environment (Brenner, Saluja & Smith, 2003; Velasco, 1994).

In the initial phase, the confidence of the child in the aquatic environment could be easily affected when, for instance, the water depth of exercitation is changed. This constrain caused by the depth of the pool could influence their autonomy. The current study didn't have the purpose to study the variability of the pedagogic intervention or of the student´s motor behavior in both pool environments (see Costa et al., 2012). Nevertheless, it is our perception that the water depth seems to be an inhibitory factor to discover the aquatic environment and it´s particularities. Thus, the water depth could condition the students' creativity in the resolution of major motor problems caused by the aquatic environment, at least in the early stages of familiarization. Although our effort to provide identical pedagogic experiences in both environments, for safety reasons it is understandable that teaching in deep water could be less

student-centered. There is a need to adapt the swimming tasks due to the mandatory use of float materials and the lack of confidence of the student. Therefore, the teaching methods in this condition tended to be more traditional (Mosston, 1992). This occurs at least in the initial phase of development, in which the students' actions are always derived from the teacher decisions (Quina, 2009). Considering a complete understanding of the concept of aquatic competence, it is not imperative that there is only one response to similar situations (Moreno & Guitiérrez 1998; Moreno & Murcia, 1998). Thus, we believe that different water depths during swimming lessons inevitably provide different psychomotor experiences. Our results, as we discuss below, seem to support such reasoning.

As reported in table 12, those children who attended to shallow water lessons presented greater level of aquatic competence in several skills, namely: breath control - immersion of the face and eye opening (Sk3), horizontal buoyancy (Sk4), body position at ventral gliding (Sk5), body position at dorsal gliding (SK6), and leg kick with breath control at ventral body position, without any flutter device (Sk10). These results are consistent with the data reported by Costa et al. (2012); although these authors reported differences between both session types after six months of practices also in the following skills: water entry (Sk1); body position at longitudinal rotation in gliding (Sk7); body position at front and back somersaults (Sk8); leg kick with breath control at ventral body position, with flutter boards (Sk9); leg kick with breath control at dorsal body position with flutter boards (Sk11); and without any flutter device (Sk12); feet-first entry (Sk13); head-first entry (Sk14); vertical buoyancy at deep water (Sk16); deep water immersion (Sk17). These substantial differences in the acquired aquatic competence as reported by Costa et al. (2012) can derive from the variability of the teaching intervention, given that teachers were not the same in both sessions' types.

The discriminant analysis showed that the Sk5 was the main predictor with significant correlation within function, consistent with the data reported by Costa et al. (2012). This could be related with the lower opportunity to develop the glide in ventral/dorsal position and in different depths in the early learning stages in deep water condition. Probably, the use of floating devices caused some changes in the horizontal position and an unreal sense of buoyancy (Blanksby et al., 1995, Langerdorfer, 1987).

Our results showed that six months of practices in both conditions allowed students to develop the aquatic readiness of the majority of the aquatic basic skills, with exception *to body position at front and back somersaults (SK8)*, which is in accordance with the results presented by Costa et al. (2012). Moreover, the *body position at longitudinal rotation in gliding (Sk7)* was nearly learned in both conditions probably because it is an aquatic motor skill conditioned by the previous acquisition of other basic skills, as the water entry, glide, respiration and static vertical balance in deep water (Barbosa & Queirós, 2004). It would be also important to refer that six months of practice in both swimming pool environments were not sufficient to achieve mastery on all aquatic skills. Similar data have been reported by Costa et al. (2012) after six and 12 months of aquatic practice.

Despite the importance of the results presented to the scientific and technical community, some limitations should be addressed to the current study. Firstly, it was only possible to access the aquatic competence of the students after six months of practice, ensuring the inclusion criterion of keeping the same teacher. Also, the limitation with regard to the size of the sample observed, conditioning the conclusions and the extrapolation of the results to other subjects. The effect size was used to better control and analyze the differences obtained. Thirdly, no data about the activity time devoted to swimming practice in both session types. Although the number of students has been reduced to enable high activity time in both sessions, we recognize that differences regarding this variable may exist. Future studies should assess the variation of activity time regarding to different learning contexts, number of students and teaching styles. Future studies should also seek to analyze the effectiveness of concurrent water depth environments programs (shallow and deep water) and the question of timing and dosing of swimming practice.

3.7 Conclusions

In conclusion, the present study suggests that a shallow water environment is more suitable for the development of basic aquatic skills in preschool children. The stepwise discriminant analysis revealed a significant association between both session types and four included aquatic skills for six months of practice; the body position at ventral gliding seems to be the main significant predictor. This could mean that aquatic skills at the children beginner's level should be learnt in a shallow water swimming pool and deep water programs should be carefully planned to stimulate certain skills (i.e. body gliding) that seems to be differently exercised in both pool environments.

3.8 References

1. Barbosa, T. (2001). As habilidades motoras aquáticas básicas. *Lecturas: Educación Física y Deportes*. (33). http://www.efdeportes.com
2. Barbosa, T. M., & Queirós, T. M. G. (2004). Ensino da natação: uma perspectiva metodológica para a abordagem das habilidades motoras aquáticas básicas.
3. Barbosa, T., & Queirós, T. (2003). A problemática da respiração no ensino da natação. *Lecturas: Educación física y deportes*, (58), 25. http://www.efdeportes.com
4. Barbosa, T., Costa, M. J., Marinho, D. A., Silva, A. J., Martins, M., & Queirós, T. M. G. (2013). Jogos aquáticos nas sessões de actividades aquáticas na primeira infância.
5. Barbosa, T.M.; Costa, M.J.; Marinho, D.A.; Silva, A.J & Queirós, T.M. (2010). Tarefas alternativas para o ensino e aperfeiçoamento das técnicas alternadas de nado. *Educación Física y Deportes,(15),143*. http://www.efdeportes.com
6. Blanksby, B. A., Parker, H. E., Bradley, S., & Ong, V. (1995). Children's readiness for learning front crawl swimming. *The Australian Journal of Science and Medicine in Sport*, 27(2), 34-37.
7. Brenner, R. A., Saluja, G., & Smith, G. S. (2003). Swimming lessons, swimming ability, and the risk of drowning. Injury Control and Safety Promotion,10 (4), 211-215.
8. Canossa, S., Fernandes, R. J., Carmo, C., Andrade, A., & Soares, S. M. (2007). Ensino multidisciplinar em natação: reflexão metodológica e proposta de lista de verificação. *Motricidade*, *3* (4), 82-99.
9. Carvalho, C. (1994). Natação. Contributo para o sucesso do ensino-aprendizagem. Edição do autor.
10. Catteau, R. e Garoff, G. (1988). *O ensino da Natação.* Editora Manole. São Paulo.
11. Clark, C. & Peterson. P. (1986). *Teacher´s thought processes*. In M. Wittrock (Ed.), of Research on Teaching (3rd ed., pp. 255-296). New York: Macmillan Publishing Company.
12. Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd Edition). Hillsdale, NJ: Lawrence Earlbaum Associates.
13. Costa, A. M., Marinho, D. A., Rocha, H., Silva, A. J., Barbosa, T. M., Ferreira, S. S., & Martins M. (2012). Deep and Shallow Water Effects on Developing Preschoolers' Aquatic Skills. *Journal of Human Kinetics*, 32, 211-219.doi: 10.2478/v10078-012-0037-1.
14. Fosnot, C. T., & Perry, R. S. (1996). Constructivism: A psychological theory of learning. *Constructivism: Theory, perspectives, and practice*, 8-33.
15. Holmér, I. (1974). Physiology of swimming man. *Acta Phys. Scand.* (407). Supl.

16. Langendorfer, S. (2014). Swimming Learning Standards: An International Perspective. In Proceedings of the XXXIV Congreso Internacional de la Asociación Española de Técnicos de Natación - Swimming Science Seminar II, Granada, Spain, 10-12 October 2014.

17. Langerdorfer, S., & Bruya, L. (1995). *Aquatic Readniss: Developing Water Competence in Young Children*. Champaign, IL: Human Kinetics.

18. Light, R., & Wallian, N. (2008). A Constructivist-Informed Approach to Teaching Swimming. *Quest*, *60*(3), 387–404. http://doi.org/10.1080/00336297.2008.10483588

19. Light R., Wallian, N. (2012). A constructivist-informed approach to teaching swimming. Quest, 60(3), 307-404.

20. Martins, M., Silva, A.J., Marinho, D.A., Pereira, A., Moreira, A.M., Sarmento, P., & Barbosa, T.M. (2010). Assessment of heart rate during infants swim session. International Sports Med Journal, 11, 336-344.

21. Moreno, J. & Sanmartín, M. (1998). Bases metodológicas para el aprendizaje de las actividades acuáticas educativas. INDE Publicaciones. Barcelona.

22. Moreno, J. (2001). *Juegos acuáticos educativos*. Barcelona: Inde.

23. Moreno, J. A. y Gutiérrez, M. (1998 b). *Actividades acuáticas educativas*. Barcelona: Inde.

24. Moreno, J. A., Murcia, J. A. M., & Sanmartín, M. G. (1998). Bases metodológicas para el aprendizaje de las actividades acuáticas educativas(Vol. 801). Inde.

25. Moreno, J. A., Murcia, J. A. M., & Sanmartín, M. G. (1998). Bases metodológicas para el aprendizaje de las actividades acuáticas educativas (Vol. 801). Inde.

26. Mosston, M. (1992). Tug-O-War, no more: Meeting teaching-learning objectives using the spectrum of teaching styles. *Journal of Physical Education, Recreation & Dance,* 63 (1), 27-56.

27. Mosston, M., & Ashworth, S. (1990). *The Spectrum of Teaching Styles. From Command to Discovery*. Longman, Inc., 95 Church St., White Plains, NY 10601-1505.

28. Mota, J. (1990). *Aspectos metodológicos do ensino da Natação*. Edição da Associação de Estudantes da Faculdade de Ciências do Desporto e de Educação Física da Universidade do Porto. Porto.

29. Navarro, F. (1995). *Hacias el dominio de la Natación*. Editorial Gymnos: Madrid.

30. Parker, H. E., & Blanksby, B. A. (1997). Starting age and aquatic skill learning in young children: mastery of prerequisite water confidence and basic aquatic locomotion skills. Australian journal of science and medicine in sport, 29(3), 83-87.

31. Quina, J. (2009). A organização do processo de ensino em Educação Física. Bragança: Instituto Politécnico de Bragança

32. Raposo, A. J. V. (1978). *O ensino da Natação*. Edições do Instituto Superior de Educação Física da Universidade Técnica de Lisboa. Lisboa.

33. Sarmento, P. (2001). *A experiência motora no meio aquático*. Algés: Omniserviços.

34. Sarmento, P., & Montenegro, M. (1992). Adaptación al medio acuático: Un proyecto educativo. *Lisboa: APTN (Associacao Portuguesa de Técnicos de Natacao)*.

35. Velasco, C. G. (1994). Natação segundo a psicomotricidade. Rio de Janeiro: Sprint Editora Ltda.

36. Warda, L. (2003). Swimming lessons for infants and toddlers. *Paediatrics & Child Health*, 8 (2), 113-114.

Chapter IV: Influence of a regular soccer or swimming practice on gross motor development in childhood

4.1 Content

This chapter presents the analysis of the short term, midterm and long term effects in the child's global motor development brought by the practice of swimming and football, during childhood.

4.2 Summary

The objective of this study is to analyze the changes on global motor development after five (T5), ten (T10) and 30 (T30) months of swimming and soccer practice. The study's sample consists of 33 preschool-aged boys: 11 children were soccer practitioners; 11 children were swimming practitioners; 11 children were controls. The Test of Gross Motor Development–Second Edition (TGMD-2) was used to assess common gross motor skills [locomotion (LC), object control skills (OC)]. Both groups improved significantly in their gross motor quotient and the standard scores for LC and OC between T5 and T10. At T10, all soccer practitioners have already reached the maximum descriptive rating for the gross motor quotient (GMQ). Between T10 and T30, swimming practitioners were able to improve the standard scores for OC. Main results showed a positive impact of swimming and soccer participation in motor proficiency.

Keywords: Swimming; soccer; motor development; childhood.

4.3 Introduction

Childhood is a key phase in the lifetime of a human being for the development of physical skills and fundamental psychomotor acquisition, which will allow, further on, the acquisition of a set of skills to influence the development of more complex motor skills (Gabbard, 2000).

The gross motor development is the qualitative and quantitative progress in the motor skills, during lifetime (Gallahue & Ozmun, 2005). The life experience of children and the stimulation they have received represent the baseline for the acquisition of more specific and critical motor skills for the different sport activities (Barnett & Okely, 2010; Clark & Metcalfe, 2002; Hands, Larkin, Parker, Straker & Perry, 2009; Lubans, Morgan, Cliff, Robinson & Goodway, 2009).

The phase between three and ten years old is considered to be the critical period in the path of gross motor development and, after that, there's a period of maturity to the acquired motor skills. Gallahue and Ozmun (2005) state that the inexistence of a rich and diverse experience of physical movements may compromise the learning of perceptive, motor and cognitive skills.

During childhood, several important development changes take place, being well established the positive influence of physical activity for a healthy growth (Boreham & Riddoch, 2001; Eisenmann, 2003; Malina, 2007; Steele, Brage, Corder, Wareham & Ekelund, 2008). Motor proficiency has been related with subsequent physical activity (Barnett et al., 2009; Kambas et al., 2012). However, physical activity leads to the development of fundamental motor skills (FMS) (Smith et al., 2014), including in children with coordinative difficulties (Kane & Staples, 2014). Therefore, the literature seems to assume the existence of a strong synergistic relationship between physical activity and motor development.

In this particular context, it should be also noted that the development towards specialized motor proficiency depends on relevant previous motor experiences in a safe age-appropriate, stimulating environment (Magill, 2000; Gallahue & Ozmun, 2005). Thus, low or inadequate motor stimulation would affect not only the child's motor development (Gallahue & Ozmun, 2005; Williams, et al., 2008), but also his cognitive, affective and social state (Sibley & Etnier, 2003; Busseri, Rose-Krasnor, Willoughby, & Chalmers, 2006). Likewise, it is assumed that poor gross motor development will inhibit children from regular physical activities (e.g., Stodden et al., 2008; Williams et al., 2008). In the long run, this may also determine a greater likelihood of becoming sedentary in adulthood (Huotari, Nupponen, Mikkelsson, Laakso, & Kujala, 2011). For that reason, we should consider the assumption that childhood isn't only a critical period for the acquisition of fundamental motor skills, but also to ensure lifelong participation in sport (Stodden et al., 2008; Barnett et al., 2009).

Lubans et al., (2010) have studied the relationship between motor competence and health, comparing 21 different studies where they identified the relationship between fundamental motor skills and self-esteem, the perception of motor competence, muscular and cardiorespiratory capacity, body mass index, flexibility, physical activity and sedentary behavior. In general, those studies revealed a positive connection between fundamental motor skills and physical exercise, in children and teenagers, as well as a positive connection between fundamental motor skills and cardiorespiratory capacity.

The period between five and ten years of age exhibits considerable improvement in general motor coordination, allowing the achievement of increasingly complex movements (Gallahue & Ozmun, 2005; Massa & Ré, 2010). During this period of fast neurological development and large neural plasticity, the child is able to understand the rules of sport and is able to participate in structured programs of sport initiation (Ré, 2011). Thus, active children often choose after-school sport activities, among them swimming and soccer are the most popular sports in several countries. These sports enhance not only motor skills but also physical abilities – but little is known about the effects on gross motor development.

Despite the fact that aquatic programs can differ (Jorgensen, 2012), the teaching methodology usually seeks to introduce children to basic aquatic skills (Gallahue & Ozmun, 2005). Games and several other fun activities are often used as an appropriate methodological resource to achieve aquatic readiness (Rocha, Marinho, Ferreira, & Costa, 2014). Studies about the effectiveness of aquatic interventions on gross motor development are scarce. However, water sports appear to provide important stimulation of body perception, inducing a positive effect on abilities associated with apprehension and balance (Sigmundsson & Hopkins, 2010). A recent study suggested that children with prior participation in swimming programs (within the educational context) demonstrate an optimized motor development, on several gross motor skill tests, but particularly on object control skills (Martins et al.,2015).

Regarding soccer, the pedagogical intervention values the development of individual skills (e.g., passing, dribbling, shooting and ball control), but also team effectiveness. Young players are encouraged to recognize the different game variables (e.g.: opponents, field and goalpost dimensions) and to assume a tactical collective behavior (Costa, Garganta, Greco, Mesquita & Maia, 2011). For that reason, contemporary soccer teaching models are supported in tactical principles (Holt, Strean, & Bengoechea, 2002). However, not enough is known about the effectiveness of the specific measures of soccer adopted in improving gross motor development. The literature has sought to determine the effects of community and school physical activities influence on children's gross motor development. There are hardly any studies on structured programs of sport initiation. Furthermore, study designs included randomized controlled trials (using experimental and quasi-experimental designs) and mostly single group pre-post trials during short time scales (< six months).

Gabbard (2000) indicates that the gross motor development is a process of permanent changes that occur in the motor behavior of an individual, since his conception to his death, as a result from the interaction between hereditary and environmental factors (Gabbard, 2000). The gross motor development is a continuous process in the long run, with bigger changes during the early years of life, in the childhood. Therefore, the practice of sport activity in a regular basis corresponds to a privileged occasion for the changes of the gross motor development, because it stimulates a higher development of fundamental motor skills, mainly locomotive and manipulative skills.

As we see, it seems important to obtain a longitudinal perspective about the impact of specific sport interventions on motor proficiency particularly because some children unfortunately never benefit from any kind of structured physical activity (physical education at school) until ten years old.

Thus, this paper aims to describe the longitudinal changes in the gross motor development after five, ten and thirty months of swimming or soccer practice. We expect that both sports interventions will play a catalytic role in gross motor development. However, we also anticipate differences in the level of acquisition and degree of mastery of some fundamental motor skills.

4.4 Method

4.4.1 Participants

This research used a convenience sample of young children that were available to participate in this study and who had a known history of swimming or soccer participation. The study sample consisted of 33 preschool-aged boys (4.8±0.5 yrs.), all residents on the metropolitan area of Lisbon (Portugal). At baseline, the following three groups were considered: 11 children (5.3±0.2 yrs.) with no previous involvement in sports or any kind of structured physical activity (control group); 11 children (4.6±0.4 yrs.) were involved in swimming classes at a beginner level, with five months of practice (swimming group); 11 children (4.8±0.5 yrs.) were involved in soccer classes at a beginner level, with five months of practice (soccer group). Children with different history or sport experience (five months at baseline), in these or other structured exercise of programs, weren't included in this study. Similarly, all physical or psychological diseases that may have precluded ability to perform the requested training exercises and testing were considered exclusion criteria.

The study included three different moments of assessment: baseline (T5), corresponding to five months of previous practice of swimming or soccer, respectively; after ten months of accumulated practice (T10) swimming or soccer, respectively; after thirty months of accumulated practice (T30) swimming or soccer, respectively. The longitudinal nature of this research did not allow an evaluation of the control group after the T10 moment; from this period onwards, most of the children included in this group started practicing sports. For obvious ethical reasons, researchers didn't inhibit children and/or guardians from being involved in sport. Similarly, we couldn't make any follow-up assessment beyond 30 months of practice.

All experimental procedures and protocols were compliant with the Declaration of Helsinki and were approved in advance by the Data Protection Authority in Portugal (Comissão Nacional de Protecção de Dados), by the managers of local swimming and football schools involved in this study and by the Ethics Committee of the Health Sciences Faculty of the University of Beira Interior. Data confidentiality was guaranteed as well as participant’s anonymity.

4.4.2 Gross motor development assessment

The “test of gross motor development 2” (TGMD-2) [Ulrich, 2000] was used to assess children’s competence of fundamental motor skills in three distinct moments: after five (T5), ten (T10) and thirty (T30) months of sports practice. The TGMD-2 is a norm-referenced measure with a good psychometric quality to assess gross motor skills that develop early in life (Ulrich, 2000). It has been used by several researchers in different countries, including for longitudinal follow up (Cliff, Okely, Smith, & McKeen, 2009; Cliff, Wilson, Okely, Mickle, & Steele, 2007; Westendorp et al., 2014). It assesses twelve fundamental motor skills typically taught in

physical education to children aged from three to ten years old (Wiart & Darrah, 2001). Skills are divided into two subtests: Locomotion (run, gallop, hop, leap, horizontal jump, skip, and slide) and Object Control (two-handed strike, stationary bounce, catch, kick and the overhand throw). Each skill defined by the TGMD-2 consists of components that together constitute mature performance of that skill.

After a standard warm-up, each skill was performed three times and measured with three to four observable criteria based upon typical movement patterns identified from motor development literature and suggested by Ulrich (2000). Each criterion was rated as zero (the criterion is observed on fewer than two of the three trials) or one (criterion is observable on at least two of the three trials). The highest total raw score for both subtests is 48. Subtest raw scores were then converted to standard scores (ranging between one and 20) for both subtests, considering the child's age at the time. Subtest standard scores (locomotion and objected control) are then summed and converted to calculate each child´s gross motor development quotient.

As proposed by the author (Ulrich, 2000), all participants repeated the TGMD-2 one week later (retest) in T5, T10 and in T30. All evaluations were conducted by two researchers familiar with the TGMD-2 battery, including the evaluation criteria for each fundamental motor skill. Even so, we performed several training sessions in our laboratory. One small pilot study was also conducted using a restricted sample of five children (4.9 ±0.5 years), not considered in the analysis. These five children were evaluated twice in a weekly timeframe. The intra-class correlation coefficients (as a measure of reliability) were very high for all measured skills (ranged from 0.80 to 1.00).

All assessments were recorded on video (Sony camera, HDR-CX115 model) that was used only for the purpose of this study. The two observers analyzed the images obtained and reviewed the individual performance for each motor skill, according to the proposed criteria. Then, it was given an opportunity to discuss each performance and the respective score.

Tests and retest were applied effectively in T5, T10 and T30, always under the same conditions (outdoor sport field), at the same time of day and with similar weather conditions (without rain, light breeze and on a mild air temperature). Participants wore shorts and t-shirts.

4.4.3 Swimming and soccer practice

Training sessions for swimming and soccer occurred at the same time, twice a week (between 6h00 and 6h45 pm). In both sports the intervention program was elementary, following mostly a mixed pedagogical concept using games to incite children to engage into learning activities but also some individual analytical motor tasks.

Swimming lessons were carried out in deep pool (plus than 1.30m) with a water temperature of 31.5ºC (the air temperature was 29°C±1 and the relative humidity was 65%). The aquatic

program aimed to improve children's aquatic readiness by teaching basic aquatic fundamental skills. At the beginning of the study all children were in a state of total inaptness to the aquatic environment with no ability to perform intended propelling actions. The pedagogical intervention was based on Langendorfer and Bruya (1995) and Canossa et al., (2007). The following aquatic motor skills were developed: water entry; water orientation and adjustment at vertical position; breath control - immersion of the face and eye opening; horizontal buoyancy; body position at ventral gliding; body position at dorsal gliding; body position at longitudinal rotation in gliding; body position at front and back somersaults; leg kick with breath control at ventral body position, with flutter boards and without any flutter device; leg kick with breath control at dorsal body position with flutter boards and without any flutter device; feet-first and head-first entry; autonomous in deep pool (legs and arms displacement); vertical buoyancy at deep water and deep-water immersion.

The soccer practice was conducted in the outdoor school sports field with synthetic grass. The sessions were planned following a coherent pedagogical approach with the latest models of soccer teaching (e.g., Bunkerm & Thorpe, 1982; Costa et al., 2011; Holt, Strean, & Bengoechea, 2002). Throughout the soccer study teaching program sought to develop three major capabilities: the ability to select appropriate solutions before different game problems (decision making); the ability to perform effectively (technical training to enhance dribbling, passing, shooting, finishing and also the weak foot for youth soccer players) and the ability to play as a team (communicate and cooperate). Hence, children's specific technical skills were developed (mastery of body movement with/without the ball) but also their tactical awareness.

Training sessions for swimming and soccer occurred at the same time, twice a week (between 6h00pm and 6h45pm). In both sports, the intervention program was elementary, following mostly a mixed pedagogical concept using games to incite children to engage into learning activities, but also some individual analytical motor tasks.

4.4.4 Analysis

Descriptive statistics were the mean and standard deviation. The Kolmogorov-Smirnov test was used to evaluate the normality of the distribution of the variables. The Mann-Whitney U test was used to compare differences between two independent groups. Kruskal-Walli's test was used for multiple group comparisons. The intra-group difference between assessment moments was tested with the Wilcoxon signed-rank-sum test. The analyses were adjusted using the Holm's sequential Bonferroni correction (Holm, 1979); according to this sequential multiple test procedure, the adjusted p-value for n paired comparisons is: $pBonferroni\ C = (C - i + 1) \times p$; where C correspond to number of comparisons and i rank of the pair in terms of degree of significance. The nonparametric effect size was obtained from the following equation (Rosenthal, 1994): $r = Z/\sqrt{N}$. The intra-class correlation coefficient (ICC) was used as a measure

of consistency of ratings over time. To establish statistical significance, a p≤.05 criterion was used. All data were analyzed using the software SPSS 22.0.

4.5 Results

Table 14 presents the subtests scores (raw and standard scores) and the gross motor quotient for all groups and assessment moments separately. Both experimental groups showed significant improvements between T5 and T10 in the gross motor quotient and in the standard scores of both subtests. The control group shows no significant improvement in this regard. Significant differences were found (p>0.05) between groups at T5, T10 and T30 for the object control standard score and also for the gross motor quotient. Inter-group differences were also found between swimmers and soccer practitioners for the locomotor standard score (at T10, p=0.009, r=0.79), for the object control standard score (T5, p=0.022, r=0.69; T10, p=0.000, r=1.11; T30, p=0.014, r=0.74) and for the gross motor quotient (T10, p=0.001, r=1.04; T30, p=0.022, r=0.69).

Table 14

Raw and standard scores (mean ± standard deviation) of the Locomotor and Object Control subtests and the respective TGMD-2 quotient for all groups and assessment moments.

		Locomotor subtest		Object Control Subtest		TGMD-2
		Raw score	Standard score	Raw score	Standard score	quotient
Controls	T5	32.00±6.02	9.45±2.16	31.81±6.79 [a]	10.00±2.41 [a]	98.36±11.33 [a]
	T10	35.36±8.33 [a]	10.45±3,39 [a]	32.18±5.33 [a]	9.27±1.85 [a]	99.18±12.59 [a]
	Pairwise comparisons	T5=T10 (p=0.091, r=.51; ICC=.710)	T5=T10 (p=.231, r=0.36; ICC=.579)	T5=T10 (p=.0538, r=.19; ICC=.324)	T5=T10 (p=.667, r=.13; ICC=.304)	T5=T1 (p=1,000, r=0; ICC=.554)
Swimming group	T5	29.91±12.87	10.73±4.38	26.09±9.97 [a,b]	9.91±3.27 [a,b]	101.91±19.82 [a]
	T10	40.00±8.67 [a,b]	14.09±4.25 [a,b]	36.18±6.21 [a,b]	12.18±2.14 [a,b]	118.82±15.48 [a,b]
	T30	46.36±1.96	14.73±1.68	46.18±2.08 [a,b]	13.55±1.57 [a,b]	124.81±7.83 [a,b]
	Pairwise comparisons	T5<T10 (p=.008, r=.86; ICC=.810) T10<T30 (p=.007, r=.81; ICC=.293) T5<T30 (p=.009, r=.89; ICC=.229)	T5<T10 (p=.021, r=.81; ICC=.827) T10=T30 (N.S., r=.09; ICC=.385) T5<T30 (p=.018, r=.79; ICC=.337)	T5<T10 (p=.004, r=.86; ICC=.700) T10<T30 (p=.009, r=.89; ICC=.557) T5<T30 (p=.009, r=.89; ICC=.293)	T5<T10 (p=.018, r=79; ICC=.737) T10<T30 (p=.014, r=.74; ICC=.765) T5<T30 (p=.021, r=.82; ICC=.586)	T5<T10 (p=.012, r=.83; ICC=.817) T10=T30 (N.S., r=.43; ICC=.480) T5<T30 (p=.015, r=.85; ICC=.393)
Soccer group	T5	34.09±7.27	12.45±2.98	36.55±4.08 [a,b]	13.36±1.63 [a,b]	117.45±11.60 [a]
	T10	46.73±3.13 [a,b]	18.45±2.21 [a,b]	45.82±1.40 [a,b]	16.45±1.29 [a,b]	144.73±6.36 [a,b]
	T30	8.00±.00	16.00±1.26	48.00±.000 [a,b]	15.18±0.98 [a,b]	133.55±6.67 [a,b]
	Pairwise comparisons	T5<T10 (p=.009, r=.89; ICC=.195) T10=T30 (N.S., r=.40, ¥) T5<T30 (p=.009, r=.89, ¥)	T5<T10 (p=.009, r=.89; ICC=.331) T10>T30 (p=.033, r=.64; ICC=.185) T5<T30 (p=.024, r=.76; ICC=.115)	T5<T10 (p=.009, r=.89; ICC=.312) T10<T30 (p=.006, r=.83, ¥) T5<T30 (p=.009, r=.89, ¥)	T5<T10 (p=.009, r=.90; ICC=.748) T10>T30 (p=.011, r=.77; ICC=.538) T5<T30 (p=.008, r=.86; ICC=.513)	T5<T10 (p=.009, r=.89; ICC=.533) T10>T30 (p=.008, r=.87; ICC=.575) T5<T30 (p=.008, r=.81; ICC=.335)

Note. All p-values were corrected according to the Holm-Bonferroni procedure. (a) = significant ($p<0.05$) differences in motor proficiency between groups; (b) = significant differences ($p<0.05$) in motor proficiency between swimmers and soccer players; (N.S.) = not significant; (¥) = ICC was not calculated because one of the component variable has zero variance and is removed from the scale.

Table 15, presents the distribution of descriptive ratings for the gross motor quotient by each group and assessment moment. Following what already mentioned, these data showed a distribution of participants that tends to higher levels of motor development among swimmers, but particularly in soccer practitioners. In fact, at T10 and T30, most participants (swimmers and soccer practitioners) were ranked above average levels.

Table 15

Distribution of descriptive ratings for the gross motor quotient

		Poor (70-79)	**Below Average** (80-89)	**Average** (90-110)	**Above average** (111-120)	**Superior** (121-130)	**Very superior** (>130)
Controls	T5	1 (9.1%)	1 (9.1%)	7 (63.6%)	2 (18.2%)	0 (0.0%)	0 (0.0%)
	T10	1 (9.1%)	2 (18.2%)	6 (54.5%)	2 (18.2%)	0 (0.0%)	0 (0.0%)
Swimming group	T5	2 (18.2%)	2 (18.2%)	4 (36.4%)	0 (0.0%)	3 (27.3%)	0 (0.0%)
	T10	0 (0.0%)	0 (0.0%)	5 (45.5%)	1 (9.1%)	3 (27.3%)	2 (18.2%)
	T30	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (36.4%)	5 (45.5%)	2 (18.2%)
Soccer group	T5	0 (0.0%)	0 (0.0%)	3 (27.3%)	2 (18.2%)	5 (45.5%)	1 (9.1%)
	T10	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (100.0%)
	T30	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (36.4%)	7 (63.6%)

Table 16 presents the results for each locomotor fundamental skill for all groups and evaluation moments separately. Between T5 and T10, one can note significant improvements ($p<0.05$) in running proficiency, in control participants. During this period, the soccer practitioners improved significantly their standard scores in hopping. In turn, the swimmers showed improvements ($p<0.05$) in running, galloping and hopping but not in leaping, horizontal jumping and sliding. Between T10 and T30, soccer players showed no significant improvements in these skills. Within a longer range (T5 versus T30), swimmers were able to improve their motor proficiency in running, galloping and hopping. As for the soccer players, locomotor skills improved significantly ($p<0.05$) between T5 and T30 only for hopping. At T5, the inter-group comparison showed no significant differences between groups in these skills. However, groups differ from each other in T10 ($p <0.05$) in almost all locomotor skills, being the group of soccer practitioners more proficient ($p <0.05$) than swimmers in hop ($p =0.47$, $r=0.68$). After 30 months of sport practice, no significant differences ($p >0.05$) were found between both experimental groups.

Table 16

Raw and standard scores (mean ± standard deviation) for the Locomotor subtest

		Run (0-8)	Gallop (0-8)	Hop (0-10)	Leap (0-6)	Horizontal Jump (0-8)	Slide (0-8)
Controls	T5	5.00±3.07	3.73±3.10	6.36±2.34	5.00±1.18	4.55±2.98	7.36±0.92
	T10	6.91±1.30[a]	4.18±2.89 [a]	6.45±4.03 [a]	4.36±1.75 [a]	6.36±1.75	7.09±1.38 [a]
	Pairwise comparisons	T5<T10 (p=.039, r=.62)	T5=T10 (p=.551, r=.18)	T5=T10 (p=.932, r=.03)	T5=T10 (p=.216, r=.37)	T5=T10 (p=.105, r=.49)	T5=T10 (p=.414, r=.25)
Swimming group	T5	5.73±1.79	4.18±3.16	4.27±4.15	5.18±1.60	4.91±3.05	5.64±2.54
	T10	7.82±.60 [a]	6.73±1.85 [a]	6.73±3.50 [a,b]	5.45±1.81 [a]	6.82±2.04	6.45±2.16 [a]
	T30	8.00±.000	8.00±.000	9.09±1.64	6.00±.000	7.64±.81	7.64±.081
	Pairwise comparisons	T5<T10 (p=.018, r=.82)	T5<T10 (p=.034, r=.72)	T5<T10 (p=.014, r=.82)	T5=T10 (p=.593, r=.16)	T5=T10 (p=.051, r=.72)	T5=T10 (p=.276, r=.33)
		T10<T30 (p=.317, r=.30)	T10=T30 (p=.059, r=.57)	T10<T30 (p=.027, r=.67)	T10=T30 (p=.634, r=.30)	T10=T30 (p=.132, r=.56)	T10=T30 (p=.082, r=.62)
		T5<T30 (p=.014, r=.82)	T5<T30 (p=.021, r=.81)	T5<T30 (p=.009, r=.89)	T5=T30 (p=.306, r=.49)	T5=T30 (p=.051, r=.72)	T5=T30 (p=.081, r=.67)
Soccer group	T5	4.45±3.62	6.00±2.79	3.55±1.04	5.45±1.29	7.00±1.61	7.64±.67
	T10	8.00±.000 [a]	8.00±.000 [a]	9.45±1.29 [a,b]	6.00±.00 [a]	7.27±1.85	8.00±.000 [a]
	T30	8.00±.000	8.00±.000	8.00±.000	6.00±0.000	8.00±.000	8.00±.000
	Pairwise comparisons	T5=T10 (p=.051, r=.72)	T5=T10 (p=.126, r=.61)	T5<T10 (p=.006, r=.91)	T5=T10 (p=.540, r=.40)	T5=T10 (p=.684, r=.12)	T5=T10 (p=.306, r=.49)
		T10=T30 (p=1.00, r=.00)	T10=T30 (p=1.00, r=.00)	T10=T30 (p=.180, r=.40)	T10=T30 (p=1.00, r=.00)	T10=T30 (p=.360, r=.40)	T10=T30 (p=1.00, r=.00)
		T5=T30 (p=.051, r=.72)	T5=T30 (p=.126, r=.61)	T5<T30 (p=.006, r=.94)	T5=T30 (p=.540, r=.40)	T5=T30 (p=.198, r=.56)	T5=T30 (p=.306, r=.49)

Note. All p-values were corrected according to the Holm-Bonferroni procedure. (a) = significant ($p<0.05$) differences in motor proficiency between groups; (b) = significant differences ($p<0.05$) in motor proficiency between swimmers and soccer players; (N.S.) = not significant;

Table 17 shows the mean and standard deviations raw and standard scores for each object control fundamental skill, for all groups and evaluation moments. Following the trend observed in the locomotor subtest, between T5 and T10 the control group didn't show any significant variations in these object control skills. During this period, soccer players show proficiency increases on most evaluated fundamental skills, except in underhand roll and catch (the proficiency level in T5 for the catch skill was already maximum). However, the swimmers were able to improve their motor proficiency in striking a stationary ball, in stationary dribble and also in underhand roll. Between T10 and T30, no significant variations were identified in soccer player's motor proficiency for any object control skills, due to the high level already achieved in T10. In turn, the swimmers showed a significant evolution in almost all the skills tested during this period. In a long-term perspective (T5 vs. T30), both experimental groups show significant improvements in most object control skills. At T5 and T10, significant differences ($p<0.05$) were found between groups, in most object control skills, except for striking a stationary ball (T5 and T10) and for overhand throw (T5). Actually, at T5 and T10 the group of soccer practitioners were even more proficient than swimmers in stationary dribble (T5, $p=0.021$, $r=0.69$; T10, $p=0.002$, $r=0.95$), catch (T5, $p=0.002$, $r=0.95$; T10, $p=0.002$, $r=0.93$), kick (T5, $p=0.010$, $r=0.78$; T10, $p=0.002$, $r=0.92$) and underhand roll (T5, $p=0.001$, $r=1.05$). At T30, following the trend of

the previous subset, no significant differences were found between the practitioners of swimming and soccer.

Table 17

Raw and standard scores for the Object Control subtest

		Striking a stationary ball (0-10)	Stationary dribble (0-8)	Catch (0-6)	Kick (0-8)	Overhand throw (0-8)	Underhand roll (0-8)
Controls	T5	7.09±2.59	4.55±3.24[a]	4.36±1.96 [a]	6.73±2.05 [a]	5.82±2.75	3.27±1.85 [a]
	T10	7.45±3.36	3.82±3.40 [a]	4.27±1.10 [a]	7.555±0.82 [a]	4.55±2.84 [a]	4.55±1.81 [a]
	Pairwise comparisons	T5=T10 (p=.722, r.11)	T5=T10 (p=.496, r=.21)	T5=T10 (p=.829, r=.07)	T5=T10 (p=.279, r=.33)	T5=T10 (p=.102, r=.49)	T5=T10 (p=.102, r=.49)
Swimming group	T5	7.27±3.00	1.82±3.28 [a,b]	3.27±2.00 [a,b]	4.82±2.14 [a,b]	5.55±2.88	3.36±2.20 [a,b]
	T10	9.27±1.35	4.27±2.80 [a,b]	4.09±2.21 [a,b]	5.82±2.14 [a,b]	7.09±1.64 [a]	5.64±1.50 [a]
	T30	10.00±.000	7.64±.81	5.64±.81	7.64±.81	7.64±.81	7.64±.81
	Pairwise comparisons	T5<T10 (p=.027, r=.67)	T5<T10 (p=.011, r=.76)	T5=T10 (p=.230, r=.36)	T5=T10 (p=.139, r=.45)	T5=T10 (p=.078, r=.53)	T5<T10 (p=.016, r=.72)
		T10=T30 (p=.102, r=.49)	T10<T30 (p=.007, r=.81)	T10<T30 (p=.016, r=.73)	T10<T30 (p=.016, r=.73)	T10<T30 (p=.083, r=.52)	T10<T30 (p=.005, r=.85)
		T5<T30 (p=.017, r=.72)	T5<T30 (p=.006, r=.83)	T5<T30 (p=.007, r=.81)	T5<T30 (p=.007, r=.81)	T5<T30 (p=.026, r=.67)	T5<T30 (p=.003, r=.90)
Soccer group	T5	5.91±1.30	4.18±1.47 [a,b]	6.00±1.18 [a,b]	7.09±.70 [a,b]	6.45±.93	6.91±.70 [a,b]
	T10	9.45±1.29	7.64±.81 [a,b]	6.00±.000 [a,b]	8.00±.000 [a,b]	8.00±.000 [a]	6.73±1.62 [a]
	T30	10.00±.000	8.00±.000	6.00±.000	8.00±.000	8.00±.000	8.00±.000
	Pairwise comparisons	T5<T10 (p=.005, r=.85)	T5<T10 (p=.003, r=.89)	T5=T10 (p=.942, r=.02)	T5<T10 (p=0.008, r=.80)	T5<T10 (p=.006, r=.83)	T5=T10 (p=.726, r=.11)
		T10=T30 (p=.180, r=.40)	T10=T30 (p=.157, r=.43)	T10=T30 (p=1.00, r=.0)	T10=T30 (p=1.00, r=.0)	T10=T30 (p=1.00, r=.0)	T10<T30 (p=0.38, r=.62)
		T5<T30 (p=.003, r=.90)	T5<T30 (p=.003, r=.89)	T5<T30 (p=942, r=.02)	T5<T30 (p=.008, r=.80)	T5<T30 (p=.006, r=.83)	T5<T30 (p=.006, r=.83)

Note. All p-values were corrected according to the Holm-Bonferroni procedure. (a) = significant ($p<0.05$) differences in motor proficiency between groups; (b) = significant differences ($p<0.05$) in motor proficiency between swimmers and soccer players; (N.S.) = not significant;

4.6 Discussion

This study sought to describe the longitudinal changes in motor development resulting from swimming and soccer practice during childhood. In general, our results showed a positive impact of these two sports participation in motor proficiency.

Assuming development as a dynamic system, different practice opportunities and even small differences in beginning states can amplify and lead to large individual differences in motor development (Smith & Thelen, 2003). So, motor performance seems notably fragile and context dependent. This is an important reason why we should understand the processes by which sports activities are influenced, leading to changes on a longer time-scale. This research aims to contribute to this particular need, enabled us to obtain a more systematic view of the effect of sports practice over time.

First, we want to point out that even in a context of lack of sports participation (control group), five months (between T5 and T10) were sufficient to induce a significant impact on running ability (p=0.039). This seems consistent with the qualitative changes that often follows the body size growth, leading to increased levels of strength and coordination that inherently improve running performance (Haywood & Getchell, 2004). Indeed, raw scores for five, six and seven years old children are expected to increase significantly with age (Afonso et al., 2009; Aponte, French, & Sherrill, 1990; Ulrich, 2000). However, five months were not enough to identify significant variations in the other eleven fundamental motor skills that seem more stable over the times. In fact, our results showed no significant decreases in the raw score means for various skills, including the standard score mean for the object control subtest (see table 14). Although we have controlled the participation in sportive activities, the circumstances and the peculiarities of the children's play weren't assessed. We recognize that this can, eventually, influence the results, just like the majority of the studies in this area. Nevertheless, it seems justified to note that the expected evolution in motor development with age isn't merely dependent on the children's growth and maturation, but is also highly influenced by environmental conditions (different practice opportunities) and suitability of the motor stimulation (e.g., Gallahue & Ozmun, 2005; Clark, 2007).

The fast evolution of motor proficiency in the first few months of sport participation (between T5 and T10) seems to be another important point to note in our results. Indeed, both experimental groups showed significant improvements between five and ten months of practice in locomotor and object control raw scores and also in the gross motor development quotient (see table 14). Between T10 and T30, motor proficiency is clearly less improved in both practitioners, but particularly in soccer practitioners. This is due to the fact that they have reached near maximum levels of proficiency in several fundamental motor skills at T10. In fact, we found that all soccer practitioners reach a "very superior" descriptive rate for the gross motor development in T10. The TGMD-2 battery has a high degree of reliability and low-test error (Wiart & Darrah, 2001), but it seems to have little sensitivity to age-related improvements in participants with high or maximum motor development levels. In our opinion, this seems to be the most plausible reason for the decrease in both subtest standard scores (and also in the gross motor quotient), between T10 and T30, when the raw score in most fundamental motor skills increases and reaches maximum values (or nearly that). This score limitation at the top of a scale is commonly termed "ceiling effect" (Wang, Zhang, McArdle & Salthouse, 2009).

The inter-group differences in motor proficiency are also an important outcome that should be highlighted. The results show inter-group differences that are more evident for object control skills in T5 and for locomotion skills in T10. This seems to mean that object control skills are more sensitive to the effects of soccer practice than actually locomotion skills, at least in these ages. In fact, in T5 no differences in locomotion skills were noticed between groups. Despite the difficulty in comparing these results due to lack of studies about this subject, the interpretation appears to be related to the comparability of training stimulation in interaction

with biological factors (Malina & Bouchard, 2001). The object control skills are clearly developed through stimulation that requires different levels of organization (e.g.: two or more children to play and different forms of playing), and objects availability. In turn, locomotor skills tend to be held more trivially, spontaneously and less dependent on environment and gender differences. For that reason, the locomotion subtest raw scores are converted into standard scores, regardless of gender, and the same isn't true for the object control skills.

The results regarding the continued evolution in object control proficiency in swimmers seem consistent with the data presented by Martins et al. (2015). These authors showed that previous swimming practice seems to induce a positive effect on several gross motor skills, but particularly on objects control skills. Games are used, mainly, as a natural methodological approach to teach aquatic readiness, because they combine both motivation and educational effectiveness and often the handling of several teaching materials for specific recreational purposes (Rocha et. al., 2014).

Notwithstanding, for the relevance of the present results, this study has several limitations. First, no information about the children's play habits and/or objectively measured physical activity levels and patterns were available; these data would be very helpful in explaining the results, namely the motor proficiency increases with age. Second, no follow-up assessments after a period of no sport-specific intervention were conducted; this would allow us to observe if these effects in motor proficiency are well founded. Third, no baseline data about the participant's motor proficiency, before sport practice; this would be valuable to understand the initial (first five months) effects of the practice of both sports. We may also point to a fourth and final limitation that seems to arise by the lack of sensitivity of the TGMD-2 battery to discriminate improvements in children of high-level motor proficiency. Further research attention is needed to explore possible methods of dealing with this ceiling effect in TGMD-2 longitudinal data.

4.7 Conclusion

In conclusion, the present study shows that sport practice during childhood seems to contribute to a higher motor development. Despite of the improved motor skill competence of soccer practitioners at short and long-term, swimming practitioners show an on-going motor development particularly on object control skills.

4.8 References

1. Afonso, G. H., Freitas, D. L., Carmo, J. M., Lefevre, J. A., Almeida, M. J., Lopes, V. P., ... & Maia, J. A. (2009) Desempenho motor. Um estudo normativo e criterial em crianças da Região Autónoma da Madeira, Portugal. *Revista Portuguesa de Ciências do Desporto*, 9 (2-3), 160-174.
2. Aponte, R., French, R. & Sherrill, C. (1990). Motor development of Puerto Rican children: Cross-cultural perspectives. *Perceptual Motor Skills*, 71(3Pt2), 1200-1202.
3. Barnett, L. M., Van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescent Health*, 44 (3), 252-259. doi: 10.1016/j.jadohealth.2008.07.004
4. Boreham, C., & Riddoch, C. (2001). The physical activity, fitness and health of children. *Journal of sports sciences*, 19 (12), 915-929.
5. Bunker, D. J. & Thorpe, R. D. (1982). A model for the teaching of games in secondary schools. *Bulletin of Physical Education*.18 (1), 5-8.
6. Busseri, M. A., Rose-Krasnor, L., Willoughby, T., & Chalmers, H. (2006). A longitudinal examination of breadth and intensity of youth activity involvement and successful development. *Developmental Psychology*, 42 (6), 1313.
7. Canossa, S., Fernandes, R., Carmo, C., Andrade, A., & Soares, S. (2007). Ensino multidisciplinar em natação: reflexão metodológica e proposta de lista de verificação. *Revista Motricidade*, 4(3), 82-99.
8. Cardon, G., De Craemer, M., De Bourdeaudhuij, I., & Verloigne, M. (2014). More physical activity and less sitting in children: Why and how? *Science & Sports*, 29, S3-S5.
9. Clark, J. E. (2007). On the problem of motor skill development. *Journal of Physical Education, Recreation and Dance,* 78(5), 39-44.
10. Clark, J. E., & Metcalfe, J. S. (2002). The mountain of motor development: *A metaphor. Motor development: Research and reviews*, 2, 163-190.
11. Cliff, D. P., Okely, A. D., Smith, L., & McKeen, K. (2009). Relationships between fundamental movement skills and objectively measured physical activity in pre-school children. *Pediatric Exercise Science*, 21(4), 436-49.
12. Cliff, D. P., Wilson, A., Okely, A. D., Mickle, K. J., & Steele, J. R. (2007). Feasibility of SHARK: a physical activity skill-development program for overweight and obese children. *Journal of Science and Medicine in Sport*, 10 (4), 263-267.
13. Costa, I. T., Garganta, J., Greco, P. J., Mesquita, I., & Maia, J. (2011). Sistema de avaliação táctica no Futebol (FUT-SAT): Desenvolvimento e validação preliminar. *Motricidade*, 7 (1), 69-84.

14. Eisenmann, J. C. (2003). Secular trends in variables associated with the metabolic syndrome of North American children and adolescents: a review and synthesis. *American Journal of Human Biology*, 15 (6), 786-794.

15. Gabbard, C.P. (2000). Lifelong Motor Development (3rded.). Madison Dubuque: Brown & Benchmark.

16. Gallahue, D. & Ozmun, J. (2005). Compreendendo o Desenvolvimento Motor – Bebês, Crianças, Adolescente e Adultos. Brasil: Phorte Editora.

17. Hands, B., Larkin, D., Parker, H., Straker, L., & Perry, M. (2009). The relationship among physical activity, motor competence and health related fitness in 14 year old adolescents. *Scandinavian journal of medicine & science in sports*, 19 (5), 655-663.

18. Haywood, K. & Getchell, N. (2004). *Desenvolvimento Motor ao Longo da Vida*. Porto Alegre: Artmed Editora SA.

19. Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, 6, 65–70.

20. Holt, N. L., Strean, W. B. & Bengoechea, E. G. (2002). Expanding the teaching games for understanding model: new avenues for future research and practice. *Journal of Teaching Physical Education,* 21, 162-76.

21. Huotari, P., Nupponen, H., Mikkelsson, L., Laakso, L., & Kujala, U. (2011). Adolescent physical fitness and activity as predictors of adulthood activity. *Journal of Sports Sciences*, 29 (11), 1135-1141. doi: 10.1080/02640414.2011.585166

22. Jorgensen, R. (2012). Under-5s Swimming as a Site for Capital Building: Supporting and Enhancing the Transitions. *Australian Journal Early Child*, 37 (2), 127-131.

23. Kambas, A., Michalopoulou, M., Fatouros, I. G., Christoforidis, C., Manthou, E., Giannakidou, D., ... & Zimmer, R. (2012). The relationship between motor proficiency and pedometer-determined physical activity in young children. *Pediatric Exercise Science*, 24(1), 34.

24. Kane, K. J., & Staples, K. L. (2014). A Group Motor Skills Program for Children with Coordination Difficulties: Effect on Fundamental Movement Skills and Physical Activity Participation. *Physical & occupational therapy in pediatrics,* (Epub ahead of print).

25. Langendorfer, S. & Bruya, L. (1995). *Aquatic Readiness: Developing Water Competence in Young Children.* Champaign, IL: Human Kinetics.

26. Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents. *Sports medicine*, 40(12), 1019-1035.

27. Magill, R. A. (2000). *Aprendizagem motora: conceitos e aplicaçõ*es. São Paulo: Edgard Blücher.

28. Malina, R. (2007). Physical fitness of children and adolescents in the United States: status and secular change. *Medicine and Sports Science*, 50, 67-90.

29. Malina, R.M. & Bouchard, C. (2002). Atividade física do atleta jovem: do crescimento à maturação. São Paulo: Roca.

30. Martins, V., Silva, A. J., Marinho, D. A. & Costa, A. M. (2015). Efeito da prática de natação em contexto educativo no desenvolvimento motor global de crianças do 1º ciclo do ensino básico. *Motricidade*, (in press).

31. Massa, M. & Ré, A.H. (2010). Características de crescimento e desenvolvimento. In L. R. Silva (Ed.), *Desempenho esportivo: Treinamento com crianças e adolescentes* (2 ed., 71-108). São Paulo: Phorte.

32. Morgan, P. J., Okely, A. D., Cliff, D. P., Jones, R. A., & Baur, L. A. (2008). Correlates of objectively measured physical activity in obese children. *Obesity*, 16(12), 2634-2641. doi: 10.1038/oby.2008.463.

33. Ré, A. H. N. (2011). Crescimento, maturação e desenvolvimento na infância e adolescência: implicação para o esporte. *Motricidade*, 7 (3), 55-67.

34. Robinson, L. E., & Goodway, J. D. (2009). Instructional climates in preschool children who are at-risk. Part I: Object-control skill development. *Research quarterly for exercise and sport*, 80(3), 533-542.

35. Rocha, H. A., Marinho, D. A., Ferreira, S. S. & Costa, A. M. (2014). Organização e metodologia de ensino da natação no 1º ciclo do ensino básico em Portugal. *Motricidade,* 10(2), 45-59.

36. Rosenthal, R. (1994). Parametric measures of effect size. In H. Cooper & L. V. Hedges (Eds.), *The handbook of research synthesis.* (pp. 231-244). New York: Russell Sage Foundation.

37. Sibley, B. A., & Etnier, J. L. (2003). The relationship between physical activity and cognition in children: a meta-analysis. *Pediatric Exercise Science*, 15 (3), 243-256.

38. Sigmundsson, H., & Hopkins, B. (2010). Baby swimming: exploring the effects of early intervention on subsequent motor abilities. *Child: care, health and development*, 36(3), 428-430. doi: 10.1111/j.1365-2214.2009.00990.x

39. Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D. & Lubans, D.R. (2014). The health benefits of muscular fitness for children and adolescents: a systematic review and meta-analysis. *Sports Medicine*, 44(9), 1-15. doi: 10.1007/s40279-014-0196-4.

40. Smith, L. B., & Thelen, E. (2003). Development as a dynamic system. *Trends in Cognitive Sciences*, 7(8), 343-348.

41. Steele, R. M., Brage, S., Corder, K., Wareham, N. J., & Ekelund, U. (2008). Physical activity, cardiorespiratory fitness, and the metabolic syndrome in youth. *Journal of Applied Physiology*, 105(1), 342-351.

42. Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), 290-306.

43. Ulrich, D. (2000). *Test of Gross Motor Development – Examiner's Manual* (2 ed.). Austin, Texas: Pro-Ed.

44. Wang, L., Zhang, Z., McArdle, J. J., & Salthouse, T. A. (2009). Investigating ceiling effects in longitudinal data analysis. *Multivariate Behaviour Research*, 43(3), 476-496. doi:10.1080/00273170802285941

45. Westendorp, M., Hartman, E., Houwen, S., Huijgen, B.C., Smith, J. & Visscher, C. (2014) .A longitudinal study on gross motor development in children with learning disorders. *Research in Developmental Disabilities*, 35 (2), 357-63. doi: 10.1016/j.ridd.2013.11.018.

46. Wiart, L., & Darrah, J. (2001). Review of four tests of gross motor development. *Developmental Medicine & Child Neurology*, 43(4), 279-285.

47. Williams, H. G., Pfeiffer, K. A., O'Neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008). Motor skill performance and physical activity in preschool children. Obesity, 16(6), 1421-1426. doi: 10.1038/oby.2008.214

Chapter V: Overall conclusions, limitations and recommendations

5.1 Conclusions

In the first investigation topic in this thesis, we have proposed to describe the way the swimming teaching is implemented in the context of the Expression and Physical Motor Education discipline, in the elementary school, in Portugal. This was a descriptive research. With the results from that study we could find some deficiencies in the integration of swimming practice in the elementary school's program and probably those are limitations of the efficiency of the teaching method adopted, in respect to the acquisition of more complex aquatic skills. Elementary schools with swimming practice in their educational program are doing it exclusively for students of the third and fourth level/year (in line with the indications from the Portuguese Ministry of Education), with weekly sessions and classes with too much students. The swimming sessions are used basically to develop basic aquatic skills and the will of practicing this sport, using some didactic material occasionally. In those elementary schools were swimming practice is out of school program, budget restrictions and difficulties to get transportation for students between school and swimming pool are reasons given to exclude swimming practice.

The second investigation topic is related to the pedagogy of swimming. We have proposed to analyze the influence of an important variable of context – water depth – in the acquisition of basic aquatic skills by children. In that respect, the results have shown that we get a better performance in shallow water than in deep water, after six months of practice. We have found significant differences ($p < 0.05$) between the sample groups, with respect to the motor proficiency of five aquatic skills: breath control, immersion of the face and eye opening (Sk3); horizontal buoyancy (Sk4); body position at ventral gliding (Sk5); body position at dorsal gliding (Sk6); leg kick with breath control at ventral body position, without any flutter device (Sk9). The body position during gliding was the main relevant predictor ($r = 0.535$). Therefore, it's probably more suitable to teach swimming in shallow water, during the initial phase of practice. If we have access only to deep swimming pools, we suggest that the swimming teaching program should focus on developing the acquisition of aquatic skills that normally draw less attention from teachers, like gliding, for instance.

The third as last investigation topic of this thesis is related to the motor development. With this study, we had the objective of knowing the importance of sports in the gross motor development, by describing the impact brought by the practice of swimming or soccer, in the short, mid and long term (five, ten and 30 months, respectively). The results indicate that sports during childhood have an important contribute to the gross motor development. Soccer

seems to have great influence on the motor development, because, after ten months of practice, soccer practitioners have achieved the highest proficiency levels in several fundamental motor skills (both at the locomotor level and object control). The impact of swimming practice on terrestrial fundamental motor skills is positive, contributing to a gradual motor development, especially in respect to skills of object control.

5.2 Limitations and directions for future research

This thesis has some relevant limitations. The critical observation of those limitations is not just desirable from a scientific accuracy perspective, but, above all, it will help opening the door for future research based on or in the sequence of the object of this thesis.

In relation to the first study hereby presented, the major limitation is related to the size of the sample used. Although we have collected and analyzed the data from 30% of Portuguese municipalities, this data is not fully representative of the current situation nationwide. Because the major part of the inquired municipalities didn't answer our survey, we weren't able to get a wider perspective. The same has happened with the inquired teachers. Besides that, our study only presents descriptive data and there's no records about the effectiveness of the swimming programs used, in the long run.

For future research, we consider it's very important to analyze the level of aquatic development of Portuguese children, in the school context. For child safety reasons, the follow-up of aquatic development during childhood is not just relevant from a scientific perspective, but, most important, should be considered a social and political concern. It is also important to evaluate the effectiveness of the swimming teaching programs used. In the second and third years of elementary school, swimming is considered as an optional complementary activity (sport practice at school). The characteristics of that practice and, in particular, its connection to local entities, like swimming clubs and collectivities, should be taken as an important subject of future study in more detail, with the objective of developing the practice of swimming.

The second study has three important constraints, as we have earlier mentioned: (i) the evaluation of the effectiveness of swimming teaching within a period of six months only, which is not enough to accurately assess its impact in the development of swimming skills of the practitioner, related to the context variable "depth level" (shallow water, deep water), in the long run; (ii) the small size of sample in both experimental groups; (iii) the lack of time control of motor involvement in both kind of session. This limitation is our strongest recommendation for future studies around this subject – lesson time control in the context of different kind of teaching and different methodologies, especially with programs using both depth options (shallow water and deep water – a very common practice, as we have demonstrated in the first study). We consider it is also very important to measure the influence of other variables in the effectiveness of swimming teaching: number of practitioners per class, number of sessions per week (intensive blocks vs. less intensive blocks), or the use the usage of didactic material. We

believe it is necessary to have a clearer understanding of the impact of different pedagogical approaches of swimming teaching in the motor, social and cognitive development of children, especially the richness of stimulations that we see in aquatic recreation programs. Finally, we think it is also important to point out that, although the teaching program used in both depth levels is identical, the development of swimming practice in deep water seems to have specific constraints, especially to beginners – the sense of unsafety (risk of drowning) is undoubtedly higher in deep water, which may represent an inhibition factor to children, with a critical influence in the development of basic aquatic skills, during the initial phase of swimming learning, which main objective is to make the child to be more confident in the aquatic environment. We haven't evaluated the stress level resulted from a more "intensive" swimming learning context; this is, therefore, a relevant subject for future studies, especially the measure of the neuro-endocrine reaction before and after each swimming session and during the whole program.

In respect to the last study, one of the major limitations is the lack of data about the ludic habits and the physical condition of children that have participated in the study. Such data would be very useful in having a clear understanding of the results achieved with this study, especially with regards to the motor proficiency, with the increasing age. The lack of data about the gross motor development in the initial phase of the swimming program (until five months of practice) represents another important constraint, although both experimental groups have initiated the program at the same time and with the same weekly frequency and duration. As we have mentioned earlier, we have faced some limitations in the TGMD-2 evaluation program in identifying improvements of motor proficiency close or even above an advanced level. From our perspective, the solution for this issue is a good subject for future studies, exploring possible methods to overcome the "celling effect" in the TGMD-2 program, with longitudinal data. We also consider a very good subject for future studies the elaboration a clear set of factors to define the motor development during childhood, by combining physical aspects, contexts and opportunities of learning and stimulation programs. This will bring important guidance into the definition of school and non-school swimming programs. Given the fact that the motor development is qualitative, sequential and even cumulative, it would be very important to know better the relationship between the progress of motor proficiency in fundamental physical skills and the progress of the acquisition of specific skills in different sports, including swimming.

ANNEXES

Annex I: Teaching swimming practice in the elementary school – swimming teacher survey

(translated version)

I. Identification

1. Name of institution

_____

2. City

_____

3. Swimming pool

_____

II. Teacher's profile

(Please select an option in each item)

4. Gender

Male	
Female	

5. Age

20-25	
26-30	
31-35	
35+	

6. Academic degree

Secondary school	
Bachelor degree	
Graduation degree	
Master's degree	
PhD	
Other	

7. Professional experience

1 year or less	
2 to 3 years	
4 to 6 years	
More than 7 years	

8. Duration of lessons per week (nr. of hours approximately)

_____

III. Methodology

(Please select an option in each item)

9. Do you know the guidelines from the Ministry of Education with regards to the teaching of swimming during the elementary school?

Yes	
No	

10. Who is responsible to define the profile of swimming classes (nr of students, annual teaching plan – per class and per student, didactic material to be used, evaluation criteria)?

The coordinator of school	
Teachers of Physical Education discipline	
Class's teacher	
Swimming trainers	
Other (*)	

(*) Please be specific: _____

11. Your opinion about the objective of swimming lessons

The objective of swimming lessons is…	Agree	Disagree
To survive in the water		
To become autonomous in the water		
To lose fear of water		
For pleasure		
To swim a short distance of 50 m		
To train future swimmers		

12. Your opinion about didactic material

Didactic material	Should be used …			
	Always	Sometimes	Rarely	Never
None				
Boards				
Arm floats				
Noodles				
Non-floating arches				

13. Your opinion about the learning topics

Topic		Should be taught …			
		Always	Sometimes	Rarely	Never
Teaching adaptation to water environment	Water entry				
	Tasks to acquire confidence				
	Submersion in apnea				
	Balance				
	Propulsion with legs				
	Propulsion with legs and arms				
	Glides				
	Rotations				
	Skills				
	Diving				
	Breathing control				
	Deep water immersion				
Teaching basic stroke techniques	Water entry				
	Dynamic balance				
	Correct propulsion with legs				
	Symmetric rotations				
	Correct propulsion with arms				
	Specific technical skills				
	Rhythmic breathing control				
	Starts and turns				
	Complex skills				

14. Your opinion about the importance given to attitude and basic understanding, during swimming learning

Topic	Should be considered …			
	Always	Sometimes	Rarely	Never
Not afraid of water				
Know how to use equipment				
Respect practice rules				
Respect instructions and organization				
Not afraid of water				
Safety and rescue rules				
Games and fun activities				
Knowing the technical language				
Theoretical domain of mechanical movement				

(original version – in Portuguese)

PROFS_ACL

IDENTIFICAÇÃO

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

*** 1. Nome da instituição promotora da natação ao 1º ciclo do EB:**

*** 2. Localidade:**

*** 3. Nome da(s) piscina(s) envolvida(s):**

I - CARACTERIZAÇÃO DO(A) PROFESSOR(A) DA ESCOLA DE NATAÇÃO

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

*** 4. Sexo**

- ○ **Masculino**
- ○ **Feminino**

*** 5. Idade**

*** 6. Habilitações académicas do(a) professor(a)**

- Secundário
- Bacharelato
- Licenciatura
- Mestrado
- Doutoramento
- Outras

Se seleccionou 'Outras' indique quais:

*** 7. Experiência profissional**

- Menos de um ano
- 2 a 3 anos
- 4 a 6 anos
- Mais de 7 anos

*** 8. Número aproximado de horas semanais que lecciona no ensino da natação a crianças do 1º ciclo**

II - ORGANIZAÇÃO METODOLÓGICA DAS AULAS DE NATAÇÃO PARA CRIANÇAS DO 1º CICLO

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

*** 9. Directrizes do ministério da educação (objectivos) para a natação no 1º ciclo do ensino básico.**

Tem conhecimento das directrizes do ministério da educação para a consubstanciação do ensino da natação no 1º ciclo do ensino básico:

- ○ Sim
- ○ Não

10. O enquadramento (nº de alunos por professor, nível de cada aluno, plano anual de cada turma/aluno, o material didáctico utilizado, avaliação) dos alunos do 1º ciclo, é realizado por (seleccione uma ou várias opções):
[OBRIGATÓRIO]

Coordenador da escola de natação	☐
Os professores de educação física das actividades de enriquecimento curricular	☐
Professor titular da turma	☐
Técnicos de natação da própria escola de natação	☐
Outros	☐

*** 11. As aulas do bloco de natação no 1º ciclo em crianças têm como finalidade:**

	Concordo	Discordo
Sobreviver na água	○	○
Deslocar-se de forma autónomo na água	○	○
Não ter medo da água	○	○
Dar prazer e satisfação	○	○
Nadar um percurso de 50 metros de crol, costas e 25 metros de bruços e mariposa	○	○
Formar futuros nadadores	○	○

*** 12. Material didáctico que utiliza, em particular nas aulas de natação, em crianças do 1º ciclo (assinale a opção que melhor se aplica):**

	Sempre	Às vezes	Raramente	Nunca
Sem material	○	○	○	○
Placas/pranchas	○	○	○	○
Braçadeiras	○	○	○	○
Esparguetes	○	○	○	○
Arcos, argolas	○	○	○	○
Outros	○	○	○	○

*** 13. Defina a importância, durante a sua prática pedagógica, dos conteúdos que orientam os programas de ensino (descritos no quadro), na adaptação ao meio aquático, em particular nas aulas de natação, em crianças do 1º ciclo (assinale a opção que melhor se aplica):**
Adaptado de Langendorfer e Bruya (1995) e Jorge Campaniço (1998).

	Sempre	Às vezes	Raramente	Nunca
Entrada na água	○	○	○	○
Utilização de tarefas que geram confiança/segurança	○	○	○	○
Submersão/apneia	○	○	○	○
Equilíbrio	○	○	○	○
Autonomia propulsiva por acção pernas	○	○	○	○
Autonomia propulsiva por acção pernas e braços	○	○	○	○
Deslizes	○	○	○	○
Rotações em torno dos eixos (longitudinal e transversal)	○	○	○	○
Destrezas básicas (movimentos posturais, locomoção, manipulação e combinação dos mesmos)	○	○	○	○
Mergulhos	○	○	○	○
Controlo respiratório	○	○	○	○
Imersões em profundidade	○	○	○	○

*** 14. Durante a sua prática pedagógica (no 1º ciclo), defina a importância que os seguintes conteúdos, no âmbito do seu programa aquático para o ensino da natação, têm na aprendizagem das técnicas formais - os fundamentos técnicos / skills básicos (assinale a opção que melhor se aplica):**
Adaptado de Langendorfer e Bruya (1995) e Jorge Campaniço (1998).

	Sempre	Às vezes	Raramente	Nunca
Entrada na água	○	○	○	○
Posição do corpo / equilíbrio dinâmico	○	○	○	○
Acção correcta do apoio propulsivo pernas	○	○	○	○
Rotações simétricas sobre o eixo longitudinal	○	○	○	○
Rotações sobre os eixos transversais	○	○	○	○
Geração do apoio propulsivo dos braços	○	○	○	○
Controlo respiratório ritmado	○	○	○	○
Destrezas específicas das técnicas (sincronização / movimentos combinados entre os membros superiores e inferiores e respiração)	○	○	○	○
Partidas e viragens	○	○	○	○
Destrezas complexas (movimentos especializados que permitem um grau de eficiência para o desempenho de habilidades motoras complexas, que são baseadas em movimentos fundamentais e básicos combinados entre si)	○	○	○	○

Annex II: Teaching swimming practice in the elementary school – school coordinator survey

(translated version)

I. Identification

1. Name of institution

_____

2. City

_____

3. Swimming pool

_____

II. Coordinator's profile

(Please select an option in each item)

4. Gender

Male	
Female	

5. Age

20-25	
26-30	
31-35	
35+	

6. Academic degree

Secondary school	
Bachelor degree	
Graduation degree	
Master's degree	
PhD	
Other	

7. Professional experience

1 year or less	
2 to 3 years	
4 to 6 years	
More than 7 years	

III. Methodology

(Please select an option in each item)

8. Type of swimming program

AEP (1)	
Elementary school	
Other (2)	

AEP – Extracurricular Activities Program, swimming practice as additional educational activity, in the elementary school.

Please be specific:_____

9. Number of schools in the area participating in the swimming program of the elementary school

_____

10. Number of students participating in the swimming program, in those schools

Nr of students in the 1st year	
Nr of students in the 2nd year	
Nr of students in the 3rd year	
Nr of students in the 4th year	

11. Transportation used by students between their school and the swimming pool

Walking	
Bus	
Other (*)	

(*) Please be specific: _____

12. Who's watching the students during the transportation?

School staff	
Physical education teacher	
Main teacher	
Other (*)	

(*) Please be specific: _____

13. Number of lessons planned annually

_____

14. Weekly frequency of swimming lessons

Once a week	
Twice a week	
3 or more times a week	
Other frequency (*)	

(*) Please be specific: _____

15. Duration of each swimming lesson

30 minutes	
45 minutes	
More than 45 minutes	
Other duration (*)	

(*) Please be specific: _____

16. Limit of students per class

5 to 8	
9 to 12	
13 to 16	
17 or more	

17. Swimming lessons are conducted by …

Teachers of Physical Education discipline	
Swimming trainers	
Other (*)	

(*) Please be specific: _____

18. Water temperature

28 to 29° C	
30 to 31° C	
32 to 33° C	

19. Swimming pool depth

Shallow water	
Deep water	
Both (progressive depth)	

20. Swimming pool area used per class

5 m^2 or less	
6-10 m^2	
11-15 m^2	
16 m^2 or more	

21. Do you know the guidelines from the Ministry of Education with regards to the teaching of swimming during the elementary school?

Yes	
No	

22. Are the number of lessons enough to address the following topics?

Practice topic	Agree	Disagree
Basic skills (balance, floating, rotations, propulsion, jumps, breathing, …)		
Autonomy in the water and start rudimentary propulsive skills		
Rudimentary butterfly and breast strokes, including starts and turns		
Perform well all the four official strokes, including starts and turns		

(original version – in Portuguese)

COORD_ACL

IDENTIFICAÇÃO

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

*** 1. Nome da instituição promotora da natação ao 1º ciclo do EB:**

*** 2. Localidade:**

*** 3. Nome da(s) piscina(s) envolvida(s):**

I - CARACTERIZAÇÃO DO(A) COORDENADOR(A) DA ESCOLA DE NATAÇÃO

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

*** 4. Sexo**

- ○ **Masculino**
- ○ **Feminino**

*** 5. Idade**

*** 6. Habilitações académicas do(a) coordenador(a)**

- Secundário
- Bacharelato
- Licenciatura
- Mestrado
- Doutoramento
- Outras

Se seleccionou 'Outras' indique quais:

*** 7. Qual é a instituição que representa como coordenador(a) da "Natação" para crianças do 1º ciclo do EB**

- Câmara Municipal (pelouro do desporto)
- Piscina Municipal (coordenador)
- Empresa Municipal (coordenador)
- Escola (coordenador AEC's)
- Outra

Se seleccionou 'Outra' indique qual:

II – ORGANIZAÇÃO INSTITUCIONAL DAS AULAS DE "NATAÇÃO PARA CRIANÇAS DO 1º CICLO"

(os campos assinalados com asterisco '' são de preenchimento obrigatório)*

* 8. A natação no 1º ciclo do ensino básico é:

- No âmbito das actividades de enriquecimento curricular
- Parte integrante do currículo do 1º ciclo
- Outros

Se seleccionou 'Outros' indique quais:

9. Número de escolas e alunos participantes nas aulas de natação dirigidas para o 1º ciclo do ensino básico

Número total de escolas participantes por ano escolar

Número total de alunos participantes de 1º ano

Número total de alunos participantes de 2º ano

Número total de alunos participantes de 3º ano

Número total de alunos participantes de 4º ano

10. Qual o meio de transporte utilizado para a deslocação das crianças da escola para a piscina e vice-versa, no âmbito da natação no 1º ciclo do ensino básico:

- A pé
- Autocarro do município
- Outros

Se seleccionou 'Outros' indique quais:

11. Quem acompanha as crianças da escola para a piscina e vice-versa, no âmbito da natação no 1º ciclo do ensino básico:

- Auxiliares da educação
- Professor de educação física
- Outros

Se seleccionou 'Outros' indique quais:

12. Qual o volume previsto de sessões / aulas de natação por ano escolar:
Número de aulas por ano escolar:

13. Qual a frequência semanal das turmas de natação para crianças do 1º ciclo:

- 1 vez por semana
- 2 vezes por semana
- 3 ou mais vezes por semana
- Outros

Se seleccionou 'Outros' indique quais:

14. Qual a duração de cada aula:

- Até 30 minutos
- Até 45 minutos
- Mais de 45 minutos
- Outra

Se seleccionou 'Outra' indique qual:

15. Qual o número máximo de alunos de 1º ciclo que regularmente compõem as classes de natação.

- 5 a 8 alunos
- 9 a 12 alunos
- 13 a 16 alunos
- Mais que 17 alunos

16. As aulas de natação no 1º ciclo do ensino básico são ministradas por:

- Professores de educação física
- Técnicos de natação
- Outros

Se seleccionou 'Outros' indique quais:

17. Qual a temperatura da água na piscina ou tanque frequentada pelas crianças do 1º ciclo:

- 28 a 29º C
- 30 a 31º C
- 32 a 33º C

18. As aulas normalmente são ministradas em piscina:

- Rasa ("com pé")
- Profunda ("Sem pé")
- Mista ("progressivamente com pé para sem pé")

19. Área da piscina disponível aproximadamente por classe, para as aulas de natação do 1º ciclo:

- Até 5 m2
- 6-10 m2
- 11-15 m2
- Mais de 16 m2

* 20. Directrizes do ministério da educação (objectivos) para a natação no 1º ciclo do ensino básico.

Tem conhecimento das directrizes do ministério da educação para a consubstanciação do ensino da natação no 1º ciclo do ensino básico:

- Sim
- Não

Annex III: Test swimming lessons

(original version – in Portuguese)

	Água Rasa ou profunda	T 0 (1º sessão)		T 6 (6 meses)	
		Não R.	**Não R.**	**Realiza**	**Realiza**
Sk1. Entrada na água	Não entra de forma voluntária: demonstra medo.				
	Entrada voluntária no meio aquático, com algum medo.				
	Entrada voluntária na água sem medo.				
Sk2. Equilíbrio Vertical	Não se desloca na posição vertical.				
	Desloca-se na posição vertical, em desequilíbrio.				
	Desloca-se na posição vertical, em todas as direções.				
Sk3. Respiração	Não imerge a face.				
	Só imerge a face.				
	Imerge a face e, ou expira, ou abre os olhos.				
	Imerge a face, abre os olhos e expira.				
	Mantém a face imersa, os olhos abertos expira, durante um período superior a 3´.				
Sk4. Equilíbrio Estático	Não realiza nenhuma das formas de equilíbrio.				
	Realiza uma ou duas das formas de equilíbrio com os seg^{mentos} desalinhados.				
	Realiza *1* das posições estáticas em forma de estrela ventral ou dorsal durante um período *superior* a 3´.				
	Realiza as 2 posições estáticas em forma de estrela ventral ou dorsal durante um período *superior* a 3´.				
Sk5. Deslize em posição ventral, PH	Não realiza o deslize.				
	Desliza, com os segmentos desalinhados, numa distância inferior a 2 m.				
	Desliza $^{(empurra\ a\ parede\ com\ os\ pés)}$ com os seg^{mentos} alinhados numa distância *inferior* a 2 m.				
	Desliza $^{(empurra\ a\ parede\ com\ os\ pés)}$ com os seg^{mentos} alinhados numa distância *superior* a 2 m.				

(original version – in Portuguese)

	Água rasa ou profunda	T 0 (1º sessão)		T 6 (6 meses)	
		Não R.	Realiza	Realiza	Não R.
Sk6. Deslize em posição dorsal, PH	Não realiza o deslize.				
	Desliza, com os seg^mentos *desalinhados*, numa distância *inferior* a 2,0 m.				
	Desliza (empurra a parede com os pés) com os seg^mentos alinhados numa distância *inferior* a 2 m.				
	Desliza (empurra a parede com os pés) com os seg^mentos alinhados numa distância *superior* a 2 m.				
Sk7. Rotação do eixo longitudinal	Não realiza a rotação.				
	Realiza a rotação, no eixo longitudinal com os seg^mentos desalinhados.				
	Realiza a rotação, no eixo longitudinal com os seg^mentos alinhados.				
Sk8. Rotação do eixo transversal	Não realiza as cambalhotas, para trás ou à frente.				
	Realiza uma das cambalhotas, para trás ou para a frente com os seg^mentos desalinhados.				
	Realiza uma das cambalhotas, para trás ou frente.				
	Realiza cambalhota para trás e frente.				
Sk9. Respiração + propulsão ventral, na PH, com prancha	Não realiza.				
	Realiza ação de membros inferiores.				
	Realiza pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, com respiração coordenada, deslocação *inferior* a 4 m.				
	Realiza a pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, com respiração coordenada, deslocação *superior* a 4 m.				
Sk10. Respiração + propulsão ventral, na PH, **autónomo**	Não realiza.				
	Realiza ação de membros inferiores.				
	Realiza pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, com respiração coordenada, deslocação *inferior* a 4 m.				
	Realiza a pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, com respiração coordenada, deslocação *superior* a 4 m.				
Sk11. Respiração + propulsão dorsal, na PH, **com prancha**	Não realiza.				
	Realiza ação de membros inferiores.				
	Realiza pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, respiração coordenada, deslocação *inferior* a 4 m.				
	Realiza a pernada alternada dos M. I., com alinhamento horizontal dos seg^mentos, respiração coordenada, deslocação *superior* a 4 m.				

	Água rasa ou profunda	T 0 (1º sessão)		T 6 (6 meses)	
		Não R.	Não R.	Realiza	Realiza
Sk 12. Respiração + propulsão dorsal, na PH, **autónomo**	Não realiza.				
	Realiza acção de membros inferiores.				
	Realiza pernada alternada dos M. I., com alinhamento horizontal dos seg^{mentos}, respiração coordenada, deslocação *inferior* a 4 m.				
	Realiza a pernada alternada dos M. I., com alinhamento horizontal dos seg^{mentos}, respiração coordenada, deslocação *superior* a 4 m.				
Sk 13. Salto vertical	Não salta para a água.				
	Salta para a água em desequilíbrio.				
	Salta para a água na vertical, com os seg^{mentos} alinhados.				
Sk14. Salto de cabeça	Não salta para a água.				
	Salta para a água em desequilíbrio.				
	Salta para a água, esticando o corpo durante o salto, com os seg^{mentos} alinhados.				
Sk15. Deslocamento autónomo em piscina profunda	Não se desloca.				
	Desloca-se autónomo, deslocação *inferior* a 4 m.				
	Desloca-se autónomo, deslocação *superior* a 4 m.				
Sk16. Equilíbrio vertical Estático piscina profunda	Não realiza.				
	Realiza em apneia, com uma ou duas mãos no bordo.				
	Realiza com expiração, com uma ou duas mãos no bordo.				
	Realiza em apneia, de forma autónoma.				
	Realiza com expiração, de forma autónoma, durante um período *superior* a 3 ´.				
Sk17. Respiração e Imersão em profundidade	Não imerge na vertical.				
	Imerge na vertical, pela vara até ao fundo, mas não recolhe os objetos.				
	Imerge, na vertical, pela vara até ao fundo da piscina e recolhe objetos.				
	Imerge, na vertical, *autónomo* até ao fundo da piscina e recolhe objetos.				

Annex IV: Test of Gross Motor Development – Examiner's Manual (2 ed.) – Ulrich, D. (2000)

Seção I. Identifying information				
Name				**Sports**
Data of Testing	x	x	x	Examiner Helena A. Rocha
Data of Birth	x	x	x	Examiner´s Title Physical Education Teacher
Age	x	x	x	

Seção II. Records of Scores									
First Testing					Second Testing				
	Raw[1]	Standard[1]	Percentile	Age[2]		Raw[1]	Standard[1]	Percentile	Age[2]
L	**x**	**x**	**x**	**x**	**L**	**x**	**x**	**x**	**x**
OB	**x**	**x**	**x**	**x**	**OB**	**x**	**x**	**x**	**x**
S[3]		**x**			**S[3]**		**x**		
GMQ		**x**	**x**		GMQ			**x**	

1-Score; 2- equivalent; L – locomotor; OB – Object Control; 3 – Sum of Standard Scores; GMQ – Gross Motor Quotient

Seção III. Testing Conditions					
Place Tested	Outdoor Sport field				
	Interfering				**Not Interfering**
B. Noise Level	**1**	**2**	**3**	**4**	**5**
C. Interruptions	**1**	**2**	**3**	**4**	**5**
D. Distrations	**1**	**2**	**3**	**4**	**5**
E. Light	**1**	**2**	**3**	**4**	**5**
F. Temperature	**1**	**2**	**3**	**4**	**5**
G. Notes and Other considerations nothing to consider					

Locomotor Subtest

Skill		Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1.	**1.Run**	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go". Repeat a second trial.	1.Arms move in opposition to legs, elbows bent	x	x	x
				2.Brief period where both feet are off the ground	x	x	x
				3.Narrow foot placement landing on heel or toe (i.e., not flat)	x	x	x
				4.Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)	x	x	x
2.					**Skill Score**		0

Skill		Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
3.	**2.Gallop**	25 feet clear space, and tape or two cones	Mark off distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1.Arms bent and lifted to waist level at takeoff	x	x	x
				2.a step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot	x	x	x
				3.Brief period when both feet are off the floor	x	x	x
				4.Maintains a rhythmic pattern for four consecutive gallops	x	x	x
4.					**Skill Score**		0

Skill		Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
5.	**3.Hop**	A minimum of 15 feet of clear space	Teel the child hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1.Nonsupport leg swings forward in pendular fash-ion to produce force	x	x	x
				2.Foot of non-support leg remains behind body	x	x	x
				3.Arms flexed and swing forward to produce force	x	x	x
				4.Takes off and land three consecutive times on preferred foot	x	x	x

6.				5.Takes off and lands three consecutive times on nonpreferred foot		
7.					**Skill Score**	0

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
8.	**4.Leap**	Minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1.Take off on one foot and land on the opposite	x	x	x
				2.A period where both feet are off the ground longer than running	x	x	x
				3.Forward reach with the arm opposite the lead foot	x	x	x
9.					**Skill Score**		0

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
10.	**5.Horizontal Jump**	A minimum of 10 feet of clear space and tape	Mark off a stranding line on the floor. Have the child start behind the line. Teel the child to jump as far as he or she can. Repeat a second trial.	1.Preparatory movement includes flexion of both knees with arms extended behind body	x	x	x
				2.Arms extend forcefully forwards and upward reaching full extension above the head	x	x	x
				3.Take off and land on both feet simultaneously	x	x	x
				4.Arms are thrust downward during landing	x	x	x
11.					**Skill Score**		0

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
12.	**6.Slide**	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Teel the child to slide from one cone to the other and back. Repeat a second trial.	1.Body turned sideways so shoulders are aligned with the line on the floor	x	x	x
				2.A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot	x	x	x

				3.A minimum of four continuous step-slide cycles to the right	x	x	x
				4.A minimum of four continuous step-slide cycles two the left	x	x	x
13.					**Skill Score**		0
14.			**Locomotor Subtest Raw Score (sum of the 6 skill scores)**		x		

Object Control Subtest

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
15.	**1.Striking a Stationary Ball**	A 4-inch lightweight ball, a plastic bat, and a batting tee	Place the ball on the batting tee at the child´s belt level. Tell the child to hit the ball hard. Repeat a second trial.	1.Dominant hand grips bat above nondominant hand	x	x	x
				2.nonpreferred side of body faces the imaginary tosser with feet parallel	x	x	x
				3.Hip and slholder rotation during swing	x	x	x
				4.transfers body weight to front foot	x	x	x
16.				5.Bat contacts ball			
17.					**Skill Score**		0

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
18.	**2.Stationary Dribble**	An 8-to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1.contacts ball with one hand at about belt level	x	x	x
				2.Pushes ball with fingertips (not slap)	x	x	x
				3.Ball contacts surface in front of or to the outside of foot on the preferred side	x	x	x
				4.maintains control of ball for four consecutive bounces without having to move the feet to retrieve it	x	x	x
19.					**Skill Score**		0

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
20. 3.Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child´s shoulders and belt. Repeat a second trial.	1.Preparation phase where hands are in front of the body and elbows are flexed	x	x	x
			2.Arms extend while reaching for the ball as it arrives	x	x	x
			3.Ball is caught by hands only	x	x	x
21.				**Skill Score**		0

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
22. 4.Kick	An 8- to 10 inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the wall. Place the ball on top of the be	1.Rapid continuous approach to the ball	x	x	x
			2.An elongated stride or leap immediately prior to ball contact	x	x	x
			3.Nonkincking foot placed even with or slightly in back of the ball	x	x	x
23.			4.Kicks ball with instep of preferred foot (shoe-laces) or toe			
24.				**Skill Score**		0

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
25. 5.Overhand Throw	A tennis ball for children age 3 to 6 a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space		1.Windup is initiatated with downward movement of ahd/arm	x	x	x
			2.Rotates hip and shoulders to a point where the nonthrowing hand	x	x	x
			3.weight is transferred by stepping with the foot opposite the throwing hand	x	x	x

				4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side	x	x	x
26.					**Skill Score**		0

Skill		**Materials**	**Directions**	**Performance Criteria**	**Trial 1**	**Trial 2**	**Score**
27.	**6.Underhand Roll**	A tennis ball for children age 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1.Preferred hand swings down and back, reaching behind the trunk while chest faces cones	x	x	x
				2.Strides forward with foot opposite the preferred hand toward the cones	x	x	x
				3.Bends knees to lower body	x	x	x
				4. Releases ball close to the floor so ball does not bounce more than 4 inches high	x	x	x
28.					**Skill Score**		0
29.		**Object Control Subtest Raw Score (sum of the 6 skill scores)**			x		