

Children's perceptions of sharks and understanding of its ecological significance for educational implications

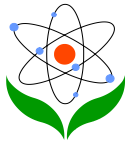
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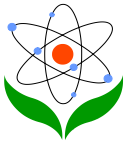


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Abstract

Global shark populations are seriously declining and many species are now threatened by anthropogenic stresses. Their extinction would cause devastating consequences to the marine biodiversity and ecosystems. However some children describe the sharks as bad guys, 'we should kill them all!' Such children's view motivates my study interest. This research aims to investigate the children's perceptual belief and conceptual understanding of sharks and its ecological significance; and the associated variables affecting the results. The study has investigated a total of 140 school pupils of primary 4 level from 2 different schools. The results are presented in five-point Likert scores. The mean perceptual and conceptual scores are 3.26 and 3.53, respectively. No correlation is found between the overall conceptual score and the variables of gender, age or schools. Yet the conceptual score is positively correlated to the perceptual score, whereas the conceptual score is correlated to their examination result of the subject General Studies. Information acquired from the parental source shows the positive correlation to the overall conceptual scores whereas the effect is particularly significant to boys. However the reading preference of the nature type shows the positive correlation to the overall conceptual scores whereas the effect is significant to girls. It is also noted that the children spending longer time on reading score higher, yet the book types of computer information or games are negatively associated with the performance of boys in particular conceptual items. The results suggest three approaches for promoting the children's perceptual and conceptual development about the environmental issues: consolidation of the ecological



knowledge backgrounds, identification of constructive information sources and the development of effective pedagogical strategy.

Keywords: Shark, ecological significance, children's understanding, ecosystem, environmental education

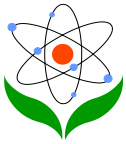
Introduction

Marine Ecosystem and Sharks

Ecosystem is a very complicated entity interacting with unlimited biotic and non-biotic components. A small change of any component may upset the ecological stability of the system. Sharks engage the top predatory position of the trophic levels and play a significant role in stabilizing the marine ecosystem (Stevens et al., 2000). However, the global shark populations are seriously declining (Baum et al., 2003; Ward & Myers, 2005). More than 122 shark species have been included in the IUCN red list, indicating that they are threatened with the risk of extinction (World Wild Fund For Nature Hong Kong, 2010). In which 10 species are currently categorized in CITES-listed species (United Nations Environment Programme, 2011). Their population drop is associated with the billion-dollar world trade of shark fin (Clarke, 2004), particularly be fuelled by the soaring of economic development of China (Clarke et al., 2007). One of the most commonly traded species, the blue shark is now threatened because the number of the species being captured has been exceeding the maximum sustainable level (Clarke et al., 2006). These vulnerable organisms characterized with low growth rate and fecundity would be probably wiped out from the ocean (Myers & Worm, 2003), leading to devastating consequences to the marine biodiversity and the entire ecosystem. There is an urge to establish the relevant conservation and resource management programmes for saving these big fish and their living environment through different aspects.

Children's Perceptions of Sharks and Environmental Issues

Many years ago, when I worked as a narrator in the Hong Kong Ocean Park (a local theme park), a boy at about 8 to 10 year-old had discussed these big fish with me. 'All sharks are bad guys. We should kill them all. Otherwise they will eat us!' I tried to explain him the real situation - 'we are killing sharks rather than sharks are

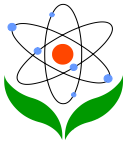


killing us!' It was not a single incident actually. Another girl gave me a similar view - 'sharks love killing so they should be removed from the ocean.' We have no idea on whether this negative insight is found in particular children only or commonly existing among the children. Yet such negative perceptions would definitely exert negative influence to children in learning higher-order concepts and developing their negative attitude towards the environment. If the conceptual frameworks are misinterpreted, the prior conception may probably form an obstacle for further learning (Booth & Koedinger, 2008). The hindrance may be particularly obvious when children are handling the complex issue (Menzel & Bögeholz, 2008). Environmental issues are generally complicated and interlinked with many disciplines (Groves & Pugh, 1996) and thus many studies reported the occurrence of misconceptions is strongly correlated to the poorly established conceptual framework in the environmental issues (e.g. Mangas et al., 1997; Thompson & Mintzes, 2002; Prokop & Tunnicliffe, 2008). In areas of marine ecosystem, alternative conceptions and misunderstandings are not uncommonly found among children as well (e.g. Brody & Koch, 1989; Brody, 1993, 1996). Thus Brody (1993) concluded the children have superficial or poor understanding of basic concepts and principles related to the marine issues. A good foundation of the conceptual frameworks in ecological system may positively support environmental education (Munson, 1994) and thus promote the development of their pro-environmental behaviors (Littledyke, 2008).

This project aims to investigate children's perceptions and their conceptual understanding of sharks and relevant environmental issues. The following questions have been addressed in this research study:

1. What are the primary pupils' perceptual belief and conceptual understanding of sharks and ecological issues?
2. What are the variables associated with the children's perceptual and conceptual development of the issues?

The results have significant implications for improving the current curriculum of environmental science (e.g. the subject General Studies) and promoting environmental education for primary school learners. We believe the children having higher level of conceptual understanding of the issues may develop more positive attitude towards the sharks and the environment, and hence the



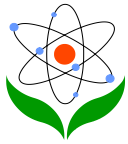
establishment of the commitment to environmental conservation and sustainability in the future.

Methodology

Research Approach

A questionnaire was designed to assess children's perceptual thought, and their conceptual understanding of sharks and its ecological significance. About 16 items of perceptual and conceptual-based issues have been developed for the assessment. The demographic variables including gender, age, academic performance and the ways of acquiring environmental information were investigated. The context of the questionnaires was developed on the basis of the curriculum framework of science education covering in the Strand 2, addressing the aims at promoting students' concern for the environment and equipping their basic understanding of nature and the relationships between the environment and human. The learning objectives 'to recognize the interdependence of living things and their environment', 'to respect and care for all living things' and 'to understand people's responsibility of environmental conservation and recognize the importance of environmental conservation' (Curriculum Development Council, 2011) for key stage 2 (Primary 4-6 levels) were specifically highlighted.

The questionnaire comprised two main parts. The first part included questions about the perceptions of sharks and cognitive understanding of ecological issues. The five-point Likert-type scale (Likert, 1932) has been adopted to measure the perceptual and conceptual issues of the children participants. The Likert scale applied in this study was adjusted (in the range from point 5 = 'very agree' to point 1 = 'very disagree' in positive statements and the 5 to 1 point scores were reversed for negative statements; the score for 'uncertain' response was set at 3). The participants were allowed to select only one option from a pre-defined list of each conceptual item. Full mark reflected the participant having the most positive perception towards the issues and the highest confidence to give the correct answer of the conceptual items. The inclusion of 'uncertain' response was adopted to minimize the random trial. The participants were allowed to select more than one options from multiple non-conflicting options in liberal multiple choice items for denoting extra-dimension of choices made by the participants (Ng & Chan, 2009).



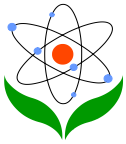
In the second part, the demographic information, the acquired information sources, the reading preference and habit were investigated. Five options ranging from 'less than 1 hr/day' to 'more than 1 hr/day' were provided to assess the reading habits of the participants.

Pilot Study

The issues adopted in the questionnaire have been pilot tested for validity, precision and reliability. Instrument content validity has been qualitatively evaluated by five expert reviewers. The reviewers are the academic and teaching scholars of the relevant expertise in science education, chemistry, biology and environmental science. The Content Validity Index (CVI) of all the 16 items were 1 whereas the the Kappa coefficient for all these items achieved 0.88, reflecting the strong agreement about the relevance of this set of items to the instrument among the experts. External validity has been checked by 8 children randomly selected from a third primary school (excluding from the studied schools) and there was no pre-determined factor applied for the selection so that the participants chosen fell in the range between 7-11 of the age. The results were analyzed and the participants were interviewed for giving comments of the questionnaire. After the interview, minor adjustments have been made to ensure the participants clearly understood the questions in the intended ways (see Summers et al., 2000). The internal consistency was assessed by the item statistics from each question. In the reliability analysis, a Cronbach's alpha coefficient $\alpha = 0.739$ revealed that the measuring tool was reliable.

Sampling Method

The study was conducted between November and December 2010. A total of 140 participants (55 male, 39%; 85 female, 61%) within the age range of 8 to 10 year-old (mean = 8.99, SD = 0.42) from two local primary schools (79, 56% from School A; 61, 44% from School B) participated in the study. The schools were randomly selected from different regions of Hong Kong (one in Tai Po and another one in Diamond Hill). Two classes were randomly selected from primary 4 level of each school and all pupils of these two classes were investigated. One-lesson time (more than half an hour) was allowed for the participants to complete the questionnaire.



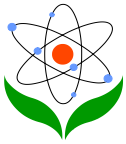
Data Analysis

The data of perceptual thought and conceptual performance of the participants were rated by using the 5-point Likert scale measure. The performance was presented in both the frequency and total score independently, yet most of the data analyses were based on the score values. The overall performance of the participants was presented by the frequency distribution of the scores. The descriptive statistics were calculated by using a software PASW Statistics 18.0.0 (SPSS, Inc.). The mean scores for each conceptual item or in grouped realm (perceptions and conceptions) were analyzed based on corresponding analytical methods provided by the previously mentioned software, including F-test of equality of variances, Student t-test, variance analysis (e.g. 2-factor ANOVA, Tukey's range test and MANOVA), PCA, linear regression and correlation analysis. Tukey's range test was performed as a post-test in analysis of variance. Pearson's correlation coefficient and the Spearman's rank correlation coefficient were calculated to determine the strength of relationship between two variables. Pearson's correlation analysis was performed under the assumptions that the data were normally distributed and measured on an interval or ratio scale while the Spearman's rank correlation analysis was based on the ordinal rank of the data and no assumption of variables approximating multivariate normal distribution. Both methods are mathematically similar but different in ways of measurement and thus a more comprehensive view on the strength of the association between the variables were obtained from both analyses. PCA was conducted on the variance of the scores in the different variables of acquired information sources. All variable variance were reorganized and presented in new groups of orthogonal components (equal to the number of original sources) which represented the dominant trends in the data set. Most noise falling into the later principal components would be discarded by the reductive nature of PCA. The statistical significance for all tests was set at $p < 0.05$.

Results

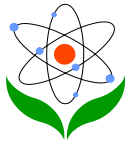
Perceptions of sharks

It was noted that 57.1% of the participants believed sharks enjoying the butchering of marine organisms (item P1 in Table 1) and the children got the lowest score (mean = 2.64, $p < 0.011$) in this perceptual item among the others (Table 2),

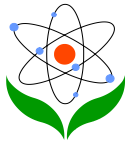


indicating that it was their most negative perception towards the sharks. About 18.6% thought that the misfortune or disaster would associate with the appearance of sharks (P2). There was 37.2% believed humans were threatened by frequent shark attacks (P3), yet 26.5% realized that 'sharks are bad animals and we should kill them all' (P4). The maximum and minimum scores were 1.00 and 5.00, respectively. The mean value of the total perceptual scores was 3.26 among all participants. The mean scores were found insignificant between two genders ($p = 0.778$), two schools ($p = 0.276$) and among different age groups ($p > 0.481$) (Table 2).

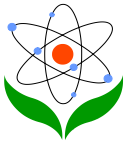
		Perceptual or conceptual items	Nature of statements	Frequency of responses in Likert scale (%) (N = 140)					Summary (%)		
				5	4	3	2	1	Correct	Uncertain	Incorrect
Perceptions	P1	Sharks enjoy the butchering of marine organisms.	-ve	14.3	19.3	9.3	30.0	27.1	33.6	9.3	57.1
	P2	The appearance of sharks links to the occurrence of disaster (misfortune).	-ve	34.3	27.1	20.0	12.9	5.7	61.4	20.0	18.6
	P3	Human beings face a bigger threat than sharks do because of frequent shark attacks.	-ve	27.9	19.3	15.7	23.6	13.6	47.2	15.7	37.2



	P4	Sharks are bad animals and we should kill them all	+ve	30.7	24.3	18.6	13.6	12.9	55.0	18.6	26.5
	Mean frequency of perceptual items			26.8	22.5	15.9	20.0	14.8	49.3	15.9	34.9
Conceptions	C1	Sharks play a role of consumer in food chain.	+ve	12.1	16.4	30.7	22.1	18.6	28.5	30.7	40.7
	C2	Human is the main (normal) diet type of sharks.	-ve	50.0	27.9	15.0	2.9	4.3	77.9	15.0	7.2
	C3	Feeding habit of sharks can be shifted from carnivorous to herbivorous diet.	-ve	27.9	20.7	13.6	15.0	22.9	48.6	13.6	37.9
	C4	Sharks play a role of predator in marine ecosystem.	+ve	25.7	31.4	15.0	15.7	12.1	57.1	15.0	27.8
	C5	Number of peoples be killed by sharks is more than those be killed in traffic	-ve	39.3	13.6	35.0	7.1	5.0	52.9	35.0	12.1

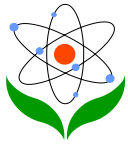


	accidents annually.										
C6	If sharks were disappeared, the marine environment would be full of life.	-ve	38.6	37.1	13.6	5.7	5.0		75.7	13.6	10.7
C7	If sharks were disappeared, the balance of marine ecosystem would not be maintained.	+ve	35.0	15.7	14.3	20.0	15.0		50.7	14.3	35.0
C8	Too many sharks living in the ocean is the main cause of decline in fish catch.	-ve	27.9	24.3	22.1	17.1	8.6		52.2	22.1	25.7
C9	If the number of sharks reduced, the amount of fish catch would dramatically rise.	-ve	28.6	30.0	20.7	13.6	7.1		58.6	20.7	20.7
C10	Many different species are living in the ocean, there	-ve	32.1	25.0	16.4	13.6	12.9		57.1	16.4	26.5

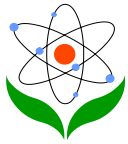


	won't be any effect to the whole environment if only the sharks' population were declined.										
C11	As plankton is not the diet of the great white, there won't be any effect on this shark if the population of planktons were declined.	-ve	25.0	25.0	32.1	8.6	9.3		50.0	32.1	17.9
C12	If sharks were removed, other marine creatures would well proliferate leading to the enhancement of biodiversity.	-ve	35.0	24.3	17.1	15.0	8.6		59.3	17.1	23.6
	Mean frequency of all conceptual items		31.4	24.3	20.5	13.0	10.8		55.7	20.5	23.8

Table 1. Percentage presentation of all participants based on the 5 points Likert Scale in different perceptual and conceptual items. For positive statements: point 5 = 'very agree' to point 1 = 'very disagree', point 3 = 'uncertain'. For negative statements: point 5 = 'very disagree' to point 1 = 'very agree'. All perceptual and conceptual items are presented in the mean frequency.



		All respondents (N=140)		Gender				Age						School			
		Score	SD	Male (N=55)		Female (N=85)		8 (N=13)		9 (N=115)		10 (N=12)		School A(N=79)		School B (N=61)	
				Score	SD	Score	SD	Score	SD	Score	SD	Score	SD	Score	SD	Score	SD
Perceptions	P1	2.64	1.43	2.82	1.45	2.52	1.40	3.00	1.53	2.60	1.40	2.58	1.62	2.39	1.41	2.95	1.40
	P2	3.71	1.22	3.75	1.24	3.69	1.23	3.85	1.46	3.73	1.17	3.42	1.51	3.92	1.21	3.44	1.20
	P3	3.24	1.43	3.22	1.54	3.26	1.36	3.08	1.55	3.25	1.39	3.33	1.72	3.22	1.43	3.28	1.44
	P4	3.46	1.39	3.47	1.45	3.46	1.35	4.23	1.24	3.31	1.40	4.08	1.00	3.56	1.41	3.34	1.35
	Mean score	3.26	0.92	3.31	0.99	3.23	0.86	3.54	1.04	3.22	0.88	3.35	1.11	3.27	0.92	3.25	0.92
Conceptions	C1	2.81	1.26	3.02	1.30	2.68	1.23	3.15	1.28	2.80	1.29	2.58	1.00	2.99	1.39	2.59	1.04
	C2	4.16	1.06	4.35	0.97	4.05	1.11	4.31	1.11	4.11	1.09	4.50	0.67	4.14	1.06	4.20	1.08
	C3	3.16	1.54	2.89	1.58	3.33	1.50	4.15	1.52	3.03	1.50	3.33	1.72	3.37	1.59	2.89	1.45
	C4	3.43	1.35	3.44	1.42	3.42	1.30	3.46	1.56	3.47	1.33	3.00	1.28	3.62	1.32	3.18	1.35
	C5	3.75	1.19	3.76	1.23	3.74	1.18	4.08	0.95	3.74	1.21	3.50	1.31	3.82	1.26	3.66	1.11
	C6	3.99	1.10	4.00	1.19	3.98	1.05	4.38	0.51	3.93	1.15	4.08	1.00	4.16	0.97	3.75	1.22
	C7	3.36	1.50	3.47	1.53	3.28	1.49	3.85	1.46	3.21	1.52	4.25	0.87	3.63	1.53	3.00	1.39
	C8	3.46	1.29	3.56	1.32	3.39	1.28	3.85	1.21	3.37	1.31	3.92	1.08	3.51	1.32	3.39	1.27
	C9	3.59	1.23	3.42	1.21	3.71	1.24	4.08	1.04	3.53	1.24	3.67	1.37	3.59	1.28	3.59	1.19
	C10	3.50	1.40	3.24	1.52	3.67	1.30	3.85	1.41	3.38	1.39	4.25	1.22	3.44	1.50	3.57	1.26



C11	3.48	1.22	3.20	1.35	3.66	1.10		3.54	1.20	3.45	1.21	3.67	1.44		3.51	1.25	3.44	1.19
C12	3.62	1.33	3.60	1.26	3.64	1.38		4.00	1.35	3.52	1.35	4.17	0.84		3.62	1.41	3.62	1.23
Mean Score	3.53	0.54	3.50	0.49	3.55	0.56		3.89	0.47	3.46	0.52	3.74	0.61		3.62	0.50	3.41	0.56

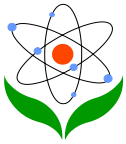
Table 2. Mean value of the perceptual and conceptual scores with standard deviation SD. The sample size is presented in parentheses.

Conceptual understanding

The minimum and maximum scores of the scale range were 1.67 and 4.75, respectively. The mean score of all participants was 3.53 (N = 140, SD = 0.54). More than 51.4% of the participants achieved a score equal to or above the mean value. About 22.1% obtained a very good score of 4 or above. The level of understanding was presented in the mean scores of all participants and different demographic categories (see Table 2). Higher marks reflected the better understanding of the particular conceptual context. Three domains of the conceptual issues were focused: the feeding habit of sharks, its ecological role in the marine ecosystem and impacts on marine biodiversity.

a. Feeding habit of sharks (for items C1 – C5):

The participants got the highest proportion (77.9%) and score (mean = 4.16, $p < 0.047$) in C2 among all the conceptual items that realizing human not the main diet of sharks. It was noted that 95.7% (data not shown in the tables) realized fish as the main diet of sharks, yet 18.6% thought that sharks feed on seaweed. The participants got the lowest score in item C1 (mean = 2.81, $p < 0.047$), indicating the children did not realize the sharks playing the role of consumer in a food chain. However, 57.1% realized the sharks playing the predator role (C4) and this item got an acceptable score (3.43). It was noted that about 51.4% did not realize or falsely believed these top predators can change their feeding mode to herbivorous diet type (C3). This item score 3.16 was not significantly different from the lowest value obtained in the item C1 ($p = 0.711$), reflecting their understanding level to the feeding habit of the sharks should be improved. Yet girls (mean = 3.33) got



significantly higher scores than the boys (mean = 2.89, $p = 0.003$) did in the item C3, reflecting girls may have a better cognitive understanding of the issue.

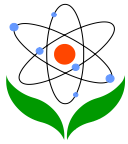
b. Ecological role (for items C6, C7, C10 and C11):

It was noted that only the item C6 (mean = 3.99) showed the higher score than that of C7 (mean = 3.36, $p = 0.007$). All the pairwise scores of the rest items among C6, C7, C10 and C11 showed no significant difference ($p > 0.093$). The results also revealed girls (mean = 3.99) got better scores than the boys did (mean = 3.20, $p = 0.003$) in understanding the ecological association between the planktons and the great white (C11), yet about 32.1% expressed uncertain response on the connection of these two organisms indirectly linked in the food chain.

c. Impacts on marine biodiversity (for items C8, C9 and C12):

More than 20% believed the presence of the sharks leading to the decline of fish stock and biodiversity (C8, C9 and C12). The mean conceptual scores of these items were ranged between 3.46 and 3.62 (no significant difference among the scores, $p > 0.999$). Yet girls (mean = 3.71) got a higher score than the boys did (mean = 3.42, $p = 0.007$) in the item C9.

Demographic variables do not show any obvious effect on the total mean scores of perceptual and conceptual issues in the study. But in particular conceptual items, females got a better performance than the males did yet the overall performance of the both genders was not different ($p = 0.075$). The conceptual score of children from two schools was not differentiated ($p > 0.978$), but the significant difference was revealed between the age groups of 8 (mean = 3.89) and 9 (mean = 3.46, $p = 0.015$). Yet the interpretation should be handled with care because the comparison was made on very unequal size of children of different age groups and of small effect size ($Z = -2.258$, effect size $r = 0.219$) and thus further evidences are required for making an affirmative conclusion. .

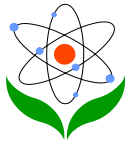


Correlation between the total scores and the source of information acquired and reading preference variable in study

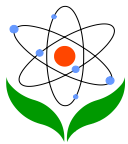
a. Source of information acquired

1. Perceptual scores:

Only both coefficients showing the significance were presented in this section. Book (the correlation coefficients were > 0.210 , $p < 0.013$) and parental (coefficients > 0.193 , $p < 0.013$) sources exerted a significant correlation to the perceptual scores in item P2 (Table 3), whereas TV documentary (coefficients > 0.179 , $p < 0.034$) exerted a positive effect in item P4. The results indicated that the children getting information from the above sources were correlated to the development of their positive perception towards the sharks in particular issues. However, sources of internet forum (coefficients > -0.172 , $p < 0.042$) and computer games (coefficients > -0.163 , $p < 0.050$) exhibited a negative effect in item P3 (Human face a big threats because of frequent shark attacks). In general, no information source was found to be correlated to the total perceptual scores for all participants. But the TV documentary exhibited the positive correlation to the perceptual scores in girls (coefficients > 0.330 , $p < 0.002$).



			Information sources								
			BK (N=77) 55.0%	DO (N=58) 41.4%	FR (N=27) 19.2%	OP (N=95) 67.9%	PA (N=75) 53.6%	PG (N=35) 25.0%	TE (N=55) 39.3%	WS (N=73) 52.1%	
Perceptions	P2	P	0.212*	0.126	-0.034	0.090	0.193*	0.000	0.068	0.022	
		S	0.210*	0.159	-0.009	0.077	0.210*	0.006	0.066	0.052	
	P3	P	-0.068	0.081	-0.172*	-0.119	0.088	-0.168*	-0.004	0.033	
		S	-0.069	0.080	-0.177*	-0.122	0.090	-0.163*	-0.002	0.028	
	P4	P	-0.008	0.179*	-0.007	-0.068	0.033	-0.015	0.026	0.053	
		S	-0.016	0.181*	-0.019	-0.082	0.037	0.001	0.023	0.051	
	Overall	P	0.030	0.146	-0.142	-0.086	0.124	-0.059	0.064	0.023	
		S	0.001	0.156	-0.159	-0.103	0.090	-0.046	0.044	0.006	
	Conceptions	C1	P	0.026	-0.026	0.159	0.178*	0.102	0.046	-0.032	0.222**
			S	0.031	-0.043	0.154	0.163	0.090	0.031	-0.038	0.218**
C2		P	-0.117	-0.007	-0.230**	0.020	0.171*	-0.058	0.041	-0.067	
		S	-0.081	0.053	-0.144	0.050	0.270**	-0.005	0.118	-0.032	
C4		P	-0.096	-0.052	0.060	-0.008	-0.055	0.012	-0.191*	-0.046	
		S	-0.084	-0.054	0.078	0.002	-0.017	0.006	-0.180*	-0.023	
C5		P	-0.094	-0.055	-0.156	-0.157	-0.075	-0.045	-0.114	-0.081	
		S	-0.092	-0.020	-0.142	-0.168*	-0.071	-0.018	-0.122	-0.085	
C6		P	0.145	0.170*	0.056	0.033	0.184*	-0.143	0.131	0.092	
		S	0.102	0.215*	0.038	0.019	0.179*	-0.116	0.148	0.078	

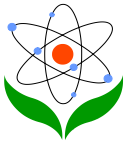


C8	P	0.009	0.084	0.037	-0.064	0.175*	-0.038	0.021	0.118
	S	0.018	0.101	0.043	-0.069	0.180*	-0.025	0.016	0.115
C9	P	-0.019	0.054	0.073	-0.029	0.134	-0.171*	0.052	0.067
	S	-0.036	0.081	0.088	-0.004	0.148	-0.152	0.062	0.076
C10	P	0.067	0.094	0.124	-0.170*	0.057	-0.113	0.110	0.118
	S	0.067	0.136	0.139	-0.191*	0.077	-0.097	0.128	0.143
C12	P	0.088	0.153	0.017	-0.116	0.221**	-0.047	0.120	0.083
	S	0.079	0.149	0.022	-0.099	0.228**	-0.045	0.103	0.097
Overall	P	-0.008	0.109	-0.004	-0.096	0.195*	-0.157	0.046	0.102
	S	-0.015	0.106	0.002	-0.118	0.215*	-0.158	0.053	0.081

*Table 3. Correlation of the perceptual and conceptual scores to different sources of information acquisition. Pearson correlation coefficients denoted by P (upper position) and Spearman's rank correlation coefficients denoted by S (lower position). Correlation is significant at the p values < 0.05 * or p < 0.01 **. The significant values are displayed in bold font. For the item that not showing any significant value is not included in the table. Number of children selecting the information sources are presented in parentheses (N=X) and its percentage over all participants (N = 140) is presented aside. (Abbreviations denoting the information sources: BK-books, DO-TV documentary, FR-internet forum, OP- HK Ocean Park, PA-parents, PG-computer games, TE-teachers, WS-internet websites of government or NGO.)*

2. Conceptual scores:

Sources of TV documentary (coefficients > 0.170, p < 0.045) and websites of government or NGO (coefficients > 0.218, p < 0.010) exerted the positive correlation to the conceptual scores in items C6 and C1, respectively, whereas the parental source showed the positive correlations in items C2, C6, C8 and C12. This source showed the most significant effects to the conceptual performance and it was the only source that affected the total conceptual scores among all information



sources in study (coefficients > 0.195 , $p < 0.021$). But it was interesting to find that the parental source was significantly correlated to the overall conceptual performance of boys (coefficients > 0.266 , $p < 0.049$), whereas the TV documentary source was correlated to the performance of girls (coefficients > 0.259 , $p < 0.017$). Yet it was unexpected to note that sources of teacher (coefficients = -0.180 , $p < 0.033$) and Ocean Park (coefficients = -0.170 , $p < 0.044$) exerted a negative effect in items C4 and C10, respectively.

3. PCA analysis of the information sources in association with the conceptual scores:

To further explore the possible associations among different information sources on the conceptual scores, data were analyzed by employing the PCA method. The PCA illustrated the relationships among the different parameters in a spatial distribution. Results were presented on the plane of the two principal components with the first one explained 91.4% and the second one explained 3.4% (Figure 1). Two clusters were distinctively identified from the projection of the data points onto the two dimensions. Cluster I grouped the various parameters with the acquisition of the information sources while Cluster II grouped those without. It was apparent that the scores between the groups of with (cluster I) and without (cluster II) the acquisition of the information sources (for most types) were distinctively differentiated. However, sources of internet forum and computer games were dissociated from the two main clusters. Both groups for computer game lie in the middle position between the two clusters, indicating their specific effects exerting on the participants' performance.

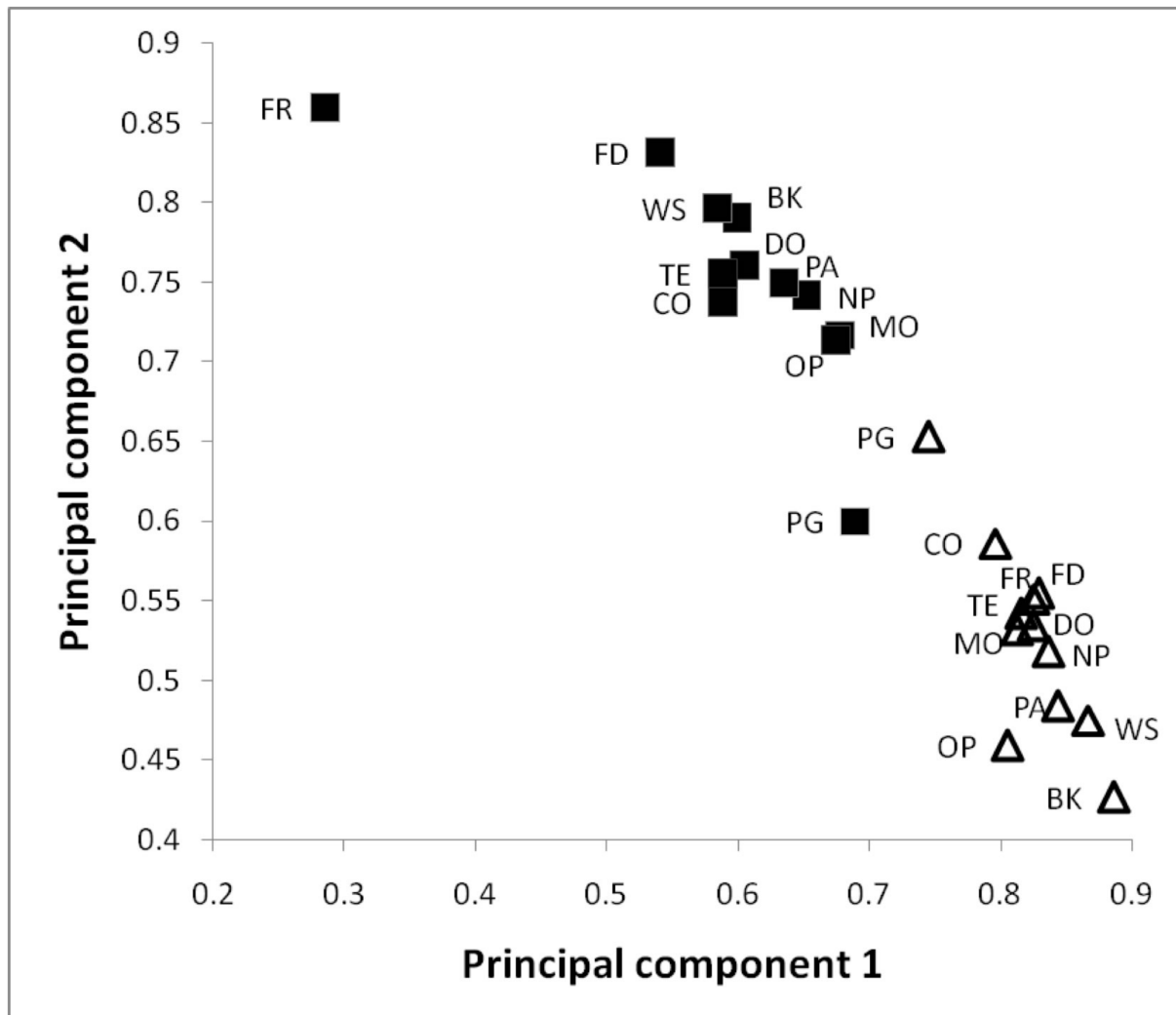
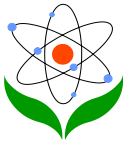
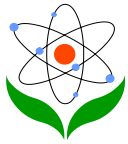


Figure 1. Ordination of acquired information sources in association with the performance on the plane of the two first axes of the PCA. The symbol \blacksquare is denoted as the data score from participants showing the acquisition of the particular information source, while \triangle is denoted as no acquisition of the source. (Abbreviations denoting the information: BK-books, CO-comics, DO-TV documentary, FD-friends, FR-internet forum, MO-movies, NP-newspapers, OP-Ocean Park, PA-parents, PG-computer games, TE-teachers, WS-internet websites (government/NGO)).



b. Reading habit and preference

1. Reading habit

It was encouraging to reveal that the participants spending more time on reading would be associated with the higher total scores in perceptual (coefficients > 0.243 , $p < 0.005$) and conceptual (Pearson correlation coefficient = 0.243 , $p < 0.005$) issues (Table 4). It was interesting to find that the correlation was obviously significant in girls for both perceptual (coefficients > 0.236 , $p < 0.035$) and conceptual (Pearson coefficient = 0.344 , $p < 0.032$) scores.

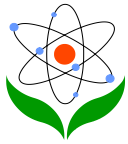
	Perceptual scores			Conceptual scores		
	Gender		All (N=131)	Gender		All (N=131)
	Male (N=51)	Female (N=80)		Male (N=51)	Female (N=80)	
P	0.267	0.277*	0.266**	0.050	0.344*	0.243**
S	0.293*	0.236*	0.243**	0.080	0.239	0.169

Table 4. Correlation of the perceptual and conceptual scores to the time spending on reading. Pearson correlation coefficients denoted by P (upper position) and Spearman's rank correlation coefficients denoted by S (lower position). Correlation is significant at the p values < 0.05 * or $p < 0.01$ **.

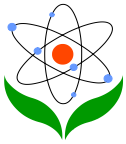
2. Reading preference

i. Perceptual scores:

Participants preferring the book types of the nature were associated with the higher perceptual scores in items P2 (coefficients > 0.167 , $p < 0.048$) and P4 (coefficients > 0.186 , $p < 0.028$), whereas the reading preference on entertainment magazines (coefficients < -0.170 , $p < 0.045$) and games (coefficients < -0.223 , $p = 0.008$) exhibited a negative correlation to the perceptual scores in item P3 (human face frequent shark attacks). But in general, no reading preference was found to be correlated to the total perceptual scores (Table 5).



			Reading preference				
			CI (N=17) 12.1%	CO (N=75) 53.6%	EN (N=20) 14.3%	GA (N=31) 22.1%	NA (N=59) 42.1%
Perceptions	P2	P	-0.110	0.017	-0.088	-0.101	0.176*
		S	-0.097	0.013	-0.085	-0.104	0.167*
	P3	P	-0.156	0.028	-0.170*	-0.224**	0.017
		S	-0.153	0.023	-0.171*	-0.223**	0.017
	P4	P	-0.014	0.116	-0.004	-0.005	0.195*
		S	-0.022	0.110	0.019	0.004	0.186*
	Overall	P	-0.102	0.109	-0.107	-0.122	0.149
		S	-0.091	0.126	-0.098	-0.102	0.145
Conceptions	C1	P	-0.049	0.022	0.190*	0.051	-0.035
		S	-0.047	0.019	0.185*	0.051	-0.036
	C2	P	-0.120	0.158	0.072	-0.018	0.141
		S	-0.043	0.185*	0.086	-0.015	0.159
	C5	P	-0.161	0.190*	-0.051	-0.004	0.009
		S	-0.168*	0.183*	-0.043	0.014	0.014
	C8	P	-0.098	-0.048	-0.034	0.064	0.157*
		S	-0.094	-0.066	-0.045	0.061	0.159*
		P	-0.090	-0.203*	-0.114	-0.089	0.106
		S	-0.079	-0.206*	-0.101	-0.095	0.091

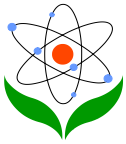


	C9						
	C12	P	-0.042	-0.017	-0.037	-0.068	0.168*
		S	-0.048	-0.019	-0.041	-0.093	0.147
	Overall	P	-0.124	0.011	0.035	-0.066	0.183*
		S	-0.120	0.011	0.064	-0.053	0.164

*Table 5. Correlation of the perceptual and conceptual scores to reading preference. Pearson correlation coefficients denoted by P (upper position) and Spearman's rank correlation coefficients denoted by S (lower position). Correlation is significant at the p values < 0.05 * or $p < 0.01$ **. The significant values are displayed in bold fonts. For the item that not showing any significant value is not included in the table. Number of children selecting the preferred reading book type is presented in parentheses and its percentage over all participants is displayed aside. (Abbreviations denoting the information sources: CI-computer information, CO-comics, EN-entertainment magazines, GA-computer games, NA-nature)*

ii. Conceptual scores:

It is interesting to note that the participants preferring the book types of comics, entertainment magazine and the nature were associated with the higher conceptual scores in items C5 (coefficients > 0.183 , $p < 0.030$), C1 (coefficients > 0.185 , $p < 0.028$) and C8 (coefficients > 0.157 , $p < 0.049$), respectively, whereas the book type of comics also displayed a negative correlation to the conceptual scores of item C9 (coefficients < -0.203 , $p < 0.016$). In general, the reading preference of the nature type was found to be positively correlated to the overall conceptual scores in Pearson correlation only (coefficient = 0.183, $p = 0.031$; Spearman's Rank = 0.164, $p = 0.053$).



c. Academic results

There was a significant correlation between the total conceptual scores and the final subject scores (examination results) of General Studies in the first semester of the academic year 2010-11 of all participants and different genders ($p < 0.002$) (Figure 2). The slopes of the regression lines for both genders were not significantly different from each other ($p = 0.985$), indicating no gender showed any advantage to the mean scores in relation of their academic results.

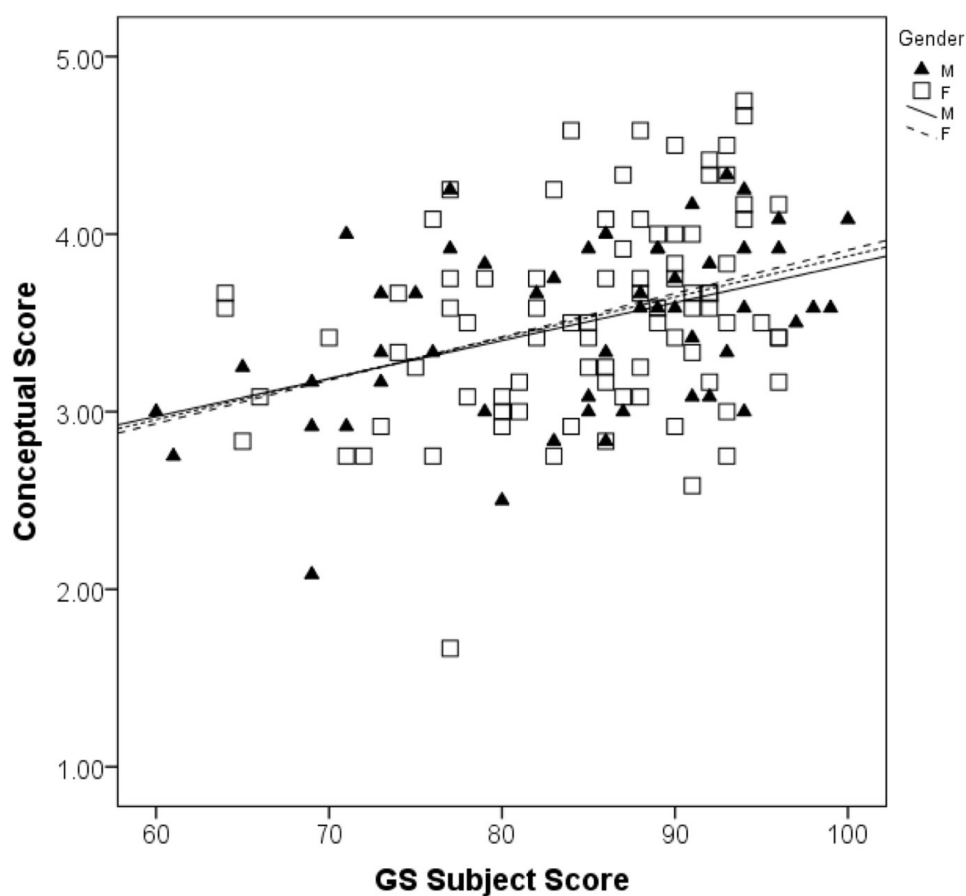
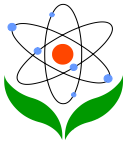


Figure 2. Relationship between the conceptual scores and the final scores of the participants in the subject General Studies in the first semester of the academic year 2010-11. Full mark of the subject score is 100. The regression equations of the best-fit lines are $Y = 0.02X + 1.69$ ($r^2 = 0.195$, $p = 0.002$, $N = 53$ for male), $Y = 0.02X + 1.47$ ($r^2 = 0.121$, $p = 0.020$, $N = 85$ for female) and $Y = 0.02X + 1.57$ ($r^2 = 0.145$, $p < 0.001$, $N = 138$ for all participants).



d. Correlation between the perceptual and conceptual scores

Positive and significant correlation (slope = 0.98, $p < 0.001$) was found between the total conceptual and perceptual scores (Figure 3), indicating that the higher level of conceptual understanding was associated with the more positive perception towards the sharks. The slopes of the regression lines for both genders were not significantly different ($p = 0.223$).

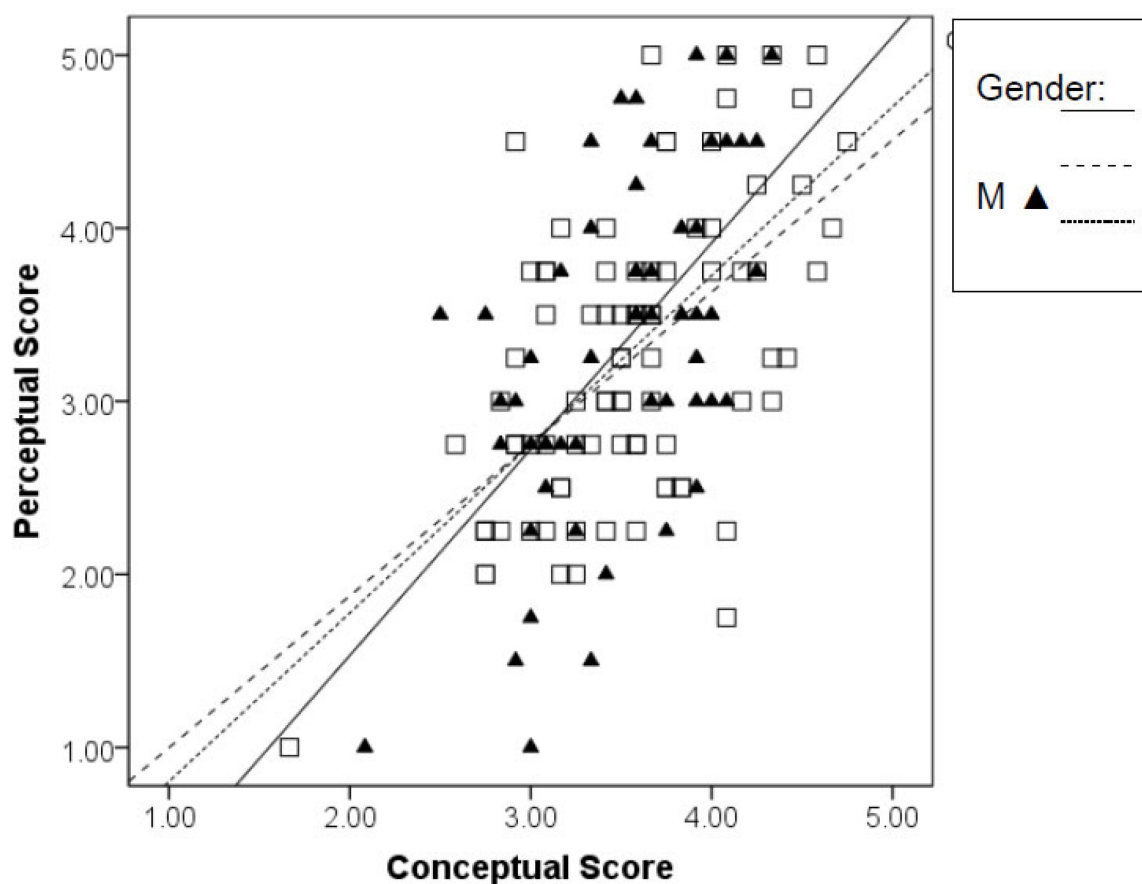
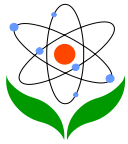


Figure 3. Relationship between the perceptual and conceptual scores. The regression equations of the best-fit lines are $Y = 1.19X - 0.85$ ($r^2 = 0.344$, $p < 0.001$, $N = 53$ for male), $Y = 0.89X + 0.12$ ($r^2 = 0.329$, $p < 0.001$, $N = 85$ for female) and $Y = 0.98X - 0.17$ ($r^2 = 0.325$, $p < 0.001$, $N = 138$ for all participants).

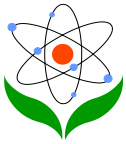


Discussion

Children's perception of sharks

More than 57% participants believe sharks enjoying the butchering of marine organisms and about 19% believe the misfortune or disaster would come once sharks appear. More than 37% suppose human face frequent shark attacks, whereas 25% have considered killing the sharks because they are claimed to be bad guys. It is interesting to unveil the causes for developing such negative perceptions toward the sharks among the children. We suppose the mass media may exert a great effect to the perceptual belief of the children. This view is affirmed by the data obtained from this project. Our study explores the significant but negative correlation between the children's perceptions and the information sources popularly accessed by the youth, including internet forum, entertainment magazines, book types of games and even the computer game itself. The discussion of the following contexts is based on these issues.

A focal group interview affirms that the fearful portray of sharks is induced by the mass media and movie. The emotive reaction and too much media hype may probably perpetuate the myths of shark attack (Peschak, 2006; Preen & Richards, 2006). The public responses of the attacks are commonly exaggerated and over-stressed, leading to the illusion that shark attacks are frequent and serious (Peschak, 2006; Rochat, 2006). A well known example is the phenomenon induced by a media show 'Summer of the Shark 2001'. The TV programme not only sparked hot debates in America, but also triggered the press over-stressing on shark attack incidence during the show period. The similar situation occurs in local media. It is not uncommon to find frightening wordings and portrays in reporting shark attack events. For instances, a headline highlighted 'Jaws is on show in Egypt – cutting swimmers into pieces' in a local newspaper, Ming Pao on Dec 7, 2010 (page A25). Children's perception of sharks might have been nurtured amid such engrossed public attention and emotive media (Corey, 2009). This may explain why about 37% of children believe we are facing the frequent shark attacks, whereas 50% of children don't know or falsely believe the number of peoples being killed in shark attack is more than those in traffic accidents. Actually the number of people being killed by the shark attacks declined from 11 in 2000 to 6 in 2010 (Florida Museum of Natural History, University of Florida, 2011), yet nearly 1.27

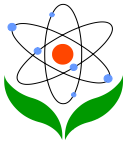


million peoples are killed in the road accident every year (WHO, 2008). Peschak (2006) suggested the media should play a more constructive role in communicating precisely on the factual issues of sharks to the public.

The improvement of the 3-dimensional or computerized graphic technique may improve the realism (Frank, 2003). Recently, such advanced imaging technique has been widely applied in making animations or movies. In some popular movies such as '*Shark tale*' and '*Finding Nemo*', sharks are described as gang members, mobs or mad guys. About 50% of the students have seen the above movies and described the sharks as bad guys as well in the focal group interview (data not shown in this study), whereas 30% of the children participating our study supports the view 'sharks are bad animals'. These informal messages combining with the overstressed propagation would exaggerate the fact (Slovic & Fischhoff, 1977), easily projecting the fearsome or bad character into all sharks (Daskolia et al., 2006). Furthermore, children and teenagers play computer games very popularly. Some shark-related online games have been searched. The match results show that almost all games project the theme of sharks killing peoples. For example, in the online game 'Mad Shark game' <http://www.funny-games.biz/shark-game.html>, the player (shark) tries to escape from the human attack but need to eat enough food (including human) to keep their strength. In another game 'Swim for your life' <http://www.freeonlinegames.name/en/games/swim-for-your-life.html>, the player acts as a boat rider to avoid the attack from a hungry shark. Such ideas influence the children's belief and perception, leading to the views like sharks enjoying the butchering of marine organisms and shark appearance associating with the misfortune or disaster. Such negative ideas also form a hindrance for handling the complex issue in the learning process (Menzel & Bögeholz, 2008).

Children's conceptual level

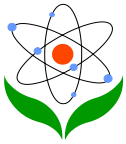
Not just the media or games, we believe the level of conceptual understanding about the shark issues is also important for shaping their perceptual thought. We have affirmed a positive and significant correlation between the conceptual and perceptual scores, indicating that the higher level of conceptual understanding is associated with the more positive perception towards the sharks. It is noted that the conceptual score is generally not correlated to any genders, age and schools according to the current study. However it is found to have a positive correlation between the academic results of the subject General Studies. According to



the *General Studies for Primary Schools Curriculum Guide* (Curriculum Development Council, 2011), one of the subject learning outcomes is to develop pupils' care and concern for the environment under the strand of 'People and Environment'. This strand aims to promote their basic understanding of the nature and the relationships between mankind and the environment. The current study reflects the effective alignment of the curriculum contexts to its intended learning objectives.

Ecological concepts are fundamental of environmental education for children (Munson, 1994; Hungerford et al., 2001; Jordan et al., 2009). The following discussion focus on the children's understanding of the ecological concepts in aspects of feeding mode of sharks, their ecological significance and impacts on biodiversity. Feeding relationships among different species of a biotic community are regarded as the core study concepts in ecology and ecosystem (Griffiths & Grant, 1985; Gallegos et al., 1994; Leach et al., 1995). More than half of children realize the predator role of sharks in the ecosystem yet it is interesting to note that the information source obtained from teachers give a negative impact on this conceptual issue. Further exploration is required to clarify what the problem is. We have discussed the perception mediated by the sensational responses of the media and the computer games that sharks are generally described as man-eating animals. Thus it is not surprised to report about one fifth of the children having the false belief that human is their normal diet type. The results of these items also reveal their insufficiency of the ecological concepts. All sharks are carnivores and most of the species feed on relatively small fish (Carrier et al., 2004). Yet around one fifth of participants claim sharks feed on seaweed and more than half believed sharks could shift from carnivorous to herbivorous feeding mode, reflecting their poor understanding of the ecological and knowledge background about the sharks.

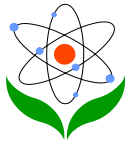
Nearly half of the children could not truly reflect the interaction among different organisms living in the marine ecosystem. The complexity of how the components interacting together in ecosystems (Hmelo-Silver & Azevedo, 2006) make the ecological concepts becoming the difficult topics for learning and understanding (e.g. Adeniyi 1985; Griffiths & Grant, 1985; Gallegos et al., 1994; Munson, 1994; Barman et al., 1995; Grotzer & Basca, 2003). For handling these complex issues, children may prone to use a simple way for reasoning (Groves & Pugh, 2002), leading to insufficient understanding or even the occurrence of misunderstanding (Papadimitriou, 2004). In our study, a conceptual item is raised to investigate their



understanding of the relationship between the great white and plankton. Plankton is not the diet of the carnivorous great white but it takes an essential role as the producer to capture the light energy (phytoplankton). It participates in the energy transfer process in the form of biomass to other organisms of the higher trophic level and finally to the top predators within the ecosystem. This tiny plankton may thus support the whole ecosystem including the great white. However, about 43% of the participants do not realize the link between these two organisms, but about 96% realize the more obvious feeding relationship between shark and fish. Their misconceptions are associated with the difficulty in understanding the concepts in views of the holistic 'system' (Barman et al., 1995; Palmer, 1997; Grotzer & Basca, 2003). The children simply consider the direct link of predator and prey, but neglect the inter-dependency of other organisms (the whole ecosystem) living in the same habitat. A similar thought is also revealed in another study that the sharks would only be slightly affected if all producers disappear (Barman & Mayer, 1994). This may explain why young learners generally made a common misconception that the population of one organism is only important for the others on which it feeds or the two organisms are directly linked by the predator and prey relationship (Griffiths & Grant, 1985; Barman & Mayer, 1994; Munson, 1994).

In the impacts of biodiversity, about half participants believe 'too many sharks' is the main cause of the fish catch decline, revealing that children tend to think about the interrelatedness in a simple link of the predator-prey relationship (discussed in the previous section) and the linear cause-effect pathway as similar as other studies reported (Griffiths & Grant, 1985; Munson, 1994; Barman et al., 1995; Leach et al., 1996; Green, 1997). An interesting finding obtained from a similar scenario shows that more than third quarters realize shark catchers should take the greatest accountability for the drop of shark population whereas only about one third claim the responsibility of fin eaters (data not shown in the result section). It is believed the children neglect someone left behind - who drives the shark catchers hunting more sharks. Children generally like to use this simple linear model to explain the direct link between the cause and effect in various ecological scenarios and thus they have the difficulty in grasping the concepts of multiple causality to account of the relation (Green, 1997; Grotzer & Basca, 2003). Therefore Jordan et al. (2009) suggested enhancing the explicit delineation of the concepts 'systems' and 'cycles' for promoting the deeper understanding of the interactions and connections.

Information sources and reading preference

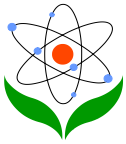


Another interesting finding is the way of information acquired for the development of conceptual framework in shark and ecological issues. Not only books, television programme and internet websites have also been regarded as the typical materials and sources of information for facilitating the conceptualization in the modern world (Tsikalas et al., 2007). Among the various information sources in study, only the parental source is found to have a significant and positive correlation to the total conceptual scores. Parental involvements have been proved to have beneficial effects to academic outcomes and achievement of children (e.g. Eccles & Harold, 1993; Strage & Swanson-Brandt, 1999; Hill, 2001; Rosenzweig, 2001; Epstein & Sanders, 2002). Ho and Willms (1996) agreed home discussion like talking with parents is strongly associated with the academic achievement of children. Rintoul et al. (1998) suggested more parental interactions may facilitate the children's cognitive development, whereas Hoff-Ginsberg (1986) and Vibbert & Bornstein (1989) reported the information providing by the parents may exert positive effects on the growth of the children's cognitive skill. Our study also reveals that the parental information source is constructive for the promotion of the children's performance, especially significant to boys, whereas book preference on nature and TV documentary are found to be significantly associated with the performance of girls. It may be explained that females are reported to preferably use reading and well-organized materials for learning (Keri 2002) or more significant use of learning strategies (Valle et al., 1997; Rusillo & Arias, 2004). However the conceptual scores and PCA results support that the information source from the internet forum and computer games exert the negative influence to the performance.

Educational implications

This study reveals a high proportion of children getting negative perceptions and poor conceptual understanding of sharks. We suggest three approaches for improving the children in learning the issues.

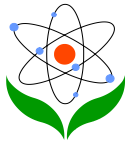
1. Conceptual background: This study verifies the positive correlation between the perceptual thought and the conceptual understanding. Negative perceptions and misconceptions are grounded on the insufficient knowledge framework and understanding of the ecological significance of the sharks and the relevant ecological issues. We believe the promotion of the shark and



environmental conservation should be based on the correct and throughout understanding of this animal and its relevant ecological knowledge.

2. Information sources: Another approach is the identification of constructive information sources in learning process. Those books and TV documentary should be actively promoted, while the parental education is a very potential way to be developed for fostering the children's environmental understanding and literacy. However for those children preferring to acquire information from internet forum or entertainment magazines, or like playing computer games and reading books about games (computer), more guidance should be given for avoiding any potential occurrence of misconceptions and negative attitude.
3. Pedagogical approaches: The third approach is the improvement of pedagogical strategy for promoting their conceptual change. This study reveals the gender sensitive attributes and thus the specific pedagogical strategies can be developed on the basis of the gender needs. For example, encouraging more parental involvement and support may have a big gain in the conceptual performance of their children, especially for boys. More seminars or workshops can be organized for the parents. More book types of nature and TV documentary should be provided in school or at home, yet girls may get a big gain from this approach instead. A good reading habit should also be encouraged to all children. The effect of computer game is bidirectional (Vigdor and Ladd 2010) and thus this tool can also be transformed into an informative learning aid if correct information and positive attitude towards the issues is aligned into the game design.

In general, this study provides some significant insights into the development of children's perceptions and conceptions of sharks and related ecological issues. These perceptual belief and conceptual understanding may form the critical foundation for promoting the environmental education and developing children's environmental literacy.

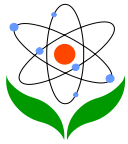


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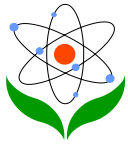
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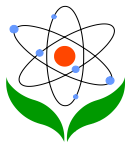
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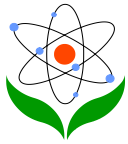
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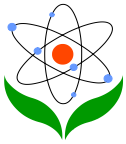
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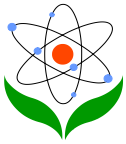
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