

SOCIO-CULTURAL INFLUENCES ON CHILDREN'S CONCEPTIONS OF CHANCE AND PROBABILITY

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This study investigates conceptions of chance and probability held by children who live and attend schools in different socio-cultural settings in Greece and Jordan.[1] Different socio-cultural settings attribute different values in those social activities that the concepts of chance and probability are rooted and referred to. Furthermore, people conceive differently world's control by God and hence causality of everyday life events due to their different religious beliefs and their associated social values. Our research evidence suggests that religious beliefs and social values may be considered as an important influence on children's conceptions of chance and probability conforming or contradicting their mathematics teaching.

INTRODUCTION

Mathematics education as cultural induction has been well researched over the last twenty years (e.g., Bishop, 1988, Seah & Bishop, 2002, Wilson, 1986) and this research clearly shows that values are an integral part of mathematics learning and teaching. As Bishop (2001: 347) put it:

“values exist on all levels of human relationships. On the individual level, learners have their own preferences and abilities that predispose them to value certain activities more than others. In the classroom, values are inherent in the negotiation of meanings between teacher and students and among the students themselves. At the institutional level, we enter the political world. Here, members of organisations engage in debates about both deep and superficial issues, including priorities in determining local curricula, schedules, teaching approaches, and so on. The larger political scene is at the societal level, where powerful institutions determine national and state priorities for mathematics curricula, teacher-preparation requirements, and other issues. Finally, at the cultural level, the very sources of knowledge, beliefs, and language influence our values in mathematics education. Further, different cultures influence values in different ways. Cultures do not all share the same values.”

It may be claimed, therefore, that values also shape children's mathematical thinking as school learners. In this context mathematics learning and teaching may not be considered culture-free – needless to say value-free – as is the case of mathematical knowledge itself. Mathematics learning and teaching are culturally situated and mathematical knowledge is culturally based, embedding social and cultural values, in an overt or hidden way.

THE 'EMBEDDED VALUES' IN MATHEMATICS

Bishop (1988) has described three pairs of complementary sets of values created during the development of modern mathematics. These values are thereafter carried by, and transferred through, the school mathematics all over the world, thus being indispensable of the dominant/Western culture of mathematics education.

The first pair of values is "*rationalism*", involving ideas such as logical and hypothetical reasoning and "*objectism*", involving ideas such as symbolising and concretising ideas. The second pair of values includes the value of "*control*", involving the security that mathematics offers through its rules and their applications to non-mathematical situations and the value of "*progress*" characterising mathematical knowledge and its development through a continuous search of mathematicians for change and alternatives. The third pair of values embedded in mathematics includes the value of "*openness*" related to the public verification of mathematical knowledge by published proofs and demonstrations; through these proofs and demonstrations mathematics is considered to be open to examination by anybody having the necessary prerequisite knowledge. Complementary to the value of "*openness*" is the value of "*mystery*" covering the sources of mathematical ideas as well as their results.

If these six values are associated to mathematics as a school subject commonly taught around the world, what about individual concepts, symbols, practices and products of the mathematical activity?

Each mathematical concept, symbol, practice and product can be seen as having two aspects. One aspect relates to its mathematical meaning that is acquired by a particular mathematical theory in which it is embedded. The other aspect of the same mathematical construct relates to the values associated by the people employing it in their everyday activities and/or by various communities using mathematics in their practices. This second aspect is socially and historically determined, since one mathematical construct can be valued in one context and de-valued in another while its value in the same context can change over time due to social changes.

Mathematical constructs, just as many other mental constructs, are used to describe and manipulate real world situations. Any such description or manipulation of a real world situation may be considered as a micro-theory of that particular aspect of the real world; in such a case any implicated mathematical statement may be interpreted as a statement about that aspect of reality. The addition on integers for instance, may be employed to and considered as a reasonable micro-theory of a particular financial transaction. Thus, any mathematical statement implied by that particular use of addition to a particular financial transaction is interpreted as a statement about that particular aspect of social reality.

Real world situations, however, acquire their meanings by implicated human activities, that are always intentional, therefore meaningful. Consequently, real world

situations and their representations, as well as associated human activities bear meanings that are never value-free. The mathematical constructs used to describe and/or manipulate real world situations reflect these particular value-laden meanings and, at the same time, contribute to the valuing of meanings imposing thus on the real world situations the values of the dominant culture of mathematics.

CHILDREN'S CONCEPTIONS OF CHANCE AND PROBABILITY

Since the first study of Piaget and Inhelder (1975) on the development of the idea of chance in children, literature on children's conceptions of chance and probability as well as on the influence of teaching on these conceptions has considerably grown. A concise review of the research on probabilistic thinking, as well as on the learning and teaching of probability during the 50 years from the 1950s onwards is provided by Jones & Thornton (2005).

Although, an overview of this literature is not feasible in our paper, an overall comment is necessary. The powerful impact of Piagetian perspective through its guiding principles of psychologisation and individualisation seems to have promoted a context-free approach of the study of children's conceptions of chance and probability, as well as of their learning and teaching in schools. The knowledge acquisition of chance and probability has not been problematised from a socio-cultural point of view, in spite of the historical reviews which underline the influential role played by philosophical ideas on the formation and development of these concepts and their relative ones (e.g. Batanero et al., 2005). Consequently, contextual aspects as represented by social, cultural and political factors has not been given considerable attention, in contrast to factors related to either psychological or instrumental aspects of learning and teaching concepts of chance and probability, as well as probabilistic thinking.

Few cross-cultural psychology studies approaching probabilistic thinking mainly from a decision-making approach (e.g. Lau & Ranyard, 2005; Wright & Phillips, 1980) seem not to have influenced the relevant research in mathematics education.

SOCIO-CULTURAL INFLUENCES ON CHILDREN'S CONCEPTIONS OF CHANCE AND PROBABILITY: A RESEARCH EVIDENCE

An exemption of the mainstream research on children's conceptions of chance and probability is the study of Amir and Williams (1999) investigating cultural influences on the thinking about "chance" and "luck" of 11-12 year old children in England, partly of Asian origin, in relation to their stories about these concepts, their religious beliefs about certain events, their use of language expressing probability and their experience of games of chance and other probabilistic phenomena. A main conclusion of this study is that language, beliefs and experience of children, as components of their culture, influence their informal knowledge of probability while a significant proportion of children (Muslim more so than Christian) revealed

superstitions and attributed outcomes of chance events to God. The researchers claim that verbal ability of children incorporating a large part of cultural differences accounted for the differences observed in probabilistic thinking.

The rationale and results of this research have influenced our study's approach; the research reported here was carried out in two stages. In the first, descriptive stage data collected using questionnaires from 6th grade children (10-11 year old) in (a) two elementary schools in Amman, Jordan (72 pupils of Arabian origin, Arabian speakers and Muslims), (b) three schools in Thessaloniki, Greece (75 pupils of Greek origin, Greek speakers and Christians) and (c) one Arabian school of the Palestinian community in Thessaloniki, Greece (11 pupils of which one parent is of Arabian origin, Greek and Arabian speakers and Muslims). At the 6th grade of the elementary school in both countries children had little formal learning on the subject of probability, thus making it easier to induce them to express their informal ideas.

The questionnaire included open questions based on ideas from the relevant literature (e.g. Amir & Williams, 1999; Konold, 1989; Shaughnessy, 1981), intended to elicit children's conceptions of chance and probability. The first part of the questionnaire included questions focusing on the meanings ascribed by the children to the words, which refer to chance and probability. In the second part, children were asked to attribute the cause of an unexpected event happened to them to one of the following: chance, probability, fate or destiny, God's will or to any other causality, making three choices according to their first, second or third thought. The last part of the questionnaire selected children's personal data such as age, gender, parents' origin, religion and languages spoken at home.

In the second, explanatory stage of our research we investigated the conceptions of chance and probability of six children selected from each school, through semi-structured interviews. These interviews further discussed with children questions included in the questionnaire, aiming at the illumination of their thinking on chance and probability, their precision in understanding words expressing chance (e.g., random, possible, frequent, rare, etc.) and their relevant experiences, especially games of chance they played. Particular attention was given to their attributions of unexpected events in relation to their religion beliefs, especially their beliefs about the role of God in the world, as well as their relevant superstitions, if any.

Preliminary observations and conclusions generated by the analysis of the evidence collected both by questionnaires and interviews are outlined in the following.

Children's conceptions of chance and probability

Children's answers to the relevant questions, summarised in the following tables, reveal similarities but also remarkable differences regarding their conceptions of chance and probability, that may be related to their different socio-cultural contexts.

Chance is identified by children with	Jordan N = 72		Greece N = 86	
	Sudden or unexpected	36	50%	40
Luck	1	1%	20	23%
Unwanted	2	3%	11	13%
Not planned	25	35%		
Happening once	6	8%		
Unclear	2	3%		
Error			12	14%
Unknown			3	4%
<i>Note.</i> Percentages in this table are column percentages.				

Table 1. Children’s conceptions of chance

Most children in both countries (in Greece irrespective of their origin) adopting a similar conception identify chance with the sudden or the unexpected event. However, a considerable number of children living in Jordan consider chance to mean something that is not planned, a conception very close to the previous one, in contrast to an equally considerable number of children living in Greece who conceive chance as luck, unwanted or error. In their interviews, children illuminate these conceptions of chance by offering examples from their everyday experiences, as for instance are “meeting unexpectedly a friend”, “finding something in the street”, “witnessing an accident”, “making a mistake in exams”. In contrast, they report “a planned trip”, “an intended something”, “a justified action”, “something difficult to be happen” as a non-random event.

Striking similarities are also found in conceptions of probability held by children in both countries. Most children identify probability with uncertainty, while a remarkable percentage of children living in Greece (irrespective of their origin) interpret probability as a hope for an event to happen. In contrast, children living in Jordan adopt either a mathematically referring meaning associating probability with a percentage rather influenced by school instruction or a meaning of choice between options. The later interpretation of probability is close to the meaning of opportunity given by a small number of children living in Greece. Children illuminate these conceptions of probability by offering examples from their everyday life experiences, as for instance weather forecasts, fulfilment of wishes, football game results. In

addition to these examples, children living in Jordan offered examples of probability referring on war incidents or peace agreements.

Probability is identified by children with	Jordan N = 72		Greece N = 86	
	Uncertainty	40	56%	41
Hope to happen	6	8%	35	41%
May be happen	6	8%	5	6%
Percentage	15	21%		
Choice	5	7%		
Opportunity			5	6%
<i>Note.</i> Percentages in this table are column percentages.				

Table 2: Children’s conceptions of probability

Overall children’s conceptions of chance and probability seems to stem from intuitions and feelings about variation, certainty, what might or what cannot happen. Conceptions, which have also been recorded and analysed in relevant research literature (e.g. Amir & Williams, 1999; Konold, 1989; Shaughnessy, 1981), however not examined in relationship to different socio-cultural contexts.

Children’s attributions of random events

As mentioned, children were asked to attribute the cause of an unexpected event happened to them to one of the following: chance, probability, fate or destiny, God’s will or to any other causality, making three choices according to their first, second or third thought. Their answers are summarised in Table 3. We have to underline that none of the children attributed an unexpected event to fate, superstition or other natural causality, a finding inconsistent with the results reported in the research of Amir & Williams (1999).

It is evident that causalities attributed to an unexpected event by children living in Jordan differ significantly from those of children living in Greece. The formers are mainly referred to God’s will (65% in a first thought) while the later is related to chance (56% in a first thought).

This finding may be ascribed to the different socio-cultural contexts of the children’s life. In a few words, the Arab-Jordanian context is characterised by a strong influence of the Muslim religion and by a widespread consequent personal and social ethos. In the case of chance and probability, Muslim doctrine asserts that God controls the life span and life story and especially the fortune of every person. Thus, Muslims when referring to the future usually qualify any predictions of what will come to pass with

the phrase “Insha’Allah” (if God willed it), recognising that human knowledge of the future is limited and that all (that may or may not happen) are under God’s control. In their interviews children affirmed these beliefs when questioned about their religion beliefs, especially about God’s role in the control of natural phenomena and human affairs. At the same time, the social practices which provide the ground for the emergence of chance and probability (initially as informal conceptions and finally as formal mathematical constructions), such as are gambling or betting, are not only undervalued, but they are prohibited in Muslim societies. However, they are these practices which brought forth the concepts of chance and probability during the 15th century in Western Europe and provided later on the ground for the theory of probability. A mathematical theory which valued and gained its scientific status, as developing capitalism extended the existing fields of its applications and introduced new ones, as for instance are insurance, pensions etc.

On the contrary, Greek context is determined in most aspects by the defining elements of the developed capitalism of Western Europe. Although religiously homogeneous, Greek society is not socio-culturally uniform, and from our research’s viewpoint it is a rather contradictory one. Modern beliefs and life styles are prevailing but they co-exist with conservative Christian religious beliefs and practices, supporting a relevant personal and social ethos characterising particular population groups. For example, gambling and betting are widespread social practices however disapproved by the strict Christian doctrine and its followers.

	Chance		Probability as frequency		God’s will	
Children in Jordan attribute an unexpected event to. N = 72						
in a 1 st thought	20	28%	5	7%	47	65%
in a 2 nd thought	12	17%	45	62%	15	21%
in a 3 rd thought	40	56%	19	26%	13	18%
Children in Greece attribute an unexpected event to. N = 86						
in a 1 st thought	48	56%	16	19%	22	25%
in a 2 nd thought	10	12%	43	50%	33	38%
in a 3 rd thought	27	31%	26	31%	33	38%
<i>Note.</i> Percentages in this table are column percentages.						

Table 3. Children’s attributions of an unexpected event

However, significant differences between children in Greece independent of their origin (Greek or Arabian) and religion (Christians or Muslims) were not found in their attributions of an unexpected event. Furthermore, a relatively high percentage of

them attributed an unexpected event happened to God’s will (25% in a first and 38% in a second and third thought).

Searching for explanation various questions were posed to the children living in Greece during their interview (18 children of Greek origin/Christians and 6 of Arabian origin/Muslims). The following is a specimen question. Seven specific events in various contexts were described (success in school exams, rainy weather, ace in throwing a dice, a football game score, head in tossing a coin, beginning of a war, a road accident) and children were asked to attribute each one to chance, human action or God’s will. The children’s answers are shown in Table 4.

Events	Children Greek origin/Christians N = 18			Children Arabian origin/Muslims N = 6		
	chance	human action	God’s will	chance	human action	God’s will
Success in school exams	6	12		1	5	
Rainy weather tomorrow	3		15			6
Ace in throwing a dice	18			5	1	
A win in football	6	12		2	4	
Head in tossing a coin	15	3		5	1	
Beginning of a war	3	15			3	3
A road accident	6	9	3	2	4	
<i>Note.</i> Numbers in this table are frequencies.						

Table 4. Children’s attributions of specific events

Considering proportionately the frequencies of children’s answers it may be certified that no remarkable differences exist between the two groups.

Thus, according to the evidence drawn from the interviews about religion beliefs and practices of the children and their families, the following claim may be put forward. The considerable number of Greek origin children who attribute an unexpected event to God’s will are strongly religious and they assign anything that happens in the world (natural and social) to God’s control. That is, strong religion beliefs either Christian or Muslim influence in a rather equal extent the conceptions of chance and probability, therefore the probabilistic thinking of people.

However, as several insights provided by interviews of the children indicated, beliefs in God’s will and probabilistic thinking may be compatible in some cases leaving

space to the formation of chance and probability conceptions. This happens whenever children believe that God intervenes in natural phenomena and human affairs in some cases considered important according to the religious doctrine. In other cases God leaves them to chance or to human initiatives. This can explain the differences in the children's attributions of an unexpected event to chance, probability or God's will, even in cases they hold strong religious beliefs.

CONCLUDING REMARKS

Adopting and modifying the idea of categorising knowledge on the basis of its social genesis proposed by Billet (1998), we may claim that the thinking and feeling involved in valuing take place in the context of a:

- Macro-genetic development of the historically derived mathematical knowledge, where cultures (whether intellectual, societal or institutional) form and validate values. It is on this level that the above mentioned dominant/Western mathematical values described by Bishop (1988) were created and are reproduced by academics, researchers, teacher educators, etc.
- Meso-genetic development of knowledge, where the historically derived mathematical knowledge is transformed by cultural needs and norms guiding practice. On this level mathematics curricula and philosophies of mathematics education, mathematics textbooks, students' evaluation and assessment practices, ethos of school mathematics teachers, etc. value aspects of mathematical knowledge.
- Micro-genetic development of knowledge, where everyday mathematics practices and the knowledge negotiation between teachers and students are shaped by/and shape values and norms of teachers and students alike.
- Ontogenetic development of knowledge, in which individuals internalise the socially determined mathematical knowledge through their participation in multiple overlapping communities. It is on this level that personal experiences of learning and using mathematics (in formal, informal and non-formal settings) as well as the relationships, if any, between in-school and out-of-school mathematics value mathematical knowledge.

At this ontogenetic level of mathematical knowledge our research may be considered as a first attempt to trace influences of socio-cultural values on children's conceptions of chance and probability. The underlying notion of our research presumes that values incorporate and determine a person's stance towards what is desirable by using criteria established on both feelings and thoughts. Therefore, a person's values about particular mathematical concepts, symbols, practices and products of mathematical activity crucially shape one's own knowledge and furthermore thinking.

NOTE

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