HOW DO PASIFIKA STUDENTS REASON ABOUT PROBABILITY? SOME FINDINGS FROM FIJI

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ABSTRACT *This paper reports on data from a large study which explored form five (14 to 16 years old) students' ideas in statistics. The study focused on descriptive statistics, graphical representations and probability. This paper discusses the ways in which students made sense of probability questions obtained from the individual interviews. The findings revealed that many of the students used strategies based on prior experiences (beliefs, cultural and school experiences) and intuitive strategies. From the analysis, I identified a four-category rubric that could be considered for describing how students construct meanings for statistics tasks. While the results of the study confirm a number of findings of other researchers, the findings go beyond those discussed in the literature. The use of beliefs and everyday and school experiences was considerably more common than that discussed in literature. The paper concludes by suggesting some implications for teachers and researchers.*

KEYWORDS

Fijian-Indian, Probability, Interviews, Culture, Everyday experience

INTRODUCTION

Probability is a tool that helps quantify uncertainty. It influences how people make individual and collective decisions. In recognition of this, there has been a movement in many countries to include probability at every level in the mathematics curricula. In Western countries, such as Australia (Australian Education Council, 1991) and New Zealand (Ministry of Education, 1992), these developments are reflected in official documents and in materials produced for teachers. In line with these moves, Fiji has also produced a new mathematics prescription at the primary level that gives more emphasis to statistics at this level (Fijian Ministry of Education, Women, Culture, Science and Technology, 1994). However, the concept of probability is introduced at the secondary level (form four) in the context of random events that the students are presumed to see as random.

Research shows that many students find probability difficult to learn and understand in both formal and everyday contexts and that there is a need to better understand how learning and understanding may be influenced by ideas and intuitions developed in early years (Barnes, 1998; Fischbein & Schnarch, 1997). Most of the research in probability has been done with primary school children or with tertiary students, resulting in a gap in the current knowledge about students' conceptions of probability at the secondary level.

Recently there has been evidence pointing to an influence of social settings and culture on mathematics thinking in general. For instance, literature on ethno-mathematics (Barton, 1996) shows strong influences of culture on mathematical thinking of adults. Begg, Bakalevu, Edwards, Koloto and Sharma (1996) suggest that cultural diversity should be valued and that cultures are different, not better or worse. They also state that we need to be aware of our own culture and that of our neighbours and as mathematics educators we can make a significant contribution to the valuing of cultures. However, research illuminating the influence of culture on probabilistic thinking is sparse. Further, most of the research in probability has been done in just a very few Western countries. It needs to be determined how culture influences conceptions of probability, whether biases and misconceptions are artifacts of Western culture, or whether they vary across cultures. For instance, Watson and Callingham (2003) argue that students in 'other cultural settings' may respond differently to their Australian counterparts, particularly to context-based items used in their studies.

Pasifika (Pacific Islands) students have been identified as the most at risk group in New Zealand in terms of academic achievement when compared to other New Zealanders (Nakhid, 2003). For instance, when the results of the Third International Mathematics and Science Study (TIMSS) were broken down by ethnic group, students of Pasifika descent did more poorly than those of Pākehā/European or Asian backgrounds across virtually all levels of the schooling system (i.e., years 4, 5, 8, 9 and 12/13). The results of New Zealand research have shown similar patterns to those of international studies, with Pasifika students performing more poorly than Asian and Pākehā/European students. For example, NEMP project data on mathematics achievement in 1997 found statistically significant differences between Pasifika and non-Pasifika students (Flockton & Crooks, 1998). A number of educators have attributed the underachievement of Pasifika students to an inability to come to terms with the culture of a Eurocentric education system (Barton, 1995; Clark, 1999). Nakhid (2003) writes that most of the literature is the work of doctoral and masters students and focuses on Pasifika students at the tertiary level. There is not much literature on Pasifika students in the New Zealand education system. There is a growing recognition of the need for more informed data and research on issues that have a significant impact on the lives of Pacific students.

Concerns about the situation of Pasifika students in education, lack of research in statistics at the secondary level and the difficulties students have with statistical reasoning all determined the focus of my study. Overall, the study was designed to investigate the ideas that form five Fijian-Indian students have about statistics and probability, and how they construct those ideas. This paper presents and discusses data obtained from probability tasks.

THEORETICAL FRAMEWORK

Much recent research suggests that socio-cultural theories, combined with elements of constructivist theory, provide a useful model of how students learn mathematics. Constructivist theory, in its various forms, is based on a generally agreed principle that learners actively construct ways of knowing as they strive to reconcile present experiences with already existing knowledge (von Glasersfeld, 1993). Students are no longer viewed as passive absorbers of mathematical knowledge conveyed by adults; rather they are considered to construct their own meanings actively by reformulating the new information or restructuring their prior knowledge (Cobb, 1994). However, this active construction process may result in alternative views as well as the student learning the concepts intended by the teacher. Another notion of constructivism derives its origins from the work of socio-cultural theorists such as Vygotsky (1978) and Lave (1988), who suggest that learning should be thought of more as the product of a social process and less as an individual activity. There is strong emphasis on social interactions, language, experience, collaborative learning environments, catering for cultural diversity and contexts for learning in the learning process rather than cognitive ability only. This new dimension influences the interpretation of chance and probabilistic thinking in different situations. Mevarech and Kramarsky (1997) claim that the extensive exposure of students to statistics in out-of-school contexts may create a unique situation where students enter the mathematics class with considerable statistical knowledge. Amir and Williams (1999) see in this topic potential for conflict and interaction between the knowledge of probability which students acquire informally and the formal knowledge and rules which the teacher presents. This means that during the teaching and learning process, students draw inferences about the new information presented to them by relating to some aspect of this prior knowledge to develop a deeper meaning for probabilistic concepts. This research was, therefore, designed to identify students' alternative ideas about probability and to examine how they construct them.

PROBABILITY: CONCEPTIONS AND MISCONCEPTIONS

Despite its decade long presence in mathematics education, a number of research studies seem to show that students tend to have intuitions which impede their learning of probability. Fischbein and Schnarch (1997) analysed the intuitive-based misconceptions of students in grade 5 (ages 10-11), 7 (ages 12-13), 9 (ages 14-15) and 11 (pages 16-17). A questionnaire consisting of seven probability problems was developed and answers were to be written. Each problem was related to a well known probabilistic misconception. One of the questions investigated the representativeness strategy. According to this strategy, students make decisions about the likelihood of an event based upon how similar the event is to the population from which it is drawn, or how similar the event is to the process by which the outcome is generated. For instance, a long string of heads does not appear to be representative of the random process of flipping a coin, and so those who are employing representativeness would expect tails to be more likely on subsequent tosses until things evened out. It must be acknowledged that the mistaken belief that successive independent events causally influence the outcome of later events is not unique to students; it abounds in everyday life, and even experts can fall prey to this fallacy.

Lecoutre (1992) proposed that an equiprobability bias should be added to the list of the biases discussed in literature. Lecoutre claimed that often the equiprobability biases were used to assess probabilities and to predict values. People who used this bias tended to assume that random events were equiprobable by nature. Lecoutre (1992) used the following questions in an experimental study of 1000 students with various backgrounds in probability:

> Two dice are simultaneously thrown, and the following two results are obtained:
>
> R1: 5 and 6 are obtained
>
> R2: a 6 is obtained twice
>
> Do you think the chance of obtaining each of these results is equal?
>
> Or is there more chance of obtaining one of them, and if so, which, R1 or R2?
>
> Or is it impossible for you to give an answer, and if so, why? (p. 557)

Lecoutre (1992) reported that most of the subjects answered, incorrectly, that the two events had the same probability. From a systematic analysis of the justifications provided by students, it appeared that the most frequent (65%) cognitive model was based on the following type of argument: "The two results to compare are equiprobable because it is a matter of chance" (p. 561). According to this model, random events should be equiprobable by nature.

Amir and Williams (1994) proposed that beliefs appear to be the elements of culture with the most influence on probabilistic thinking. They interviewed thirty-eight 11 to 12-year-old children about their concepts of chance and luck, their beliefs and attributions, their relevant experiences and their probabilistic thinking. Some pupils thought God controls everything that happens in the world, while others thought God chooses to control, or does not control anything in the world. Several pupils believed in superstitions, such as not walking under a ladder or breaking a mirror, and lucky and unlucky numbers. There were also beliefs directly related to coins and dice; for example, that when throwing a coin, tails is luckier. A majority of children in the Amir and Williams study concluded that it is harder to get a 6 than other numbers (17 out of 21 interviewees).

It is often taken for granted that children see devices such as dice, coins and spinners as random. However, research shows that a number of children think that their results depend on how one throws or handles these different devices (Amir & Williams, 1999, 1994; Fischbein, Nello & Marino, 1991; Riston, 1999; Truran, 1995; Way, 2003). In other words, there was a belief that the outcomes could be controlled by the individual. Fischbein et al. asked 139 junior high school students (prior to instruction) to compare the probability of obtaining three fives by rolling one die three times, versus rolling three dice simultaneously. Two main types of unequal probabilities were mentioned by about 40% of the students. Of these students, about three-fifths considered that, by successively throwing the die, they had a higher chance of obtaining the expected result, and about two-fifths considered that by throwing three dice simultaneously, they would have a higher chance of obtaining the expected results.

In the Truran studies (1994, 1995), children described using many different methods of tossing coins and dice in order to get the result they wanted. For example, for tossing three dice together, some children thought that it is better to throw the dice one at a time because (when tossed together) dice can bump into each other and change the numbers which would otherwise have come up. Even if their carefully explained and demonstrated method did not work, children were still convinced that, if they did everything right, it would work the next time.

It must be noted that the research discussed above has been done in Western countries. Since mathematics is not culture free, it is important that the prior knowledge of Pasifika students is given serious consideration in statistics education. Additionally, many of the tasks that have been administered by researchers have involved forced-type responses to particular item stems. A disadvantage of forced-choice methodology is that it does not allow alternative responses to surface. In my study, individual interviews were used to explore the full range of student responses to the tasks.

OVERVIEW OF THE STUDY

The secondary school selected for the research was a typical Fijian-Indian high school. The class consisted of 29 students aged 14 to 16 years, of whom 19 were girls and 10 were boys. According to the teacher, none of the students in the sample had received any in–depth instruction on probability prior to the first interviews. Fourteen students were selected from the class and these constituted the research sample. The criteria for selection included gender and achievement.

Tasks

To explore the full range of students' thinking about probability concepts, open-ended questions to do with probability were selected and adapted from those used by other researchers. In situations such as tossing a coin, the outcomes are said to be equally likely, the particular one that does occur when a coin is tossed being purely a matter of chance. Thus, a head is said to have a 50-50 chance, or a 50% chance, or one chance in two of occurring. The tasks about a single die (Item A), the advertisement regarding the sex of a baby (Item B) and the Fiji Sixes task (Item C) were used to explore students' understanding of the equally likely concept.

Item A: Single Die Problem

Manoj feels that a six is harder to throw than any other score on a dice. What do you think about this belief?

Item B: Advertisement Involving Sex of a Baby

Expecting a baby? Wondering whether to buy pink or blue? I can GUARANTEE to predict the sex of your baby correctly. Just send $20 and a sample of your recent handwriting. Money-back guarantee if wrong! Write to ______________________________ What is your opinion about this advertisement?

Item C: Fiji Sixes Task (Fiji Sixes is a Lotto Game)

Here is a Fiji Sixes card filled out by a friend of mine. She had to select six numbers out of 45 so she chose the six consecutive numbers from 40. Are there other numbers she could select to increase her chance of winning? Explain your reasoning.

1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27
28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45

Interviews

I interviewed each student individually in a room away from the rest of the class. The interviews were audio taped for analysis and notes were made of student non verbal behaviours observed during the interview. Each interview lasted between 40 to 50 minutes. Paper, a pencil and a calculator were provided for the student if he or she needed them.

RESULTS AND DISCUSSION

The data revealed that many of the students held beliefs and used strategies based on prior knowledge that would inhibit their development of probability ideas. I created a simple four-category rubric that could be helpful for describing research results relating to students' statistical conceptions, planning instruction in statistics and dissemination of findings to mathematics educators. The four categories in the model are: non-response, non-statistical, partial-statistical and statistical. The main focus is on the non-statistical responses (in which students made inappropriate connections with everyday experiences) and the partial-statistical responses (in which students applied rules and procedures inappropriately or referred to intuitive strategies). The responses to the three questions (Item A, B and C) are summarised in Table 1. Extracts from typical individual interviews are used for illustrative purposes. Throughout the discussion, *I* is used for the interviewer and *Sn* for the nth student.

Table 1. Response Types for Tasks Involving Equally Likely Concept (n=14)

Response type	Single die task	Advertisment for baby task	Fiji Sixes task
Non-response	–	2	1
Non-statistical	6	7	4
Partial-statistical	2	5	7
Statistical	6	–	2

Table 1 data reveal that a minority of students displayed non-response and statistical reasoning with respect to all three tasks. Six students showed some grasp of the statistical principles underlying equal chance on the single die item, and two did so on the Fiji Sixes task. For example, Student 2 said that she did not believe that a six is hardest to get because there is only one face with six dots and there are six faces, so the probability will be only one upon six. In addition, Student 25 not only believed that the chance of getting a six on one roll of a die was one-sixth, but was also able to provide a reason why some people believe that a six is hardest to throw. He explained that it is often the side which one needs, and so one's attention is focused on the chance of a six coming up, rather than on seeing how often the six comes up compared with each of the other outcomes.

Non-statistical Responses

These results involved reasoning based on determinism, perceptions of luck, superstition and previous experience. Each of these will be outlined, with examples from the three tasks. Firstly, the non-statistical category consisted of students' responses which related the data to their beliefs and everyday experiences in non-statistical ways. It is often taken for granted that children see common random devices such as dice, coins and counters as random. The results of this study provide information that beliefs about random generators sometimes cause students to see these common random devices in a non-statistical way. Two students, whose responses were classified as non-statistical on the single die task, believed that outcomes can be controlled by individuals. This is revealed in the following interview:

S26: It is not harder. It depends on how you throw it.

I: How do you throw so that you get a six?

S26: If you put six down and then throw you can get a six.

I: Can you try that?

S26: [Throws and gets a five].

I: Do you still think that you can make a six come?

S26: Yes.

Clearly, the student's comments are based on deterministic rather than probabilistic thinking. They also reveal a creative ability to interpret events to fit prior ideas. In this case, with a classic hand roll, he is able to throw a six. Another student did not believe in these claims because the same force is applied when throwing a die.

Luck formed an important component of these students' explanations. Two of the pupils responded on the basis of superstition, such as good luck on the single die item. For example, student 20 responded:

> S20: Eh ... because six is a number that starts a game eh, so if you put a six the game starts and this is luck eh. You would be lucky and you will be able to throw a six.
>
> I: What do you mean by lucky?
>
> S20: Like when you playing cards eh so if your luck is not there, you can lose. So if you get a six you are lucky.

Student 21 thought six is not harder to throw. However, since it is a bigger number, it is difficult to get and one would be lucky to get a six.

On the Fiji Sixes task, three of the pupils responded on the basis of superstition, such as lucky and unlucky numbers. The students thought that a person could increase his/her chance of winning in the Fiji Sixes by selecting lucky or birthday numbers. Manifestations of the lucky number aspect are reflected in the following interview:

> S14: She should have followed some other methods like I have followed, the members of the family or her lucky number.
>
> I: What do you mean by lucky numbers?
>
> S14: Like for me the lucky number is 18.
>
> I: Why is 18 your lucky number?
>
> S14: Because it is my birthday.

In addition to basing their thinking on superstitious beliefs, such as luck and lucky numbers, students based their reasoning on their religious beliefs and experiences. Strong influences of religious beliefs were apparent when students were asked to comment on the advertisement regarding the sex of a baby. Even when challenged about how the people placing the advertisement could make money, the students could not see that roughly half the babies born would be girls and half would be boys. Anyone could expect to be right in half the number of cases just by guessing. Even if predictions were made incorrectly, some would not bother to complain anyway. Even if they did, a clear profit can be made on 50% of all the $20 payments sent in. The powerful nature of their religious beliefs is reflected in the response of Student 17:

> As I have told you before that God creates all human beings. He is the one who decides whether a boy is born or a girl is born. Unless and until like now they ... have made a machine if one is pregnant

> and they can go there and they tell you whether the baby is a girl or a boy. But they can't tell until the baby is 8 months old. So that it means that the God created like that before we can't tell that the baby is a male or a female.

Three students referred to previous experience on the single die problem; they tended to think that it is harder to throw a six than any other score with a single die. The explanations provided by these students seemed to indicate that they remembered, from their experience with board games, waiting a long time for a 6 on the die that is often needed to begin a game. Another student explained that since six was a bigger number, it was harder to throw.

The three students who referred to previous experiences when commenting on the advertisement regarding the sex of the baby said that the advertisement was placed just to earn money. Student 25 offered the following explanation:

> Sometimes ... my sister is a nurse, she tells this is the time only for boys to be born. She came at our place. She said that this time only boys are being born. My aunt, she was expecting a baby. She said it will be a boy because it is the season. My aunt had a boy.

When picking numbers from a Fiji Sixes card, three students referred to previous experience. For every Fiji Sixes game in the Fiji Times, there is always a sample which shows people how to play the game. In the sample, a number is crossed from each row. It seems that Student 26 thought this is how numbers should be crossed, one number from each row, and experience seemed to confirm this.

S26: You have to select one number from each row.

I: Why do you say that?

S26: Because it is written in the Fiji Times example; they cross the numbers from each row. I have also seen people who play Fiji Sixes; they put numbers from each line.

Partial-statistical Responses

Students who displayed partially statistical responses on the three tasks showed some understanding of chance. They were sensitive to some features of the data that should be considered in summarising a set of data, but either ignored other features or were not able to synthesise all the information they had. Their conceptions of probability tended to be based on naive strategies. The procedures and patterns they used were not really statistical because they work only in some settings. Three of the intuitive strategies identified in this study that do not help statistical understanding related to representativeness, equiprobability and unpredictability bias. Students who based their explanations on the unpredictability bias tended to believe random events to be unpredictable by nature.

Six students who used the representativeness strategy for the Fiji Sixes item thought that the chance of getting six consecutive numbers out of 45 in a Fiji Sixes card was less than getting other numbers, because it did not represent a random process of generating these numbers. The students thought that they should choose numbers that are distributed throughout the range of choices. They did not realise that any set of six numbers is just as likely to be chosen as another. The following justification is indicative of this argument by Student 5:

> Yeah ... Like she doesn't have much chance. It is really very unlikely to happen. More likely to be from all over the place. She should choose one from each line, one from 1-10.

Two students displayed the unpredictability bias with the single die task, three with the prediction task and one with the Fiji Sixes problem. For example, Student 29 explained that he did not believe in the advertisement because one cannot predict the sex of a baby. For the Fiji Sixes item, the student offered the following justification:

> We don't know what will happen in future. The numbers that people will pick, they can pick any number.

Probability: A Broader Context

The finding that a number of students think that outcomes can be controlled by individuals concurs with the results of studies by Amir and Williams (1994, 1999), Fischbein et al. (1991) and Truran (1995). Fischbein et al. (1991) used problems similar to those in the present study and found that only half the children in their study could see that the two procedures led to the same results. Amir and Williams (1999) and Riston (1999) noted that children's reasoning appeared to be related to their religious, superstitious and causal beliefs. The results suggest that in any particular context provided in the classroom students' individual learning is influenced to a certain extent by their prior experiences and beliefs. This may be problematic if students' prior experiences and beliefs conflict with the mathematical concepts that teachers are trying to teach them. Sometimes, seemingly relevant experiences may get in the way of statistical learning. For instance, if students believe that outcomes can be controlled by individuals or by some outside force, then they need help to overcome a reluctance to predict.

It may be comforting to believe that probability theory is reconcilable with everyday examples. However, my research indicates that there are times when these domains clash and it is important for teachers and students to become aware of these mismatches. In probability theory we work with an idealised die: we assume the likelihood of throwing a one, a six or any number between them, is exactly one-sixth even though we know that such dice do not exist in the real world. People laugh when they hear that outcomes can be controlled by God or individuals. There is a sense in which these answers are true. Although we consider the flip of a coin and the throw of a die as random, deterministic physical laws govern what happens during these trials. It does not make sense to say that the die has a probability of one-sixth to be sixes because the outcome can be completely determined by the manner in which it is thrown.

Cultural Influences: A Broader Context

The students' beliefs and experiences can be understood in the context of Indian culture. Several aspects of the culture could have influenced these ideas. Some of these are discussed below and are based mainly on my own knowledge, as a Fijian-Indian, of schooling and the way of life in Fiji.

In many respects, students' attitudes and beliefs about luck and lucky numbers are consistent with the way Fijian-Indian people view superstition and cultural conviction, such as one's fate being pre-determined, and there always being a guiding force influencing the outcome of events. People often use phrases such as *takdeer ki baat hai* (it depends on fate), suggesting that they feel these people are particularly helpless and the events are outside their control. Indeed, almost all events in real life can be explained in terms of the causality perspective. Perhaps believing that some outside factor influences one's behaviour means that one does not feel so responsible when things go wrong.

The prominence of the view that God decides the sex of the baby could be attributed to certain aspects of Indian culture. Unlike the sample in the New Zealand pilot study I conducted before doing the research reported here, a number of students in the main study in Fiji drew upon their religious beliefs when resolving their thinking. The differences between the New Zealand and Fijian-Indian students' inclination to take a statistical view of events can be explained in terms of the relatively religious orientation of Indian culture. For instance, the sex of a baby is considered to be determined by God. Thus, in everyday life, children hear phrases like *Bhagwan ki upaar hai, chai ladki dei yeh ladka dei,* which literally means, "God decides the sex of the baby". Thus in everyday life, parents might pray at home or even go to a *mandir* (temple) in order to have a boy or a girl.

Indian cultural influences such as these need to be addressed during the teaching and learning process to ensure that students construct appropriate views of learning that will promote and enhance their statistical thinking. It appears that there are certain aspects of the culture that are at odds with the statistical thinking promoted by the statistics curriculum. This presents a real dilemma, which needs to be resolved if statistics education is to flourish in Fiji. For example, if students come to the class with the religious view that God decides the sex of a baby, and the teacher is trying to teach the mathematical view that chance is blind and not controlled by prior knowledge, then how this can be done in a way that does not denigrate the first view needs to be investigated. Perhaps it is important to point out to students that there are alternative points of view.

IMPLICATIONS OF THE STUDY FOR TEACHERS AND RESEARCH

Although this study provides some valuable insights into the kind of thinking that high school students use, the conclusions cannot claim generality because of the small sample. Additionally, the study was qualitative in emphasis and the results rely heavily on my skills to collect information from students. The open-ended nature of the tasks and the lack of guidance given to students regarding what was required of them certainly influenced how students explained their understanding.

The students may not have been particularly interested in these types of questions, as they are not used to having to describe their reasoning in the classroom. Despite these limitations, the findings of the study have several implications for teachers and research.

One direction for further research could be to replicate the present study and include a larger sample of students from different backgrounds so that conclusions can be generalised.

Secondly, when beginning instruction on probability, it is important for teachers to know the individual abilities of their students. Teachers can assess their students' understanding through interviews. A major disincentive for teachers is the amount of time required to interview each student. Teachers wishing to use the interview in its usual form would have to undertake considerable extra work outside normal class time. To deal with this difficulty, teachers can get an insight into all students' learning by interviewing just two or three students and generalising to the entire class. Teachers can incorporate informal interviewing into their regular teaching (concurrent interviews) or interview small groups of students at the same time. These interviews need not necessarily be lengthy; a few minutes is often enough to gain important insights into how a student is thinking about a concept. Once an understanding of the students' informal knowledge is gained, it is important for the teacher to create interventions to confront misconceptions and develop appropriate statistical understanding.

Third, another implication relates to relevant contexts. Background knowledge can be used helpfully and unhelpfully in tackling a problem in mathematics. The background knowledge, as it were, obscured the mathematical core of the problem. In the study described here, background knowledge, which is often invoked to support a child's mathematical understanding, is getting in the way of efficient problem solving. Given that statistics is often taught through examples drawn from 'real life,' teachers need to exercise care in ensuring that this intended support apparatus is not counterproductive.

Fourth, teachers need to point out to students that there are alternative points of view. A number of students in the study in Fiji drew upon their religious beliefs when resolving their thinking. Indian cultural influences, such as God decides the sex of the baby, need to be addressed during the teaching and learning process to ensure that students construct appropriate views of learning that will promote and enhance their statistical thinking. As stated earlier, if students come to the class with the religious view that God decides the sex of a baby, and the teacher is trying to teach the mathematical view that chance is blind and not controlled by prior knowledge, then how this can be done in a way that does not denigrate the first view needs to be investigated.

In addition, there is also a need to reconsider the timing of teaching probability in the curriculum. At present in Fiji, although statistics has been incorporated in the mathematics prescription at all age levels, probability is not taught until the senior years of high school. It is the last topic in the curriculum document and can easily be passed over or taught in a very abstract way. Primary school children are able to express probabilistic judgements in simple situations; children have listened to and taken part in conversations about the possibility of winning at lotto or Fiji Sixes, and the likelihood that the team they support will win the soccer match or that they will pass an examination. Some children will have played games using dice or playing cards. As a result of these experiences, students come to school with preconceived ideas about probability. The present practice of delaying instruction in probability until after children have mastered statistics procedures should be reconsidered. This topic could come earlier in the curriculum and be taught as part of statistics activities. This would ensure that the topic is not passed over and it would give teachers an opportunity to adapt their teaching approaches.

Finally, this small scale investigation into identifying and describing students' reasoning from social constructivism has opened up possibilities to do further research at a macro-level on Pasifika students' thinking, and to develop more explicit sub-categories for each category of the framework. Such research would validate the framework of response types described in the current study and raise more awareness of the levels of thinking that need to be considered when planning instruction and developing students' statistical thinking.

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