Teaching and Learning Statistics in Singapore's Junior College

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Abstract: The purpose of this study is to investigate the current curricular, pedagogical, and assessment practices in statistics education in junior college mathematics classrooms. This study seeks to answer the following questions: How are statistics curricula designed and enacted in Junior College classrooms? How do teachers teach and assess students' learning, how does assessment link to curriculum and pedagogy? We interviewed 18 mathematics teachers from 10 Junior College from February to May 2006. Each interview was audio recorded and later transcribed. Our finding provided a overview of the statistics teaching and learning in Singapore, and it also revealed that the statistics curriculum and pedagogy in Singapore are highly aligned to, and are driven by, the 'A' level statistics exam. In this paper we also reported on teacher beliefs and concerns, which pointed to areas in which researchers and teacher educators could support teachers' practices.

Introduction

Statistics plays a vital role in mathematics, scientific research, and social studies. It also assumes an increasingly greater role in everyday life (Gordon & Gordon, 1992, Lajoie, 1998). Major political, social, economic, and scientific decisions are made using information based on statistical models. Statistical information such as reports of public opinion polls, of drug test results, and of scientific studies permeates the popular media. A large proportion of literate citizens will presumably encounter such information and an understanding of statistics would assist their attempt at making sense of them. Given the growing influence that information has on decision-making and on issues of power, opportunity, and equity in our society, statistics has become one of the key topics in the high school and college curriculum (Gordon & Gordon, 1992), and the question of how to support the development of students' statistical reasoning takes on increased importance.

Educational communities across the world have, during the last decade, increasingly pushed to have students exposed to statistics instruction in earlier grades. There is a surge of efforts in the international mathematics and statistics education research community in designing and improving statistics curriculum and instruction, in preparing students to develop conceptual understanding of statistics, and in conducting professional development for statistics teachers at all levels (Cobb, 1999, Hovarth & Lehrer, 1998, Liu & Thompson, 2004, delMas & Liu, 2005, Garfield, 2003, 2005, Ben-zvi & Garfield, 2004, Chance and Garfield, 2002, Rossman & Chance, 2001, 2002a, 2002b). In the United States, for example, probability and statistics are now taught as early as in the fifth grade; and more and more high school students are enrolling in Advanced Placement (AP) statistics courses (Bohan, 2004). There is also a surge of efforts that investigate the complex nature of statistical reasoning and the challenges and obstacles students face in their learning both in and out of classrooms (Kahneman, Slovic, & Tversky, 1982, Kahneman & Tversky, 1972, 1973, Konold, 1989, Konold, Pollatsek, Well, Lohmeier, & Lipson, 1993, Thompson, Liu, & Saldanha, 2004, Thompson & Liu, 2002).

In contrast, statistics has been marginalized in Singapore's mathematics curriculum. There is very little statistics content below Junior College (a two-year pre-university program, equivalent to US high school Grade 11 and 12). The statistics content for primary and lower secondary mathematics curriculum is limited to the concepts of mean, median, and mode; graphs, and simple probability. In their seminal review of statistics education in Singapore, Pereira-Mendoza & Kaur (1998) provide a snapshot of what Singapore students can do in statistics in primary and secondary level. They found that in primary school students aged 11 and 12 can represent data using graphs; critique newspaper report, write word problems based on graphs, and draw appropriate inferences from the data. In secondary school, students aged 14 and 15 are more refined in their use of graphs and drawing inferences. Notwithstanding these achievement indicators, Singapore has lagged behind in enriching and strengthening statistics content in its mathematics curriculum, as least during the past eight years since Pereira-Mendoza & Kaur's review. In a recent report *What the United States can learn from Singapore's World-Class mathematics system (and what Singapore can learn from the United States),* Ginsburg, Leiwand, Anstrom, and Pollock (2005) pointed out that, compared to Singapore's mathematics curriculum, the strength of the U.S. mathematics curriculum is that it "places a greater emphasis on applied mathematics, including statistics, probability, and real-world problem analysis".

This contrast points to an educational imperative: That the teaching and learning of statistics in Singapore schools needs to be reconsidered and reformed, in ways that support the long-term development of students' statistical reasoning. In this study, we wish to begin this endeavour by generating a better understanding of the current curricular, pedagogical, and assessment practices in statistics in Singapore's Junior College. Specifically we aim to investigate the following questions: How are statistics curricula designed and enacted in Junior College classrooms? How do teachers teach and assess students' learning, how does assessment link to curriculum and pedagogy? We believe that such an understanding is crucial in allowing teachers, curriculum designers, and researchers as a whole to make informed decisions about what needs to be done and how it should be done in the reform effort.

Background

Junior colleges (hereafter JC) in Singapore offer a two-year pre-university educational program. At the end of secondary school, students take the Cambridge 'O' or 'N' level tests. Based the results of these test, the top performing students will enter JC, while the rest of the students enroll into polytechnics and institute of technical education. The gross graduation ratio for JC students varies slightly around 25% from 2000 to 2006 (MOE, 2006). Students at junior colleges are split between the sub-populations of Arts and Science students. Almost all science students choose mathematics as a subject because it is a pre-requisite for entry into faculties of Science and Engineering. Typical Arts student would take mathematics only if they seek entry into business or accountancy subjects in university. Following the Ministry of Education (MOE) guidelines for pupil-teacher ratio and teacher workload, schools typically set about 5 to 5.5 hours of mathematics lessons a week in JC. All schools taught statistics as the last topic in their mathematics program. Typically students study pure maths during the first year of JC, statistics on the first two terms of second year, and spend the rest of the year on test preparation.

Methods

To generate an understanding of the curriculum, pedagogy, and assessment of statistics, we collected written and interview data from 18 teachers from 10 Junior Colleges across the island. Table 1 illustrates the teachers' profiles including their mathematics and statistics background, training and years of teaching, and types of classes taught this year. All teachers' names in this list are pseudonyms.

Table 1: *Teachers Demographic*

Teacher	**y.o.t**	**Degree**	**statistics background**	**Teacher training**	**Classes taught**
Tony	11	MEd (MathEd) BSc (Maths)	Stats modules up to 3rd year in univ.	1 year PGDE Maths	Maths-C[1] and Further Maths[2]
Henry	9	MSc (Stats) BSc (Maths)	MSc (Stats)	1 year PGDE Maths	Maths-C and IP classes
Kim	20	BSc (Maths)	Stats modules in univ.	1 year PGDE Maths	Further Maths
Wendy	5	BSc (Maths)	Probability module in univ.	1 year PGDE Maths	Maths-C
Ben	5	BSc (Maths)	[No data]	1 year PGDE Maths	Maths-C
Peter	10	BSc (Maths)	Little stats in univ.	1 year PGDE Maths	Maths-C
Mary	16	BSc (Maths)	Stats modules in univ.	1 year PGDE Maths	Maths-C
Leo	1	B.Eng (EE)	Further Math in JC	1 year PGDE Maths	Maths-C
Helen	6.5	BSc (Maths)	[No data]	3 year Diploma Maths	Maths-C
Will	8	BSc (Maths)	Stats modules up to 3rd year in univ.	1 year PGDE Maths	Maths-C
Susan	3.5	BSc (Maths)	2 Stats modules in univ.	1 year PGDE Maths	Maths-C
Charlie	4.5	BSc (Maths)	Further Math in JC	1 year PGDE Maths	F-Maths
Chad	5	BSc (Maths)	Stats modules in univ.	1 year PGDE Maths	F-Maths
Cindy	3	MSc (Maths) BSc (Maths)	Stats modules in univ.	1 year PGDE Maths	Maths-C
Anna	5.5	BSc (Maths)	Univ. major in statistical inference	1 year PGDE Maths	Maths-C
Laura	0.5	B.Eng	2-3 stats modules in univ.	1 year PGDE Maths	Maths-C
Katie	1	BSc (Maths)	2-3 stats modules in univ.	1 year PGDE Maths	Maths-C
Perry	8	BSc (Eng)	Stats modules up to 3rd year in univ.	1 year PGDE Maths	Maths-C

As we could see, all but two teachers received a B.S. degree in mathematics. Three teachers also pursued Master degree. All teachers received training in NIE to teach

[1] Topics in Math-C include: Probability, DRV, CRV, Sampling (including CLT), Confidence Interval, Estimation, Hypo Testing.
[2] Additional topics in Further Math include: t-test and its confidence interval, exponential and geometric distribution, chi square test, linear regression.

mathematics at Secondary level. Teachers' statistics background varied from 'A' levels to Master degree in statistics. Majority of the teachers took some core statistics modules in the university. Teachers interviewed had various years of teaching experience, ranging from less than half a year to 20 years. All but one teacher taught at the same school throughout their teaching career.

The interviews were conducted between February to May 2006. Each interview lasted for about 2 hours, and was audio recorded and later transcribed. During the interviews we collected information about teachers' background and experiences in teaching statistics, their statistics curriculum, the way they teach, how they teach and assess their students, their beliefs about statistics and their students, and last but not the least, their concerns about teaching statistics, areas in which they needed support. To assist our understanding of the issues, we also collected teaching materials, scheme of work, lecture and tutorial notes from the teachers.

Results

Statistics Curriculum

The statistics curriculum in Singapore is largely defined by the Singapore-Cambridge General Certificate of Education (Advanced level) Examination (hereafter "'A' level exam") conducted annually in Singapore. The mathematics 'A' level exam syllabus, revised the periodically, is the guiding document from which the teachers in schools generate and revise their instructional materials. To view a sample copy from recent years, the reader can visit the website of Singapore Examinations and Assessment Board (www.seab.gov.sg).

None of the schools studied had a compulsory textbook for statistics. Instead, teachers prepared lecture notes. Across all schools, teachers develop their lecture notes by "customizing" the curricular material designed by previous generations of teachers in their schools. The first cohort of teachers in each school, whom we could not get access to, produced the first set of notes, upon which the subsequent generations of teachers modified based on changes made to the examination syllabus, testing styles, and teaching preferences of the individual teachers. Apparently, it would not have been difficult to find examples from notes that were more than fifteen years old. Examinations also contributed to modifications in lecture note emphasis. The lecture notes were uniform for all classes studying mathematics, even though they may be from different subject combinations or separate faculties.

Although there was no compulsory textbook, teachers did recommend some references for students and the most common reference is the "Core mathematics for Advanced Level" by Bostock and Chandler (2000). Among other references are Crawshaw and Chambers (2001), A Concise Course in Advanced Level statistics; Walpole and Meyer (1993), Probability and Statistics for Engineers and Scientists; and Schaum's Outline of Probability and Statistics (commonly known as the Schaum's Series).

All the schools follow similar sequence of topics in a suggested order of the 'A' level exam syllabus (Table 2).

Table 2: *Topic sequence for statistics at 'A' level*

Sequence	**Topic**
1	Probability
2	Discrete Random Variables

3	Binomial Distribution
4	Poisson Distribution
5	Uniform Distribution
6	Continuous Random Variables
7	Normal Distribution
8	Uniform Distribution
9	Sampling & Estimation
10	Confidence Interval
11	Hypothesis testing

Teachers justified the logic of sequence as that of the ascending nature of concept development where the new topics/ideas are built upon the prior ones. For example, probability should be taught before discussing random variables as it defines the properties of random variables distribution.

Pedagogy

The common instructional model is the lecture-tutorial systems, practiced by all but one school. These schools typically split up the lessons into approximately 2 lecture hours and 3 tutorials hours a week, with the period duration ranging from 45 minutes to an hour. A lecture is delivered to between 200 to 400 students. During the lectures, teachers go through the lecture notes and work through some examples. In typical tutorial sessions students are engaged in solving tutorials questions, most of which came from previous ‘A’ level exams, neatly compiled by publishers into a “Ten Year Series”. More than the name suggests, these books contain past ‘A’ level questions, sorted by topic, for up to 25 years. Alternative sources are other colleges’ examination questions and reference books that the teachers possessed.

Teachers’ use of ICT varied from use of PowerPoint presentation for lectures, to the graphing software program Autograph, and the use of websites with interactive demonstrations as enrichment references for students. Graphing calculators were being explored by some of the teachers as a way to show their students the effect of changing variables on the shape of the distribution.

Almost all the schools reported the use of ability grouping to some extent in their teaching. Some of the grouping strategies involved selecting a top class per subject combination, and then random-sorting the rest while a couple tried “pull-out” groups from different classes, where instruction for mathematics in particular was grouped by ability. It was found that ability grouping helped the higher ability group, allowing them to go further and faster than their peers, but at the expense of the lower ability group, which ended up with self-esteem problems. Even though the students were not informed that they were grouped by ability, they managed to figure it out rather quickly. Almost all teachers reported having extra consultation sessions with students who were weak in their subject, although most qualify that the demand for such sessions does not peak until time came close to the major examinations.

When asked “what is main thing you want you students to learn”, 9 out of 18 teachers stated explicitly that the aim of teaching statistics in JC is for the students to pass the ‘A’ level exams. However, 14 out of 18 teachers also expressed their expectation of students being able to understand and appreciate statistics and see its practical implication in the real world. Among the goals are those of preparing students for their future educational careers.

Teachers commented that statistics would be useful for those students who pursue careers in sciences, engineering, mathematics, economics, accounting, business, and so on.

When asked "what is the best way to teach statistics", 13 out of 18 teachers suggested that it would be one in which there is a strong practical component, in which the students could collect real data, conduct sampling, construct statistical scenarios, and/or do project work using statistical knowledge. However, at the same breath, these teachers also lamented that due to the pressure of helping their students pass the 'A' level exam, they did not have time to implement these activities in their classrooms. A few teachers also noted teachers' deficiency (either their own or other teachers) in designing and implementing such activities in the classrooms. Susan's comments below is reflective of teachers' sentiment in general:

> As encouraged by my HOD, we should also use more real-life data, which is the "real" data we collected from them repeatedly in every sub-topic discussed so that they could see the continuity of statistical concepts. Real life examples will also help to bridge the reality and Maths. Sadly that at the end of the day, there's still examinations so that we should teach them problem solving skills…

Assessment

Our conversations with the teachers confirmed the adage of the education system; that of the assessment "tail" wagging the curriculum "dog". As we noted earlier, the 'A' level exam syllabus is the core nucleus around which the statistics curriculum and instruction are designed, planned and implemented: the examples in lecture notes and tutorials questions are largely of the same type as that of 'A' level exams, majority of the instructional time are devoted to training students to solve previous or potential 'A' level questions.

Informal testing during the JC program is conducted in various frequencies among schools. Some schools has a scheme whereby a test was given at the end of the each topic, in which students were to answer one or two questions in about 30 minutes. This resulted in a test frequency of about once every fortnight on average. Some schools, preferring not to give students too many tests, had them take 4 to 6 mock exams before the 'A' levels instead. In one school, a policy had been implemented that there should be not more than 2 tests per week, regardless of subject, which resulted in a test frequency of approximately twice per 10-week term. The testing materials were derived from similar sources to that of the tutorials. None of the schools provided alternative forms of assessment.

While 'A' level exam provides a fast and efficient way of evaluating students' performance in statistics, many teachers expressed their dissatisfaction with the questions and the testing style. Table 3 summarized a few teachers' comments on the 'A' level exam, both on the nature of the 'A' level questions, and on the way it propelled students and teachers to organize their activities around passing the exam.

Table 3: *Teachers' Perception/Dissent about A-Level Requirements*

Teacher	**Responses**
Kim	Because the 'A' level syllabus limits what the students need to know, students are not able to more deeply appreciate the reasons for doing things in a certain way, because that may require more content that they need to know.
Peter	Ideal [way of teaching statistics]? The ideal is to put exam aside.
Susan	Sadly to say that at the end of the day, stats is actually a very lively subject but

	there's still exam so that we should teach them certain skills to recognize problems.
Charlie	Because, I felt that at this point, they may just simply memorizing the formula and handle the exam questions and that's it…80-90% of questions they can go through that. They have certain minimum understanding."
Anna	It can be due to time-constraint that teachers can't talk more about confidence interval for example, or hypothesis testing, because the focus of syllabus is your students must know about the procedure of how to do certain test, on mean, population proportion etc.
Perry	After all, we prepare them for the exam and score. Sometimes when they pass exam and score does not mean they really know statistics.
Will	Syllabus is too tight, so when they're doing stats actually they're rushing syllabus…they are very concern about result already, exam oriented."
Helen	We have limited period of time to complete the syllabus. If we want to do too many things, it's also not practical. Because we don't have time to complete the syllabus.
Leo	When I was taught stats, it was done in a very mechanical fashion with very little understanding involved.

The overarching theme from teachers' comments is that the 'A' level questions do not assess students' understanding; quite contrarily, it is possible for students to score full marks even when they do not understand the material. Students only need to know the conditions for using a formula, as a teacher noted, "when they have this, there is no need to appreciate." However, teachers also noted the irony in that the ease with which students could score marks with little understanding actually led some of them to like statistics as the topic was "easy to score".

Teachers' beliefs

Almost all the teachers interviewed agreed that statistics was valuable in daily life, suggesting that it was useful in reading the statistics reported in the newspapers and aiding students' ability in critically interpreting the numerical data presented. Yet, these same teachers were quick to qualify that most of the statistical concepts were too advanced for everyday use, but could be applied in specific fields that the students might choose to get into in due course. Most of their students, in their opinion, did not possess sufficient appreciation of the concepts of statistics, since the students were taught statistics from a very mechanistic point of view, to "see this condition, then apply that formula". Some teachers reflected that unless one was working in a job that specifically calls for statistics, it was usually hard for the students to apply their knowledge. A typical response is that of Tony's:

> Whether statistics is valuable in daily life, the answer is yes and no. It depends on one's life and work. For example, I know someone who actually works in the statistics department. For him, statistics is very important. In any case, I rarely use it in my daily life. For students, they will like statistics when they score in the subjects. Its importance in Singapore is driven by examinations. Whether or not the students are able to transfer their learning to daily lives, I could say that if teachers were make effort to connect it to daily lives, then there is a better chance of it happening.

In their daily lives, most teachers had little opportunity to use the sophisticated concepts, except for Tony, whose anecdote is interesting enough to relate here: he used his invitations to others' wedding banquets to sample the no-show rate, and used that in his estimation for number of seats to be catered for his own wedding banquet to minimize wastage. Henry and Kim had the experience of having to explain the school performance indicators statistics to their colleagues in the non-mathematics departments when the statistics were published annually. Wendy, as an example of one of the dissenting voices, reported that she did not feel that statistics was particularly useful, except for newspaper reports with statistical data:

> When it comes to the exams, I told my students to not concentrate on statistics too much, as statistics only takes up 66 out of 200 marks. I get them to focus on calculus, curve sketching, and trigonometry as the bulk of the marks comes from those sections instead.

Teachers interviewed stated that students had the most difficulty with the idea of the continuous random variable, permutations and combinations, sampling, and the central limit theorem. One of the teachers, Tony, acknowledged that the central limit theorem is the concept which he had the most difficulty explaining, due to his own inability to understand its mathematical proof himself.

Teachers' concerns

Besides revealing their discontent with the fact that many students did not get a proper appreciation for the deeper ideas of statistics but only learned the mechanical processes of answer production, some teachers also expressed their worry about their own teacher training. Kim, one of the senior teachers interviewed, revealed that the recent cohort of teachers have been teaching statistics at the 'A' level with insufficient training. She explained that during the undergraduate years, the mathematics students have to choose to major in either pure or applied mathematics. Since the courses typically run at the same time, it was not impossible for a graduate in mathematics to have no deeper knowledge of statistics than his/her 'A' level understanding. Another common concern reflected by many teachers was that the NIE Postgraduate Diploma of Education Program (PGDE) that prepares them for teaching in mathematics has as its focus only secondary level mathematics and statistics. Most teachers felt that secondary level statistics, with "only the concept of mean, median, mode, and interquartile range" (Leo) did not prepare them enough for the teaching of statistics at the 'A' level, which they all felt introduced concepts that were particularly foreign to their students. In terms of training, none of them had attended any in-service courses specifically on statistics at the 'A' level. This could be due to, as reported by Wendy, a lack of such courses at the MOE intranet training and monitoring portal, TRAISI (web-based MOE training tracking and sign-up tool).

At the end of the interview, we asked the teachers to tell us the areas where they needed support and the ways in which we as researchers could help them. Table 4 summarized teachers' responses.

Table 4: *Areas where teachers need support and ways researchers could help*

Teacher	**Responses**
Tony	We could need help in the topic of the central limit theorem. If teachers can be involved in research, and they see their hard work in process, then…maybe that is a good starting point to get things started.
Henry & Kim	The need of more conference, workshops, or seminars on statistics. Sharing sessions and conferences tend to emphasis more on pure maths
Wendy	I would be appreciative of your assistance in showing the students the real life

	examples of the normal/binomial distribution. There have been no formal professional development programs in statistics in particular, and even the programs for pure mathematics available in TRAISI are targeted at the secondary school level.
Ben	If you can help design for us mini-projects that require skills relevant to the syllabus, I think that would be great. [it will be good to] have attachments for teachers, in depth, for an understanding of how these knowledge can be applied.
Mary	Lack of textbook, lack of resources available in terms of real application and how should we make stats more meaningful for our students. We don't specialize in just stats, so in terms of depth and link is very weak… How we teach depends on how we were taught. So we couldn't see much change or deviation.
Peter	Will you assessing teachers' competence as well? Because actually we have limited training, apart from A-level education. It is important to know the standard of teachers. When I attended Rosalind Pang's courses, she made us realize that our concepts are not strong.
Helen	It will be good if you can see the current practice that using the GC.
Leo	I'd be interested in new pedagogies to teach the stats concepts. Here, we are so used to teaching to the test, over time we fall into the trap that if you're not good at it, then just practice more – the more you do the better you get.
Will	Right now curriculum changes towards to GC, for most of us we are still learning how to use GC proficiently…Even if they cut down syllabus we still cannot see how they cut down… We are not very sure the whole direction of teaching, the exams, and all this. If there are something that can make them appreciate Maths, statistics, of course better lah. If we drill too much, in the end students hate Maths. Even if the students score A, I think they lose the battle.
Susan	Resources: real-life and application problems. Teaching pedagogy: it's good to sometime have a booster session like 1 short workshop that can keep teacher up to date to current trend. It's good to profile teachers. Profiling teachers in schools, because teachers' backgrounds are different, even those who have Maths degree, so can get a picture of teachers' depth of knowledge. Classroom observation: examples of teaching practices of "good lesson" and "not-so good lesson" examples, how the delivery is done. Especially for new teachers, it will be good resources to observe teaching practices. For training… teachers normally don't have too much time. Graphic calculators training. Attachment for students: e.g. create a package of lesson, 2-week attachment to get them hands-on in doing stats. Reflection for teachers: before-after delivery, to have some framework for this reflection and create a habit of teachers.
Charlie	Maybe give us knowledge beyond the A-level Stats.
Chad	I think in terms of pedagogy maybe…some students may find it very difficult to understand certain concepts. So through your research you gather some information on how to really teach this particular area, mainly for the weaker students. Maybe some activities… for the teachers or students to try on.

	How about technology wise like - things like statistical software.
Cindy	Provide us with more ideas on how to teach statistics.
Anna	The area of developing students' understanding of stats. Help the teachers to promote students' understanding of statistics. To provide some activities or knowledge to teachers of how they can guide students in understanding statistics. Providing professional development courses for teachers to upgrade themselves.
Laura	I do welcome like if you have some suggested area to make lessons more interesting, or activities, or how to get them to see certain things. I'll be happy if you could do sharing with us practices in other colleges.
Katie	Mainly, how to teach statistics. I mean not the content, most likely… it's like we know the very basic required in the syllabus, but if we know a little bit more, then we will be able to better help students.
Perry	Any feedback from researchers will help me to fine tune their work.

Table 4 shows that teachers were in great need of professional development opportunities in the form of conferences, workshops, and seminars on statistics; they also needed more resources, such as textbooks and statistics experts, to enhance both their content understandings and in their pedagogical understandings. Training in technology, particularly in the use of graphing calculator, was also an area where teachers needed more support.

Conclusions

In this paper, we reported the preliminary findings from our interviews with 18 Junior College teachers regarding their statistics curriculum, pedagogy, assessment, and their beliefs and perceptions of statistics and statistics teaching. We wish to highlight some of the core findings and their implications for statistics curriculum reform and teacher preparation.

First, our interview with the teachers revealed that the curriculum, pedagogy, and assessment of JC statistics are highly aligned. Yet they are aligned in such a way that they impoverish students' opportunities in developing deeper understandings of statistics and expertise in applying statistical knowledge in real life situations. Majority of the teachers believed that statistics are useful knowledge for students, they saw the importance of having students understand the statistical concepts and be able to apply them in real-life situations, and they wish to teach statistics in ways that are meaningful and engaging. Yet they perceived insurmountable constraints in changing their practices due to the 'A' level exams and their perceived lack of capacity in designing meaningful instructional activities and effective instructional strategies.

Second, there is no systematic training in place for JC statistics teachers. Some teachers do not even have training in statistics beyond what they learn in JC mathematics. Training programs in teaching statistics have a focus on secondary mathematics as opposed to at the JC level. This problem is likely to be compounded by the disconnection between 'O' level and 'A' level statistics: If what was learned in secondary school does not sufficiently prepare them for learning at junior college, then training in secondary statistics content and pedagogy will certainly not prepare teachers to teach JC statistics. Teachers also reported a lack of in-service training programs and workshops. This lack of both pre-service and in-service training is alarming, especially given the fact that the new 2006 curriculum puts a heavier emphasis on statistics, and presented greater challenges for the teachers.

In summary, these findings provided a picture of statistics teaching in the JC, and pointed to the kinds of challenges that we face if we were to push for a system of education whereby students were taught not only to pass the exams but also to be able to comprehend the matters they learn, to make meanings and connections, and to be able to use them in appropriate settings. We argue that to move forward, actions should be taken in several interrelated areas: there needs to be a close examination of the O level and 'A' level syllabus and of the realignment of the curricula; there also needs to be exploration of modifying questions in 'A' level exams so that students' conceptual understandings could be assessed-such change will likely to induce changes in the pedagogical practices because of the highly aligned systems of pedagogy and assessment; in teacher training, both pre-service and in-service programs should be evaluated and reformed so that they better meet the needs of the teachers.

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