Teaching Strategies and Effects of Learning Outcomes: A Case Study of the Extended Curriculum Programme at the University of the Western Cape

Running Head: *Teaching and Learning Outcomes*

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ABSTRACT

An educational environment influences how, why and what students learn to achieve the needed learning outcomes. In other words, a positive educational environment supports effective learning modes. Research has shown that students have different learning styles and that their academic performance is related to their learning styles and the method of teaching. However, change in academic performance of the Extended Curriculum Programme (ECP) in Statistics has not previously been investigated at the University of the Western Cape in South Africa. Thus, this paper explores the relationship between teaching strategies and the performance of students in ECP programme. In addition to the traditional methods of teaching, our research encompasses innovative teaching methods such as technology, problem solving and cooperative learning for the Introductory Statistics Module in the ECP. The students' final marks data for the academic years from 2008 to 2014 were used for analysis. The Kruskal-Wallis test was used to compare the performance (in terms of marks) of students over time and the Dunn's post-hoc test with a Bonferroni adjustment was used to indicate which groups (years) were statistically significantly different from one another in terms of performance. Results show that there was a gradual increase in median achievement of class groups from 2008 to 2014 as new teaching strategies were introduced. This suggests that, though there might be other factors that have contributed to the students' success, the employed teaching strategies had a positive impact on the performance of these students over time. It is recommended that educators should analyze and evaluate the trends of both teaching methodology and learning outcomes overtime. This would indeed help making decisions on an appropriate curricula and effective methods of learning to equip students for real life situations.

Keywords: Extended Curriculum Programme, Statistics, Traditional methods, Technology, Cooperative learning.

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INTRODUCTION

Background

Teaching methods that work refers to the general principles, pedagogy and management strategies that is used for classroom instruction (Felder et al. 2000). Research on teaching methods has shown that, choice of a teaching method is related to what suits the lecturer's educational philosophy, classroom demographics, subject area(s) and institution mission statement (Classroom Compass 1994). Teaching theories primarily fall into two categories; teacher-centered and student-centered (Sparrow et al. 2000, Nanney 2004). These approaches are conceptualized around education pedagogy: direct instruction, inquiry-based learning and cooperative learning. Within each of these three main teaching styles are teaching models (Grasha 1996). Teaching methods have been a popular topic in educational circles and has elicited several views and inputs from researchers for more than a decade (Classroom Compass 1994). Methodology means, according to Webster's definition (1993 edition) "a body of methods, procedures, working concepts, rules and postulates employed in the solution of a problem or in doing something". Hence, methodology can be used as an equivalent to the words "teaching strategy" as it is used throughout in the paper. One of these techniques, among others, is cooperative learning and the traditional method of teaching (Magel 1998; Cooper and Muek 1990; Johnson and Johnson 2010). Looking at methods of teaching, "telling is not teaching and listening is not learning" (Ali et al. 2010).

Roff et al. (2001) and McParland et al. (2004) explain how educational environment plays an important role in the student's learning experience and outcomes. Their results show that educational environment influences how, why and what students learn (Roff et al. 2001 in Al-hazimi 2004). In other words, a positive educational environment goes together with positive learning outcomes. Furthermore, other research has also shown that, teaching with audio-visual alerts students, increases more attention and focus on the topic being discussed (Arbaugh 2000). In this vein, cognitive learning is increased through the connection between visual content, memory knowledge, and student's potential of retaining new information. This increases the engagement level among students and enhances a positive attitude towards learning experience (Appleton et al. 2008). Further, the use of technology such as video when lecturing motivates students, increases attendance, participation and student's engagement (Arbaugh 2000; McBrien and Jones 2009). Thus, students learn more from peers and this enhances mutual collaboration (McCarthy and Anderson 2000). However, in a students' centred learning process, the lecturer is mainly a facilitator and guides the student to master the content (Nanney 2004, McParland Noble and Livingstone 2004). It has been suggested by Akinoglu and Ruhan (2007) that, in all active learning processes, the students should learn according to their own needs and at their own pace (Higbee et al. 1991 cited in Magel 1998). As perceived by Bornman and Rose (2010) the educator should keep in mind learners' learning styles and focus on it because they are different in nature (Doorlag 2006, UNICEF 2010).

South Africa, like other countries has prioritised improved access to quality and equitable education since 1994 (Fiske and Ladd 2004), with the aim to improve educational outcomes (Reddy et al. 2012). The introduction of statistics in the educational process has now been recognised and is confirmed by its introduction in many disciplines of science in higher education in South Africa and abroad (Galmacci and Milito 2002). In modern societies, statistics inform and provide knowledge to assist citizens to make informed decisions; and therefore it is important to supply precise objectives and targets for the teaching of Statistics (Garfield 1995).

In the academic year of 2008, the University of the Western Cape, South-Africa, incorporated a new stream called the Extended Curriculum Programme (ECP) across the faculties. The extended curriculum has been designed to equip students who do not meet the minimum admission requirements with the necessary competencies to be successful in their studies at university. Therefore, students complete their three year degree in four years, instead. Academic support and skills development are integrated with regular academic work. In the first two years of the extended programme, students are equipped with the necessary skills and competencies needed in sciences to complete their studies successfully. Statistics for Life Science is one of the modules taught to ECP students and it is only introduced in the second year of the ECP, just one year before students join the main stream. In this program, the subjects are taught for an entire year in contrast to a semester for main stream modules. Due to ECP student's poor background in science, they receive intensive academic support incorporating numerous alternative teaching methods such as group work, teaching with technology.

For many decades, Garfield (2013) notes that passive learning occupied an important space in teaching. The new innovative teaching methods are gradually taking over the traditional methods from passive learning to being more active with problem based learning where students more openly interact and collaborate with each other even during the lecture session (Margaret 1999). Therefore cooperative learning refers to a variety of collaborative classroom activities, ranging from long term simulation to five minutes cooperative problem solving exercises (McCarthy and Anderson 2000**).** Garfield (1993) advocates cooperative learning methods for statistics instruction in the higher education, but few studies address the use of cooperative learning, problem solving, and teaching with technology in addition to traditional teaching methods to boost students' performance (Felder and Brent 1996, Nanney 2004).

Therefore, to gain a better understanding of the fundamentals of each teaching style, it is best to view them through the lens of direct instruction, inquiry-based learning, and cooperative teaching. Thus, this paper examined the influence of varying teaching methods on the performance of the students in this specific Statistics ECP module at the University of the Western Cape between 2008 and 2014.

Brief Review of Related Literature

Different studies including Keeler and Steinhorst (1995), Giraud (1997) and Magel (1998) attempted to investigate the influence of cooperative learning in teaching statistics at their institutions, and generally found positive results. The investigation done by Keeler and Steinhorst (1995), Wenglinsky (2001), indicates for example, that when students worked in pairs, the final grades were higher and more students stayed in the course than in a previous semester compared to those who were working alone. Using cooperative learning groups in class to work on a task led to higher test grades than students in a lecture class (Giraud (1997). This helps especially students who are shy to ask questions in public. Magel (1998) noted that implementing cooperative learning groups in a large lecture class also led to improved test scores compared to grades from a previous semester that did not use group work *(*www.academia.edu*).* With regards to problem solving, when traditional teaching was compared to problem based learning, the study on the effectiveness problem based learning of McParland et al. (2004) found that examination performance was significantly improved compared to traditional teaching. The study further showed that examination performance increased when a problem solving curriculum was used compared to the traditional method. Furthermore, research has indicated that educational strategy should include elements of problem based and community based approaches to teaching and learning (McParland, Noble

and Livingstone 2004). Students are encouraged to take more responsibility for their own learning as they go through the curriculum. The mutual exchange of opinions boosts and stimulates cognitive thinking (Efland 2015). In this vein, it is up to the instructor to facilitate cooperative group work so that students can exchange ideas leading to a group goal and individual accountability (Classroom Compass 1994, McParland et al. 2004, Ofodu and Lawal 2011).

Looking at the methods of teaching in general, research has shown that students have different learning styles and that their academic performance is related to their learning styles and the method of teaching (Magel 1998, Nanney 2004). There is an assumption that methods of teaching are closely related to the learning style of students (Rahman et al. 2011). This means that the teaching methods should cohere with the learning style of students (Magel 1998, Rahman et al. 2011, Bostan et al. 2015). In Al-hazimi's view, the teacher is the main source of information where the teaching depends mainly on information conveyed by the instructor (Al-hazimi et al. 2004). In the traditional method of teaching, lectures, tutorials and practical sessions are used, but with limited problem-based learning (Al-hazimi et al. 2004). With this method, students are more likely to memorise what is to be learnt. In this regard, when the teacher is perceived as authoritarian, and students were more likely to feel tired, less able to memorise all they learnt, and less likely to enjoy the course (Al-hazimi et al . 2004). This learning environment made the students to rate their learning and teaching environment significantly lower during courses' evaluation, compared to their counterparts in an innovative class.

There is an assumption that cooperative groups provide a natural setting for peer tutoring and for skilled students to model for less skilled students (Sharan 1980). Hence, learning in a cooperative group is very important since it helps less competent students to learn from those who are more competent. Scaffolding occurs when learners are assisted by others in constructing knowledge (Wood, Bruner and Ross 1976). It is further assumed that teaching with technology appears to help students improve their performance in order to learn basic statistical concepts. This is done by providing different ways to represent the same data set such as going from tables of data to histograms to boxplots, or by allowing students to manipulate different aspects of a particular representation in exploring a data set. For example, changing the data to change the shape of a histogram to see what happens to the relative positions of the mean and median. Also, students may acquire an understanding of measures of location and dispersion by using graphical presentations of the data. The computer can also be used to improve students' understanding of hypothesis testing by allowing them to explore and represent the data using various statistical models.

Various strategies have been suggested for organising and managing cooperative learning groups (Garfield 1993). Methods include the use of rewards, structured processes involving periodic tests, assigning roles to group members, training tutors and, training students in group processes as well as interactive skills (Garfield 1993). Johnson and Johnson (1985) suggest four conditions for successful group work (Margaret 1999), such as interdependence, where the task require cooperation, and rewards are such that all members will participate; face-to-face interaction, whereby groups are small enough for personal interaction; individual accountability, meaning that students are individually accountable for asking and giving help; and students know or are taught interpersonal and small-group skills. Garfield (1993) suggests that there is no right way to configure cooperative learning groups in a class. This study follows mainly Vygotsky's theory of proximal development (1978). This theory postulates that students help each other through interaction when working on a specific task. When students

work in a group, those who are more knowledgeable help those who are weaker. In this way, students learn better and acquire knowledge through their peers where they feel more comfortable to talk and to discuss the work around the task given (Mastropieri and Scruggs 2002, Louis 2009).

Theoretical Framework

To determine if innovative teaching methods are effective, a link to theories of learning can explain the influence of teaching methods on student's performance (Gunawardena 1998). It is crucial to think of how students learn, before new teaching methods can provide some insights (Hutchings and Garaway 2010). In the literature, one theoretical framework about how students learn statistics has been discussed in Mills (2004). A theory of constructivism postulates that, based on observation, students develop and construct their own knowledge and understanding of the world around them (Mills 2004). By constructing their own ideas, and knowledge about statistics concepts, students will understand better what they learnt in theory when they put it to practice. Constructivism teachers encourage students to constantly assess how the activity is helping students to understand the work (Felder and Silverman 1998, Mills 2004). Further, the theory of conceptual change contends that, as a result of interacting with new knowledge, students may eventually change their ideas or come to understand the scientific explanation behind the work. In this instance, students must realise that any old and faulty ideas are at the least, partially in conflict with the new and scientific ideas and that the scientific explanation provide a more convincing and more powerful alternative. If learners are able to change to the new and scientific conception, they are then able to solve problems overtime in a better defined, straightforward fashion, to, in turn, this enhances their performance. In addition, the theory of expertise may be used to describe the development of a learner's problem solving skills which may provide some evidences of a learner's progress toward statistical understanding and literacy towards his/her performance in the course.

METHODS

Study Design.

The statistics ECP students were taught in a large lecture hall for delivering the new course material and content. The classes were interactive where the lecturer played the role of facilitator using traditional and cooperative methods of teaching. The interaction was twofold: such as the interaction between student to student, and also student and lecturer which boosts students' engagement. In addition to the three one-hour lectures per week, practical sessions for three hours per week and one-hour tutorial session per week (see table 4) were also provided to strengthen what was taught during lecture classes. The practical and tutorials mainly focused on group work. Students were also informed of basic group work skills and the class was split into small groups of between five and ten students per group with one tutor. The group was formed through self-selection and they were assisted by teaching assistants in choosing groups, thus, everyone participated. During practical and tutorial sessions when the groups worked together, students rearranged desk-chairs into groups within the classroom and the lecturer(s), consistently, updated the practical and tutorial facilitators on the task to be covered at every sessions. The teaching assistants prepared worksheets containing exercises corresponding to the current chapter. The practical and tutorial facilitators also distributed worksheets among students working in groups, and each facilitator was given between one or two groups to assist. Teaching assistants further interacted with the groups during these sessions to check progress. In addition to this, intervention programmes (see table 4) were also offered to students who were not making good progress in their continuous assessment (2009 to 2011). In these programmes, the lecturer(s), teaching assistants, and tutors were highly involved.

Students were also given time to attempt exercises by helping each other. Prior to the end of the session, the students would choose among themselves who will write-out the answers on the teaching board. Alternatively, the teaching assistants further helped with corrections of the exercises on the board in case students were struggling to answer the questions. As per the methods of assessment, students wrote twelve tutorial-tests and four term tests (see table 4), and in some cases, they were given assignments. The tutorial tests were written at the end of every chapter, while the term tests were written at the end of every term. The schedule of tutorial- and term tests were given to students at the beginning of every term. Among the twelve tutorial tests, the lecturer selected ten (10) of the best marks. Tutorial tests contributed 50% of the continuous assessment mark. Of the four (4) term tests, three (3) of the best test marks were selected which made up 50% of the continuous assessment mark. At the end of the year a final exam was written. The final exam mark and the continuous assessment mark contributed 50% each towards the final result.

Data

The study was conducted on students enrolled in an introductory level statistics course to investigate the influence of teaching strategies on statistics students' performance overtime. This study used the final year marks of ECP statistics students who registered, attended, and completed the respective years from 2008 to 2014. These data were used to assess the performance of students over this specified period.

Statistical analysis

The descriptive analysis of the students' marks for each year was first done. This included the calculation of the minimum, median, maximum and range values of the marks. A box-and-whisker plot was also used to describe the distribution of the marks across the years. Furthermore, the Kruskal-Wallis test was used to compare the performance (in terms of marks) of students over the year groups (2008 - 2014). The choice of this non-parametric test was based on the fact that the marks data were asymmetrical. This was however expected in an academic environment as some students tend to score high and others low marks. For statistically significant results from the Kruskal-Wallis Test, the Dunn's post-hoc test for median difference with a Bonferroni adjustment (Dunn, 1964; Dinno, 2015) was used to determine which groups were different from each other in terms of performance.

RESULTS

The study first used descriptive statistics analysis, and then it proceeded with a non-parametric test to check if the data were statistically significantly different. Moreover, a post-hoc test was utilised to test which groups or academic years were statistically significantly different.

In Table 1, the summary statistics of the academic year marks is presented. The results show that the academic year that had the smallest number of students was the 2008, with median and range final year marks of 64% and 65% respectively. The highest number of students registered for the module was in 2010 (N=155) and during that academic year, the median year marks was the lowest (median = 60%). The students' best performance was in 2012 where a median final marks of 74.5% was obtained. The findings show reveal that the pass rate ranged from 72% to 100% over the period investigated.

In Figure 1, the distribution of students' marks showing the performance between 2008 and 2014 is displayed. As indicated, the median marks of students decreased slightly from 2008 (64%) to 2009 (58%). The increase of students' performance was remarkable from 2009 (58%)

to 2012 (74.5%), then the median academic year marks slightly decreased between 2013 and 2014 from 74 % to 72.5 % respectively.

In Table 2, the Kruskal-Wallis test results are presented. As indicated, there was a statistically significant difference in performance among ECP statistics students from 2008 to 2014 ($\chi^2(6) = 220.6, p-value = 0.0001 < 0.05$). As indicated, the highest performance score was in the 2012 academic year.

The Dunn's test results for the difference in medians across the groups (years) are given in Table 3. Referring to the results in this table, the data show that the median marks of 2009 and 2010 did not differ from each other, but were significantly lower than the marks in the other years. Marks in 2008 and 2011 were similar to each other, but differed from the marks in the other years. The marks in 2014, 2013 and 2012 were also similar, but were significantly higher than the marks in the other years.

DISCUSSION

Table 1, indicates that the median marks of ECP statistics class has increased over time, except in 2009 and 2010 where median marks were significantly lower compared to other academic years. The reason could be the increase in the number of students enrolled into the programme without the sufficient number of tutors and teaching assistants, who could, effectively, assist students. At that time, there was only one lecturer who could teach all ECP statistics students in one classroom. In addition to that, the intervention programme introduced in 2009 was not sufficient to increase the performance of the risky students. Furthermore one teaching assistant employed to assist the lecturer in a class consisting of 119 ECP statistics students was not adequate, given that the class was supposed to be divided into two groups. During this period (year), tutorial and practical were introduced in the programme. However, cooperative learning and problem solving by helping students in small groups was not used due to financial restraint to employ extra tutors and teaching assistants in year. 2009 was the beginning of teaching with technology whereby computers were used for data analysis in a 60-seatercomputer laboratory. Though the number of computers was not enough to equip all the students as two students could share one computer when it was necessary.

In 2010, the median of the final marks had increased though the pass rate slightly decreased. This slight increase in the median final year marks resulted from the appointment of qualified, dedicated, committed teaching assistant and tutors in addition to one existing teaching assistant and one lecturer. In addition to that, March and June intervention programmes were organized especially for those who were performing below standards (50% and below). During this academic year, students were split into two practical and two tutorial groups in the second semester. However, repeating mathematics at the same time taking statistics could affect ECP students' performance.

The data shows that, from 2010 to 2012, the median marks of ECP statistics students have increased. This increase was enhanced by the split of the class into two lecture groups which made them more interactive. The practical and tutorials were handled by two qualified teaching assistants, assisted by PhD and Masters student-tutors. Once again, this was a result of the availability of funding to employ more staff which also enhanced cooperative learning and problem solving methods of teaching. This strategy contributed significantly on ECP statistics students' performance during this period. Johnsen (2009) teaching experiment found that students who participated in collaborative learning had performed significantly better on

critical thinking. This is in agreement with Vygotsky's theory of proximal development (1978) who saw that, working in group help students on specific task to improve their understanding.

Teaching with technology including the use of medical and excel computer applications. This was performed by taking students to the lab for data analysis which could help students to understand the calculations and it enhanced their understanding and performance. These results are consistent with Aloraini (2012), Mohamed and Abdulghani's (2016) findings who saw that teaching with technology in education is an effective way to reach better understanding. Hence, the performance of ECP statistics students was also a result of cooperative learning and problem solving, and engagement to problem solving in small groups and the enhanced use of technology. These results are supported by Alshammari who found that students who employed cooperative learning or group work had good academic achievement (Alshammari 2015). The intervention programme during term breaks and June-July vacation provided supplemental opportunities for students to become acquainted with the content (Swail, 2000) and it contributed to a very good performance of ECP statistics students in these academic years.

CONCLUSION

The study looked at teaching strategies and effects of learning outcomes. The study used final year marks of statistics students in ECP from 2008 to 2014 at the University of the Western Cape. The findings indicate the variations among the medians of academic year marks from 2008 to 2014. Our data a good improvement of achievement over time. For example, the marks in 2008 and 2011 were moderately good. In 2014, 2013, and 2012 the marks were slightly higher than the marks in other years. Only in 2009 and 2010 academic years where medians marks were slightly lower than other years. From 2012 to 2014, the median marks increased, and then it stabilised. Though students did not receive an intervention programme in the last three years, it is clear that professional teaching assistants and qualified tutors continued to work hard together to keep the momentum. Despite the shortage of venue to accommodate the second group for practical and tutorial, and the insufficient number of computers in laboratory, there was a gradual improvement in the academic performance of ECP statistics students from 2008 to 2014.

The evidence in this paper shows that technology had a positive influence on ECP students learning outcomes and expectations. Cooperative learning and problem solving using group work played a crucial role in boosting ECP statistics students' achievement. The intervention programmes offered to risky students also contributed to ECP student's achievement. Though traditional method is more likely to be criticized in discourse, the evidence from this study shows that it played a positive role where the lecturer could not interact with every student individually in a class room. This was useful, especially, in the academic years where classes were very large. Nonetheless, future studies are needed to address how ECP students perform after joining main stream.

RECOMMENDATION

From the foregoing analysis, we recommend as follows:

1. Teaching with technology should be encouraged help students to learn more enthusiastically and remain focused.
2. Cooperative learning and problem solving should be encouraged in practical and tutorial sessions. Evidence suggest that students learn better in small groups. In-addition, group work should be highly supported in classroom so that those who are more knowledgeable assist those who are less knowledgeable.

3. Academic institutions should make provision of appropriate venues for each course beforehand. Preferably, venues for practical and tutorial should be flat, in order to facilitate group work in classrooms.
4. Lecturers and other stakeholders in academic planning, should identify risky students as early as possible in order to plan for intervention before it is too late.
5. Future studies are needed to address how ECP students perform after joining main stream.

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Table 1: **Summary statistics of the students' marks across the academic years**

Year	N	Minimum %	Median %	Maximum %	Range %	Interquartile range %	Pass rate %
2008	80	21	64	86	65	13	72
2009	119	39	58	79	40	15	86
2010	155	16	60	89	73	15	83
2011	131	41	68.5	90	49	13	85
2012	123	43	74.5	93	50	11	88
2013	122	52	74	96	44	15	100
2014	89	53	72.5	98	45	13	96

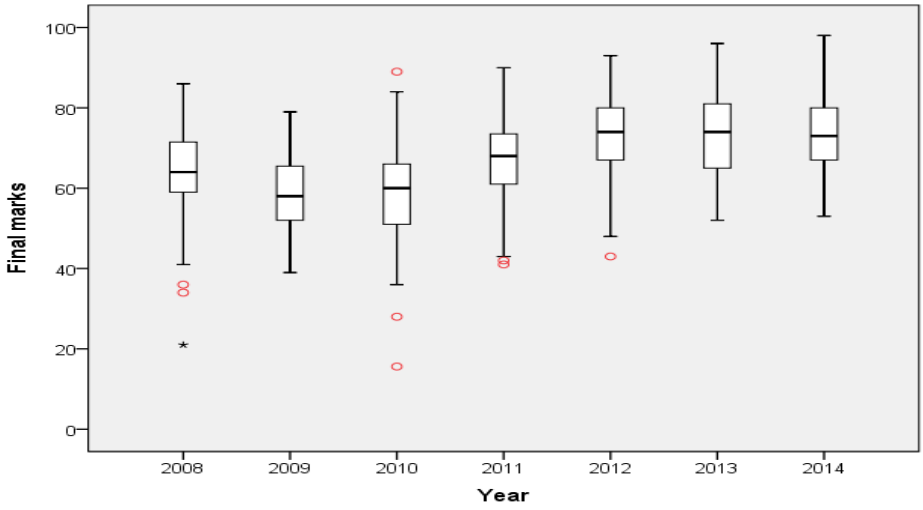

Figure 1: ECP statistics students' performance overtime: 2008 – 2014

Table 2: Kruskal Wallis Test results

Year	Obs	Rank Sum	Kruskal Wallis Test		
2008	80	28858.0			
2009	119	29480.5	Chi-Squared	df	Probability
2010	154	41277.0	220.567	6	.0001
2011	131	54119.5			
2012	123	67269.5			
2013	122	65484.5			
2014	89	48482.0			

Table 3: Dunn's test post-hoc analysis

Col mean Row mean	2008	2009	2010	2011	2012	2013
2009	3.308666 0.0098*					
2010	2.847508 0.0463*	-.704061 1.0000				
2011	-1.563510 1.0000	-5.529326 0.0000*	-5.168251 0.0000*			
2012	-5.487925 0.0000*	-9.850544 0.0000*	-9.763447 0.0000*	-4.511141 0.0001*		
2013	-5.180431 0.0000*	-9.497279 0.0000*	-9.386789 0.0000*	-4.160151 0.0003*	0.336252 1.0000	
2014	-5.056799 0.000*	-8.972728 0.0000*	-8.798279 0.0000*	-4.056475 0.0005*	0.065864 1.0000	-0.242461 1.0000

*: Significant at 5% level

Table 4: Teaching Activities 2008 – 2014

	2008	2009	2010	2011	2012	2013	2014
Number of lecturers	1	1	1	2	2	1	1
Number of TAs	-	-	1	2	2	2	2
Number of students	80	119	155	131	123	122	89
Number of tutors	1	2	3	4	4	6	6
Teaching methods	Traditional & cooperative learning	Traditional & cooperative learning	Traditional, cooperative learning & problem solving	Traditional, cooperative learning & problem solving	Traditional, cooperative learning & problem solving	Traditional, cooperative learning & problem solving	Traditional, cooperative learning & problem solving
Design of the class room	Lecture hall	Lecture hall	Lecture hall	Lecture hall	Lecture hall	Lecture hall	Lecture hall
Number of lectures/week	3	3	3	3	3	3	3
Number of hours of practical/week	1 in computer lab	1 in computer lab	3 in lecture hall/flat lab	3 in lecture hall/flat lab	3 in lecture hall/flat lecture hall	3 in lecture hall/flat lecture hall	3 in lecture hall/flat lecture hall
Number of tutorial/week	1	1	1	1	1	1	1
Intervention program	-	1	3	1	-	-	-
Methods of assessment	Tests, tut tests, and Assignments	Tests, tut tests, and assign	Tests and Tutorial Tests	Tests and Tutorial Tests	Tests and Tutorial Tests	Tests and Tutorial Tests	Tests and Tutorial Tests
Class median marks (%)	64	58	60	68.5	74.5	74	72.5
Pass rate (%)	59	86	83	85	88	100	96

TA: Teaching Assistant