VISTAS

Journal of Humanities & Social Sciences

Volume 7 / 8 *2011/ 2012*

Teaching Statistics and Research Methods Using a Learner - Centred Approach

L. D. I. Wijetunga
The Open University of Sri Lanka

ABSTRACT

Most statistics courses offered by Social Sciences Departments in universities face a number of problems. This has resulted in negative attitudes towards statistics by students. As a consequence, this has led to low transferability of critical statistical skills towards innovative individual research. Their difficulties with quantitative methods often arise from a poor background in mathematics and an inability to relate the techniques taught in the classroom to practical research projects. Therefore, it is suggested that the content side of statistics education should move away from the mathematical and probabilistic approach and place greater emphasis on "research design and statistical thinking". Accordingly, the goal should be to integrate "statistical thinking" into the subject matter on which the students are working. Consequently, a study was designed as a model for teaching the basic Statistics and Research Methods (SRMs) course to students. A learner-centered approach served as the basis for this model. Despite the abundance of research studies, most of them have only general implications. Much is still to be learned about particular problems. Important questions that still need to be asked include: how would students react to being placed in the position of learner-centered awareness in line with statistical thinking process?

In this case study, significant changes to classroom teaching methods were introduced to the Statistics and Research Methods subject. Qualitative and quantitative data were collected via formative and summative subject evaluations, student performance in assessments, and classroom observation. These data were comparatively analyzed with similar data collected on the same subject at the beginning of the class, with an emphasis on qualitative findings and descriptive statistics. The shift toward student-centredness through the use of interactive small group activities appears to have significantly enhanced students' learning in Statistics and Research Methods. The assessment results suggest an overall strong engagement with the subject matter, and student feedback was very positive. Follow-up studies could be conducted using observational research methods and interviews. Observing actual classroom behavior and interviewing the students would provide more insight into the teaching styles used by the teachers and the variables that may influence these styles.

Key Words: Research Methods, Statestics for ESL Research, Postgraduate Students, Learning Preferences

1. INTRODUCTION

Inability of undergraduates and postgraduate students to deal with statistics is well documented. Courses in statistics offered by Social Sciences Departments in universities face a number of constraints related to statistics: (a) negative attitude of students (b) low student motivation towards the subject (c) student being passive learners in the statistics class room. All the above problems result in low transferability of critical statistical skills towards innovative individual research. Student difficulties with statistics often arise from a poor background of mathematics and an inability to relate the techniques taught in a statistical class to a practical research project (Morris, 2005; Murtonen and Lehtinen, 2003; Hughes and Berry, 2000; Ware and Brewer, 1999; Murtonen and Lehtinen, 2003; Lehtinen and Rui, 1995; Thompson, 1994; Kelly, 1992; Garfield and Ahlgrewn, 1988). For this reason, it is suggested that "the 'content side' of statistics education should move away from the mathematical and probabilistic approach and place greater emphasis on "data collection, understanding and modeling variation, graphical display of data, design of experiments, surveys, problem solving, and process improvement" (Snee, 2011).

The suggestions made by the above researchers to focus on statistical thinking and, thus, on the processes involved in data production, have a significant bearing on the domain of subjects like research methods. Accordingly, the goal should be to integrate "statistical thinking" into the subject matter on which the students are working (Snee, 1993, 2001). Therefore, the challenge is to promote the interest and personal commitment of students, and develop their appreciation for statistical thinking by embedding the research methodology into the subject matter.

Consequently, a study was designed as a model for teaching the basic Statistics and Research Methods (SRMs) course to students. A learner-centered approach served as the basis for this model. The proposed learner-centered approach accommodates the different educational and professional backgrounds of the learners, particularly because, as a group, they have not had any common learning experiences. We adapted it to the requirements of a Statistics and Research Methods (SRMs) course offered at masters degree level in Teaching English as a Second Language (TESL) with the objective of developing students' critical and practical skills in managing empirical research relating to language studies.

2. CONCEPTUAL UNDERPINNINGS

2.1 Statistical thinking

In the 1990s there was a strong call from some prominent statisticians to develop students' statistical thinking, resulting in the American Statistical Association setting the agenda for the future of statistics education by promoting three elements of practice, emphasise statistical thinking; use more data and concepts, with less theory and recipes; and foster active learning. Pfannkuch and Wild (1999) summarise statistical thinking as taking account of variation, constructing and reasoning from models, transnumeration, and the synthesis of problem context and statistical understanding. Vandenbroeck and Vandevyvere, (1996) propose the following definition: 'statistical thinking is a generalist skill that is focused on the application of nontechnical concepts and principles with the aim to better understand how statistical methods can contribute to fnding answers to specifc research problems and what the implications are in terms of data collection, experimental setup, data analysis, and reporting'. Gal (1998) distinguishes two contexts for interpretative skills, namely reporting and listening or reading. The novice researcher must be able to interpret, create, communicate and defend opinions based on statistical argument. Both contexts are relevant for researchers, but data producers, at whom this project is aimed, are particularly concerned with the interpretative skill of the reporting context. Therefore, they must be able to defend the use of an experimental or survey design or the implications of an analysis of experimental data. On a similar theme, Moore (1998) argues that statistical thinking should be considered as a liberal art and that we should therefore spend more time on broad ideas rather than technical content. Chance (2002) states that "statistical thinking processes clearly involve, but move beyond, summarizing data, solving a particular problem, reasoning through a procedure and explaining the conclusion." He states its de?ning characteristic "is the ability to see the process as a whole, including 'why,' to understand the relationship and meaning of variation, to have the ability to explore data in ways beyond what has been prescribed in texts."

According to Garfeld et al. (2003) "statistical thinking involves an understanding of why and how statistical investigations are conducted and the 'big ideas' that underlie statistical investigation (Snee, 2011). Statistical thinking also includes being able to understand and utilize the context of a problem in forming investigations and drawing conclusions, and recognizing and understanding the entire process.

As whole, the statistical thinker has the ability to integrate these potentially competing priorities into a coherent and statistically underpinned research strategy. Statistical thinking is a practice fully integrated with the researcher's scientific field, not merely an autonomous science. Hence, the statistical thinker is deeply involved in applied research, with a good working knowledge of the substantive science. These skills combined lead to ef?ciency, important to increase the speed with which research data, analyses, and conclusions become available, as well to enhance the associated quality, and to reduce the associated cost. Statistical thinking then helps the scientist to build a case and negotiate it on fair and objective grounds with those in the organization seeking to contribute to more business-oriented measures of performance.

2.2 Learner-Centred Approach as a teaching method

Deriving from the constructivist view of learning, a "learner-centered approach" has been advocated in higher education during the last few decades (Zophy, 1982; McCombs & Whistler, 1997; Weimer, 2002; Pillay, 2002). Learner-centered teaching represents a paradigm shift from traditional teaching methods by focusing on how students learn instead of how teachers teach. Thus, the model's conceptual underpinning is rooted in learning, challenging us to ask the rarely heard question, "How can I improve my students' learning?" instead of the often asked "How can I improve my teaching?" Even though there is disagreement over the precise definition of student-centred learning, the core assumptions are active engagement in learning and learner responsibility for the management of learning (Lea et al., 2003). Once we have articulated our goals for students in statistics and research methods classes, we need to address the issue of how we enable students to learn these ideas and to change their already established beliefs about subject matter.

In Learner-Centered Classroom Discussion (LCCD), teachers might take themselves out of the role of leader entirely, becoming a facilitator instead. In this scenario, students are empowered to be responsible for the discussion while the teacher provides learning outcomes, a text for the discussion. Unlike traditional instruction that culminates in a problem after basic instruction on facts and skills, Problem Based Learning (PBL), begins with a problem, teaching facts and skills in a relevant context.

3. RESEARCH QUESTIONS

Despite the abundance of research studies cited above, most of them have only general implications. Much is still to be learned about particular problems. Important questions that still need to be asked include: how would students react to being placed in the position of Learner-Centered awareness?

3.1 Specific questions

1. What specific Learner-Centred activities work best in helping students learn particular concepts and develop particular reasoning skills?
2. What types of teaching strategies inform teachers about students' understanding?
3. What are students' attitude regarding how research methods is discussed or analyzed in the classroom?
4. Are students being adequately prepared to use statistical thinking and reasoning, to collect and analyze data, to write up and communicate the results of solving real researchable problems?

This study examines the answers to these questions and helps close the gap between learner and teacher by adopting a Learner-Centred Approach as a classroom teaching methodology.

4. RESEARCH DESIGN

In this case study, significant changes to classroom teaching methods, which are discussed below in detail, were introduced to the Statistics and Research Methods subject. Qualitative and quantitative data were collected via formative and summative subject evaluations, student performance in assessments and classroom observation. The reflections discussed in this paper form the basis for further curriculum changes in the future.

The class-teaching experiment (n=12) comprised 6 sessions each of 3 hours. In the teaching sessions, the Masters-level in Teaching English as a Second Language (TESL) course served as the context and provided both categorical and numerical data. All students in class were assessed prior to and immediately following the teaching experiments using the same protocol that had been used to validate the Framework. This is often evaluated using a simple pretest-posttest design. Despite methodological limitations, the simple pretest-posttest design involves examining the extent to which participants gained cogitative knowledge about the topic. The crucial step toward the goal of improving practice efficacy is to ensure that continuing education participants obtain knowledge about the subject matter.

5. STATISTICAL THINKING FRAMEWORKS

As a whole, two levels of Statistics (Descriptive Statistics and Inferential Statistics) were used in the development of the initial SRMs framework resulting in three sub-processes for analyzing and interpreting data: (a) making comparisons within data sets or data displays, (b) making comparisons between data sets or data displays, and (c) making inferences from a given data set or data display. The ability to analyze and interpret data builds upon the ability to read data displays, organize and reduce data, and represent data. Traditionally, the tool used in analysis and data representation is the Statistical Package for the Social sciences (SPSS). While this tool (SPSS) is attractive, it can impinge on the development of the skills needed for proper statistical analysis (Field, 2009). Therefore, to overcome this problem an attempt was made to introduce the PBL teaching technique along with SPSS. As such, the PBL was an attempt to strike a necessary balance between theory and practice. This is achieved by bringing interactivity into the classroom and encouraging students to participate fully in all discussions and activities.

5.1 Students in small groups

During problem based learning, the researcher develops sequences of instructional activities or learning trajectories and analyzes students' individual and collective statistical learning as it occurs in the social situation of a small group in the class room. In our teaching experiments, the learning trajectories (goals, tasks, and expected learning outcomes) were based on the framework, which was also used as a lens to trace changes in students' learning during the intervention. Students usually solve problems in small groups (4-6 students), in which cooperative learning is encouraged. Students are also stimulated to search for new information, and solve a part of a given problem as independent learners. The teacher is a facilitator, who assists the students in the skills acquisition process and develops the students' independent-learning capacities.

5.2 Selected students learning activities[1]

i. Cooperative logic activities

Cooperative logic activities used groups of four to six students. Each student was given a clue which was read, but not shown, to the other members of the group. Each student owns a vital piece of information needed to solve the problem. This is an excellent way to practice "reading the data" as the initial stage of interpreting and analyzing data in SRMs.

Class activity 1

Using SPSS- select Analyze>descriptive statistics> Frequencies to create and interpret frequency tables and several summary tables such as mean, median, mode.

Class activity 2

Using SPSS- select Analyze>descriptive statistics> Explore option.
Get a detailed summary statistics and interpret

Class activity 3

The mean height of 500 women, normally distributed, in the Colombo District is 5 ft 5 inches with a standard deviation of 2.5 inches. How many women would you estimate to be between 5 ft, 5 in, and 5 ft 7.5 in? (Between the mean and one standard deviation above the mean?)

[1]This section is heavily dependent on the work carried out by Jones et. al. (2002).

Class activity 4

Students are asked to read the following passage and think about how the terms are used.

A confidence interval represents a range of reasonable values. If the hypothesized value is inside the confidence interval the null hypothesis is accepted, and if the hypothesized value is outside the confidence interval the null hypothesis is rejected. Use a 95% confidence interval for a test with 5% significance, and a 99% confidence interval for a test with 1% significance.

The words inside, outside, accepted, rejected have the same meaning as in ordinary usage but words such as significance and confidence have precise mathematical meanings. In this mathematical context the word confidence alone has little meaning. It is the phrase confidence interval that conveys the meaning.

ii. Comparatives cause problems

Comparatives cause problems for all students. There are so many ways of expressing the same idea, such as 'at most'and 'not more than'. Students need to be taught the differences and similarities between constructions such as those listed below. The example below is a cooperative logic problem based on the normal distribution.

at least	less than	exactly
at most	neither ... nor	none
more than	either ... or	only

Problems understanding the words are the most obvious difficulties encountered by students. Students need to understand the meanings of technical terms.

Class activity 5

Interpret the following expressions using the constructions given above.

$\leq$ $\neq$ $\geq$ $=$ $<$ $<$

iii. Cloze passage

In a cloze passage, words or phrases are deleted and the student fills in the gaps. Students can fill in the gaps in the passage or be given a list of words to choose from. Whilst this can be done individually, it is more effective if students work in pairs, as discussion and reading practice. Cloze passages are particularly useful for summaries. If one's teaching objective is to reinforce vocabulary, delete key vocabulary items or if one's objective is to teach structure, delete prepositions and linking words as in the example below.

Class activity 6

$Z = (X - \mu)/\sigma$ *change the subject of the formula to X*

$\sigma Z = X - \mu$ *multiple both sides ---------------σ*

$\sigma Z + \mu = X$ *addμ ....both sides*

$X = \mu + \sigma Z$ *rearrange so that the equation reads from left to right*

iv. Matching meanings

Matching meanings include multiple-choice and sorting or matching for equivalent or opposite meaning. This technique is best in pairs or in groups of three. In the example below, the eight responses to the problem are written on separate cards and students are asked to group the cards with the same meaning. The students are then asked to pair the cards with opposite meaning but similar language structure.

Class activity 7

An unbiased die is thrown. What is the probability of throwing:

at most a 4	less than 5	not more than 4	neither a 5 nor a 6
at least a 5	more than 4	not less than 5	either a 5 or a 6

v. Logical connectors

Logical connectors cover some of the aspects of sequencing and logic, however this section goes further. How do students follow the logic of a proof or derivation in a second language? These skills are related to following a story in English and so teaching techniques can be adapted to teach these skills in SRMs. The following techniques can be useful for teaching sequencing and logic. For example, a common technique in TESL teaching is to take a paragraph and chop it up sentence by sentence like a jigsaw. The students then put the sentences back in order. This technique can be used with statistics teaching. Take an example, write out the solution, chop it up and ask the students to reconstruct the solution.

In some cases there is no unique solution - this leads to discussion and more practice of speaking and listening skills.

6. DATA ANALYSIS AND DISCUSSION

The findings allow us to address the four questions in the study. The first research question was "What specific Learner-Centred activities work best in helping students learn particular concepts and develop particular reasoning skills? Repeated group work helped students to understand different perspectives and think more critically and reflectively about their own assumptions and values in relation to doing research. Students enjoyed getting to know each other, and felt confident to express themselves in class as a result of feeling comfortable with each other.

The initial findings have confirmed that Problem Based Learning (PBL) is regarded as an effective teaching and learning environment. See Figure 1 for a summary of the results on the following six questions:

1. I enjoyed my experience with PBL
2. PBL contributed to the speed of my learning process.
3. PBL made my learning experience easy.
4. The interactivity provided by PBL made the sessions more interesting.
5. PBL allowed me to participate in answering questions without being embarrassed.
6. I would very much like to have PBL incorporated into my learning materials.

Table 1 Students' feedback on classroom performance

Question:	**classroom performance**				
	1	2	3	4	5
1	0(0%)	1(8%)	0(0%)	5(42%)	6(50%)
2	0(0%)	0 (0%)	2 (17%)	6(50%)	4(33%)
3	1(8%)	1(8%)	2 (18%)	4(33%)	4 (33%)
4	0 (0%)	1(8%)	0 (0%)	2 (17%)	9 (75%)
5	1(8%)	0 (0%)	1 (8%)	4 (33%)	6 (50%)
6	0 (0%)	0 (0%)	1 (8%)	5 (42%)	6 (50%)

(1= Strongly Disagree, 2=Disagree, 3= Neither Agree or Disagree, 4= Agree, 5=Strongly Agree):

As the feedback illustrates, most students who participated in the study, agreed that the PBL way of conducting the lesson was advantageous. For instance, almost 90% of the students strongly agreed with the interactivity provided by this way of learning. Approximately 80% agreed (or strongly agreed) with the fact that PBL allowed them to participate in answering questions without being embarrassed. The results also suggest that 92 % of the participants would prefer to have PBL incorporated into their learning materials.

With regard to the second research question "What types of teaching strategies inform teachers about students' understanding?"

The following observations were made:

Results of this study indicated that

a. "relating to experience" (75%), and "assessing student needs" (69%) most successfully,
b. "learner-centered activities" (72%) and "participation in the learning process" (55%) reasonably well, and
c. "personalizing instructions" (47%) and "flexibility of personal development" (40%) below average.

As for the third research question "What is their attitude regarding how research methods are discussed or analyzed in the classroom? Results showed that utilizing teaching approaches that encourage students' active and experiential engagement with the subject matter (and with each other) has the potential to be extremely effective, in terms of student satisfaction and class performance. This is particularly noteworthy in the context of a research methods subject, given that research methods is traditionally considered to lend itself to more didactic approaches in which vast amounts of technical information is transmitted from teacher to student.

Our results also show that collectively students revealed conceptual knowledge of center and spread that was multifaceted (Watson & Moritz, 2000) and useful in informing instruction. The difficulty for the teacher lay in deciding how and when to use students' different representations of center (e.g. median or mode). Students' prior knowledge in representing data appears to be constrained by limited accessibility to pervasive sorting and organizing schemas.

The final question is, "Are students being adequately prepared to use statistical thinking and reasoning, to collect and analyze data, to write and communicate the results of solving real researchable problems? Student feedback on both the formative and summative evaluations of the subject discussed here consistently indicated that formal presentation of technical material and disciplinary insights by the lecturer was a very important part of their comprehension and learning in this subject. What appeared to make the transmission of this information more effective, however, was the use of group exercises and primary source material that allowed students to build a common experience from which to draw concrete examples and to which they could relate specific dilemmas. This common experiential ground was generally created through small group activities prior to the more formal presentation.

With respect to analyzing and interpreting data, students' thinking, prior to the intervention, was more normative on tasks that involved reading between the data than on tasks that involved reading beyond the data. The intervention revealed some unanticipated problems with tasks that focused on reading between the data, especially those that involved identifying and comparing two subsets of the data. The analysis also highlighted the importance of students' knowledge of the data context in relation to tasks that involved reading beyond the data.

Nevertheless, the most important outcome of the class is the student learning about research, its process and its findings. For example, during the semester of 2010, the course was evaluated using MA module based on student outcomes using a pre-test/ post-test design. The tests focused on assessing students' knowledge about methods, the role of statistics, and the nature of variables and hypotheses before and after the course began. Preliminary results show that the percentages of students being able to answer the questions correctly improved remarkably, from the pre- to the post-test, for every question asked, except for the question that asked students to identify the limitations of science, which showed no change (see Table 2).

Table 2. Pre-Test and Post-Test Evaluation of course:

Question Asked			**Answering Question Correctly (Percentage)**
1.	In social research the purpose of statistics is to…	pre-test post-test	25.0 62.2
2.	In the language of science, the variable that is thought to be the assumed cause is called a(n) _____ variable.	pre-test post-test	33.9 85.4
3.	A hypothesis differs from a theory in that it is...	pre-test post-test	48.8 84.1
4.	A hypothesis states, in part, that "income increases as education increases." In this statement, education is the _____ variable.	pre-test post-test	51.8 79.9
6.	In the research process, the role of statistics is limited because...	pre-test post-test	79.8 80.4
7.	A professor of English at OUSL suspects that when compared to male students female students have a higher average GPA. Restate this suspicion as a hypothesis.	pre-test post-test	59.5 78.5

Several learning patterns emerged from the analysis of instruction. These learning patterns are described by statistical process. With respect to describing data, students brought varying degrees of prior knowledge about meanings and conventions associated with contextual data displays. However, categorical data was more troublesome for these students than numerical data. Students' intuitive thinking with respect to organizing and reducing data was problematic.

7. CONCLUSION

The shift toward student-centredness through the use of interactive small group activities based on PBL appears to have significantly enhanced students' learning in this case. The classroom experience was characterised by a high level of dialogue and interaction, the assessment results suggest overall strong engagement with the subject matter, and student feedback was very positive. One of the key strengths of this approach was that it allowed students to build common experiential ground, which provided a shared base for engaging with more technical aspects of the subject matter. This is increasingly important in higher education contexts where flexible learning pathways are producing diverse student cohorts with no, or highly limited, common learning experiences.

As reported in the findings, the majority of the students who participated in the study indicated their preference for visual features. These features represent the statistical concepts, relationships and patterns which were demonstrated to them visually. It should be noted that most of the students who participated in this study regarded learning statistical topics an enjoyable experience.

In this researcher's experience few students choose a statiscal approach as a result of learning quantitative techniques from the research methods module. The researcher acknowledges that these issues concerning quantitative methods were resolved largely by reducing the teaching of mathematical concepts and removing the associated component of research. Research must continue to provide the practical, theoretical, and intellectual underpinnings to enable educators to achieve this potential.

8. LIMITATIONS

In order to make the case that a change, any change is the result of some kind of intervention, one must meet the three criteria of cause. First, the researcher must demonstrate that the intervention or cause precedes the effect in time. Second, there must be an empirical link between the independent and dependent variables. Third, and most important, "the observed empirical correlation between two variables" cannot be explained away as being due to the influence of a third variable.

With regard to this study, the most difficult of the three criteria for cause to be met is the third, ensuring that a variable other than the intervention does not cause changes in participants' knowledge and practice. Assuming scores on a knowledge test do indeed increase from the pre-test to post-test administration, this design clearly meets the first two criteria for cause: proper time order and empirical link. It is the third criterion however, that threatens the design's internal validity. In addition to the intervention, it is possible that another variable (or variables) caused the learners' scores to increase. Without a control or comparison group, one cannot determine how much of the observed change can be attributed to the intervention and how much can be attributed to the third variables. Hence the simple pre-test-post-test design has low internal validity and requires interpretation with caution.

9. FURTHER RESEARCH

Indeed, follow-up studies could be conducted using observational research methods and interviews. Observing actual classroom behavior and interviewing the students would provide more insight into the teaching styles used by the teachers and the variables that may influence these styles. For examples, under what conditions will specific constructivist approaches be most effective for enhancing student achievement? For which learners and for what learning outcomes will constructivist methodologies be most efficacious? More research is needed to answer these questions. In addition, to compare performance with a control group for whom teacher-centred methods used should be carried out to check the mean effectiveness of an intervention. Only if the mean result of the group differs signi?cantly from that of an untreated control group is the conclusion justi?ed that the treatment caused the effect.

REFERENCES

Babbie, E. (2004) The Practice of Social Research, 10th edition, Thomson Asia Ltd, Singapore.

Barr, R.B. and Tagg, J. (1995) From teaching to learning: A new paradigm for undergraduate education. *Change Magazine*, 27 13-25.

Bigwood, S and Spore, M. (2003) *Presenting Numbers, Tables, and Charts*, Oxford University Press, New York.

Boud, D. and Feletti, G.I. (1998) T*he Challenge of Problem-Based Learning* (2nd ed.). London: Kogan Page.

Brookfield, S., & Preskill, S. (2005) *Discussion as a way of teaching: Tools and techniques for democratic classrooms*. (2nd Ed.). San Francisco, CA: Jossey-Bass.

Bruner J. (n.d.), *Constructivism Theory* Retrieved August 15, 2004 from http://www.artsined.com/teachingarts/Pedag/Constructivist.html

Bryman, A. (2007) 'The research question in social research: what is its role?', *International Journal of Social Research Methodology*, Vol. 10 No. 1, pp. 5-20.

Cannon, R. and Newble, D. (2000) *A Handbook for Teachers in Universities and Colleges, A Guide to Improving Teaching Methods*. London: Kogan Page.

Cobb, G.W. (1993). Reconsidering statistics education: A national science foundation conference. *Journal of Statistics Education*, 1 [Electronic version] (http://www.amstat.org/publications/jse/v1n1/cobb.html)

Dougiamas, M. (1998) A journey into Constructivism Retrieved September 15, 2004 from http://dougiamas.com/writing/constructivism.html#intro

Driessen, E. and Van der Vleuten, C.P.M. (2000) Matching student assessment to problem-based learning: lessons from experience in a law faculty. *Studies in Continuing Education*, 22, 235-248.

Field, A. (2009) *Discovering Statistics Using SPSS*, (3rd edition), SAGE, London, UK.

Fillebrown, S. (1994) Using projects in an elementary statistics course for non-science majors. *Journal of Statistics Education*, 2 [Electronic version] (http://www.amstat.org/publications/jse/v2n2/fillebrown.html).

Flick, U. (2009) An introduction to qualitative research, (4th edition), SAGA, India.

Garfield, J. (1993) Teaching statistics using small-group cooperative learning. *Journal of Statistics Education*, 1 [Electronic version] (http://www.amstat.org/publications/jse/v1n1/garfield.html).

Hendry, G.D., Frommer, M., and Walker, R.A. (1999) Constructivism and problem-based learning. *Journal of Further and Higher Education*, 23, 359-371.

Hosker, I. (2010) *Statistics for Social Sciences*. (2nd Edition), Viva books, New Delhi.

Joan, G. (1995) How Students Learn Statistics, *International Statistical Review*, International Statistical Institute, USA

Lovie-Kitchin, J. (2001) Reflecting on assessment. In P. Schwartz, S. Mennin and G. Webb (Eds.), *Problem-Based Learning: Case Studies, Experience and Practice, Case Studies of Teaching in Higher Education*, 149-155. London: Kogan Page.

Mackisack, M. (1994) What is the use of experiments conducted by statistics students. J*ournal of Statistics Education*, 2 [Electronic version](http://www.amstat.org/publications/jse/v2n1/mackisack.html).

Magel, R.C. (1998) Using cooperative learning in a large introductory statistics class. *Journal of Statistics Education*, 6 [Electronic version](http://www.amstat.org/publications/jse/v6n3/magel.html).

Mahoney, M. (2004) *What is Constructivism and Why is it Growing?* Retrieved October 8, 2004 from http://www.constructivism123.com/What_Is/What_is_constructivism.htm.

Mendoza, P.L. (Ed.), (1998) *Proceedings of the Fifth International Conference on Teaching of Statistics (ICOTS5)*. Singapore: The National organizing committee.

Mehryar Nooriasher (2005) Innovative and Technology Based Methods of Teaching Statistics Concepts, University of Southern Queensland, Toowoomba, Australia, *The Mathematics Education into the 21st Century Project, Universiti Teknologi Malaysia, Reform, Revolution and Paradigm Shifts in Mathematics Education, Johor Bahru, Malaysia, Nov 25th - Dec 1st 2005*

Moust, J.H.C., Bouhuijs, P.A.J., and Schmidt, H.G. (2001) *Problem-Based Learning: A Student Guide. Groningen*: Wolters-Noordhoff.

Nicola, D., and Macfarlane-Dick, D. (2006) Formative assessment and self regulated learning: a model and seven principles of good feedback practice, *Studies in Higher Education* Vol. 31/2, April 2006, pp. 199-218.

Rossman, A.J., Chance, B.L., C., Lock, R.H., and von Oehsen, B. (2002) *Workshop Statistics: Discovery with Data. Guide for Instructors*. http://www.keycollege.com/ws/Discovery_with_Data/InstructorGuide.html

Schmidt, H.G. and Moust, J.H.C. (2000) Factors affecting small-group learning: a review of research. In D.H. Evensen and C.E. Hmelo (Eds.), *Problem-Based Learning: a Research Perspective on Learning Interactions*, 19-51. New York: Lawrence Erlbaum Associates.

Woods, D.R. (1995) *Problem-Based Learning: Helping your Students Gain the Most from PBL*. www.chemeng.mcmaster.ca/pbl/pbl.htm.