A STATISTICS SAMPLING EXERCISE

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Abstract

A required topic in the statistics course of accounting programs is sampling techniques. The sampling techniques topic is often presented theoretically in textbooks without practical illustrations. Practice questions provided in textbooks are also superficial that do not challenge students to understand the actual differences between sampling techniques. A practical alternative is to ask students to conduct a survey within the actual residential community thereby undertake actual sampling techniques. The survey would involve large amounts of time for both students and tutors, require human ethics approval, and students may encounter sampling technique issues in the field that cannot be answered by the tutor at the critical time. A novel approach was designed so that students can undertake the sampling exercise within the confines of the classroom in a practical means; thereby any sampling technique issues raised by the students can be answered in the classroom by the tutor. The practical exercise can be conducted within the supervision of the tutor so that content issues can be resolved and learning outcomes can be met at a deep learning level for the student rather than at a surface level. The sampling exercise has been developed every semester over the last few years. Each semester the exercise has become more refined and used in diploma and degree courses. The exercise can now be conducted by hand or using the computer. This paper presents a summary of the practical exercise. Student resources, frequently asked student questions, and tutor notes can be obtained upon request.

Acknowledgments: The author would like to thank Dave Ratcliffe for his contribution to the development of the sampling notes and computer practical. The author would also like to thank the comments made by anonymous reviewers.

Keywords: Statistics, education, teaching, practice, exercise.

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Technology and the type of accounting student are different to what they once were. There have been significant changes in the education environment in recent years. Large proportions of the classroom are international students (see Rankin, Silvester, Valley, & Wyatt, 2003) and so the dynamics and learning styles are different than in the past.

In education there has been the realisation that not all students learn the same way. To cater to these differing learning styles, there now persists greater emphasis on student centred learning, which is a principle of catering the teaching pedagogy to the students in the class. There is also more emphasis on using non-traditional teaching methods than there was before using conventional methods.

An outcome of emphasising non-traditional teaching approaches has been more inclusion of role-play and simulation activities in the classroom, and this inclusion has also been prominent in recommendations by several professional organisations. There have now been many calls, since 1990, from governing accounting bodies to change teaching approaches and to provide student interest. The accounting discipline, as well as other disciplines, have not escaped the calls for education to change. AECC (1990, 1992) and AAA (1986) are some examples of the calls for accounting education to change.

Simulation as a game enhances student learning through enjoyment and motivation. Students are motivated to inquire further and the activity provides an opportunity to communicate and interact with others (Heyman, 1975 cited in Kober & Tarca, 2002).

Lightbody (1997) used a factory simulation exercise to engage students in active-based learning and concluded that the activity offered an effective and entertaining method of teaching management accounting theory and practice.

Kober & Tarca (2002) used the well known game of Monopoly as a simulation to provide transactions for annual reports and scenarios for decision making and problem solving that were assessed. The results found that the teaching instructors believed technical and other skills of students' were improved, while students' themselves did not believe their interpersonal skills were improved. Both students and instructors indicated that the simulation was practical, enjoyable, and that students learned more.

In addition to written and verbal skill development, simulation activities are also thought to provide a variety of tasks and thus, provide the learner with opportunities that coincide with their learning style.

Engeholm and Bigel (1996) also claim that the simulation situation provides opportunities to develop skills to be an effective group leader and member.

Provided the simulation goes as planned, there are two big disadvantages of simulations; the cost and time to the instructor. Cost can be a large disadvantage especially since there are few prepared simulation activities ready for instructors to use, unlike textbooks that are already printed, and the publisher aggressively sells the text to instructors. If the activities are not already prepared, then the instructor may need to develop the resources, which may take large amounts of time, especially if the

resources and activities require detail. Even if the activities are already prepared, they often do not exactly match the requirements of the instructor, or the conclusions that the instructor is attempting to portray.

The advantages of simulations stated above indicate that simulations can support teaching by preparing the minds for careers by providing a more realistic environment, and develop relevant skills. Plucinski and Falgiani (1989) believe that simulations provide greater retention of the principles being taught because they are linked to visual images. Practical simulations attempt to bring the actual real life of business into the classroom. The purpose of bringing actual business into the classroom is so that students can benefit from action learning. Action learning is an approach that emphasises self-development and learning through experience, reflection, and action (Smith & Brown, 1995).

A common use in business classes is the use of case studies. While case studies provide a real life situation appropriate to what the accounting student may encounter in reality, students often gain greater enjoyment from simulations than case studies (Miles, Biggs & Schubert, 1986, cited in Kober & Tarca, 2002). Keyes and Wolfe (1990) used course grades, examinations, and exercises to conclude that simulation games provided greater results than case studies. Chanin and Wolfe (1993) also support the claim that business games are useful as a learning tool. Because enjoyable simulations provide a higher degree of emotion, they provide a greater ability to remember the information.

Providing students with lectures and tutorials has limited appeal to some teachers because students also obtain the ability to obtain and analyse information specific to their roles at work. Course tutors should also be teaching the ability to independently find relevant information. The traditional mode of teaching should be limited to its use. Evans (1998) used videos and computer technology to encourage independent and student centred learning. "The traditional mode of teaching however, is not the only way to achieve teaching goals and may sometimes be inadequate in producing the sort of graduates capable of independent and lifelong learning who are required today" (Evans, 1998).

Business programs typically include some sampling content. The sampling content is typically taught in a statistics, or auditing courses. A required topic in the statistics course of accounting programs is sampling. The sampling topic is often presented theoretically in textbooks without practical student involvement. Practice questions provided in textbooks are also superficial that do not challenge students to understand the actual differences between sampling techniques. Davis (1997) also finds that audit students in a third year business degree have particular difficulty with statistical sampling. Students also tend to view topics within statistics as separate rather than integrated and that a choice made by a statistician may affect the statistician's results, analysis, or conclusions.

A practical alternative to theoretical illustration of sampling is to ask students to conduct a survey within the actual business or residential community thereby undertake actual sampling. The survey would involve large amounts of time for students and tutors, require human ethics approval, and students may encounter

sampling technique issues in the field that cannot be answered by the tutor at the critical time.

Davis (1997) provides a practical teaching exercise for students to resolve the teaching difficulty of the sampling topic. The auditing exercise of Davis (1997) involved the counting of beans and extrapolation (estimation), with the theoretical class discussions focusing on issues of sample size, confidence level, bias, and precision in an unstructured acceptance sampling exercise.

Important fundamental theory of sampling also involves the use of sampling techniques to collect sample data. The particular sampling technique may also impact on those topics focused on by Davis (1997). The practical exercise used by Davis (1997) has limited scope to use for teaching sampling technique issues.

A novel approach to teach sampling technique issues was designed so that students can undertake the sampling exercise within the confines of the classroom in a practical means; thereby any sampling technique issues raised by the students can be answered in the classroom by the tutor. The practical exercise can be conducted within the supervision of the tutor so that content issues can be resolved and learning outcomes can be met at a deep learning level for the student rather than at a surface level.

The sampling exercise has been developed by accounting, statistician, and computer system tutors every semester over the last few years. Each semester the exercise has become more refined and used in diploma and degree statistics courses at first year

level of business studies programs. The exercise can now be conducted by hand or using the computer on either the Microsoft Office 2003, or 2007 versions.

The following section outlines and describes the sampling exercise. The sampling exercise includes student resources, frequently asked student questions, and tutor notes upon request.

Method

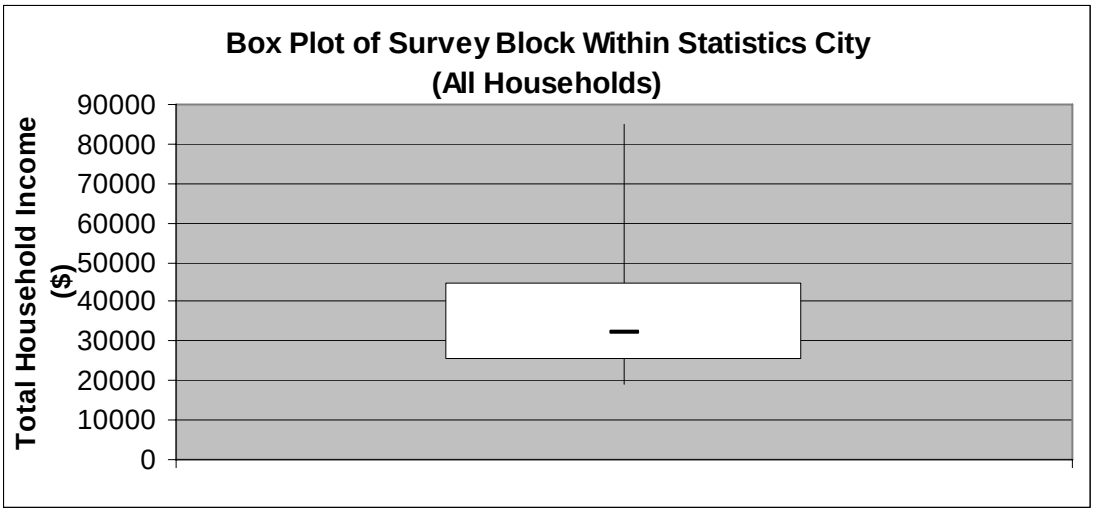
The sampling exercise has been based on Bowen's (1987) conclusion that experiential learning is most successful when accompanied by an optimal amount of emotional arousal, takes place within an environment of safety, and is accompanied by adequate processing time and a clear summary of the experience. The sampling exercise has also benefited from the advice given by Jones (1995), Maidment and Bronstein (1973), Jones (1985), and Gredler (1994).

Students were required to conduct four types of probability sample selection techniques to gain data from a block within a hypothetical city. The survey block was originally straddling the boundaries of three suburbs. Each suburb had a slightly different characteristic of the household so that each suburb could be used as a cluster and so the survey data could become biased depending on the technique used. The identification of the suburb boundaries has been omitted as the recognition of suburbs caused student confusion and the survey block was too small to warrant sampling

within each suburb or cluster. Areas of the survey block still contain slightly different characteristics, thereby providing varying results for students.

The survey block within the city contains 128 households in a structured residential area. The survey block has straight streets, with regular street numbers, and identical property sizes and shapes.

The household data has been constructed so that the central tendency of income is around $32,000 (median) to $37,000 (mean) and the data is positively (right) skewed as in actual income statistics. The distribution of incomes from all households within the survey block is illustrated in the box plot below:

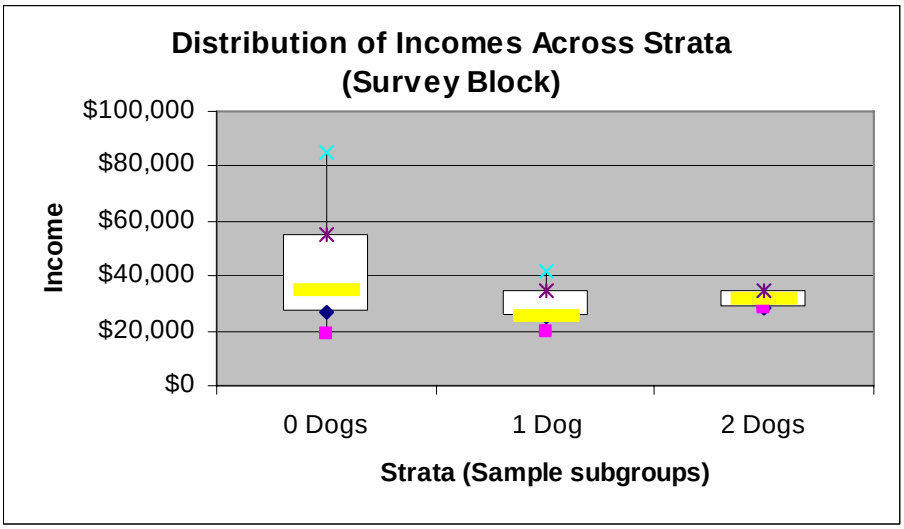


In each sampling technique, students were asked to select 16 households for their sample size. A constant sample size of 16 in each sampling technique avoids the affect sample size has on the results and thereby any variation in the results is not due to sample size. However, sample size does affect the results of the stratified sampling as described below.

Originally students were required to conduct one of four sampling techniques to collect data and then present the results to the class. However, individual students would get the experience of only one sampling technique. This instruction has been altered so that students were then required to collect four samples of data using four different sampling collection techniques.

The four sample selection techniques were simple random samples, systematic samples, proportionate stratified samples, and cluster samples. Consequential learning outcome of the simple random sample technique is that students learn to allocate numbers to objects (households) and to generate random numbers. The systematic sample technique requires students to calculate a regular interval and the stratified sample technique is intended for students to identify strata and calculate sample proportions gathered from population data. The cluster sample technique is a geographic cluster technique intended to illustrate to students the difference between cluster and stratified sampling.

The central tendency for all strata (number of dogs) is between $25,000 and $35,000 (median) for the stratified sampling technique. The small number of households with two dogs provides a narrow distribution of data. There are more households with one dog and no dogs than there are with two dogs, so the distribution of data is much wider for one dog and no dogs than with two dogs. The results of the stratified sampling technique for the whole survey block are illustrated below.



Once the data has been collected using each of the four data collection techniques, students are required to bring the data along to each of the classes that follow in the semester. The remaining classes require the students to use the data for exercises in the respective topics that follow. The use of the sampling data throughout the course provides a theme and integrates course topics so that students understand how the topics are related and that topics are not disjointed topics in isolation. The idea of using a single case to integrate a course has previously been conducted by Dennis (2003).

The topics in the statistics course that require the data from students are descriptive statistics and inferential statistics including correlation and regression analysis, confidence intervals, and sample sizes. Each student must provide summary statistics and graphical analysis of the data of each sample so that results of each sample selection technique can be compared.

While engagement with practical problems is required, action learning also involves the student to make observations, reflections, and generalise about their reflections (Kolb, 1984). Students are brought together as a class once the data collection of the exercise has been completed by all students. Once brought together the tutor leads a discussion of the class to complete the learning cycle. While a discussion takes place directly after the exercise, the learning cycle is not fully complete at least until the remaining topics of descriptive statistics are covered. The following section provides an illustration of past descriptive statistics of students.

Results

Originally an unstructured sampling exercise was written that set out the objectives of the exercise given the sample size and survey block that followed a lecture that covered sampling and sample selection techniques. The numerous questions and difficulties that students had clearly showed that the lecture and textbook were not enough to allow students to begin the exercise. Now there exists a detailed set of structured instructions in addition to topic notes. The number of student queries and difficulties has greatly reduced so that many of the students complete the exercise without hesitation.

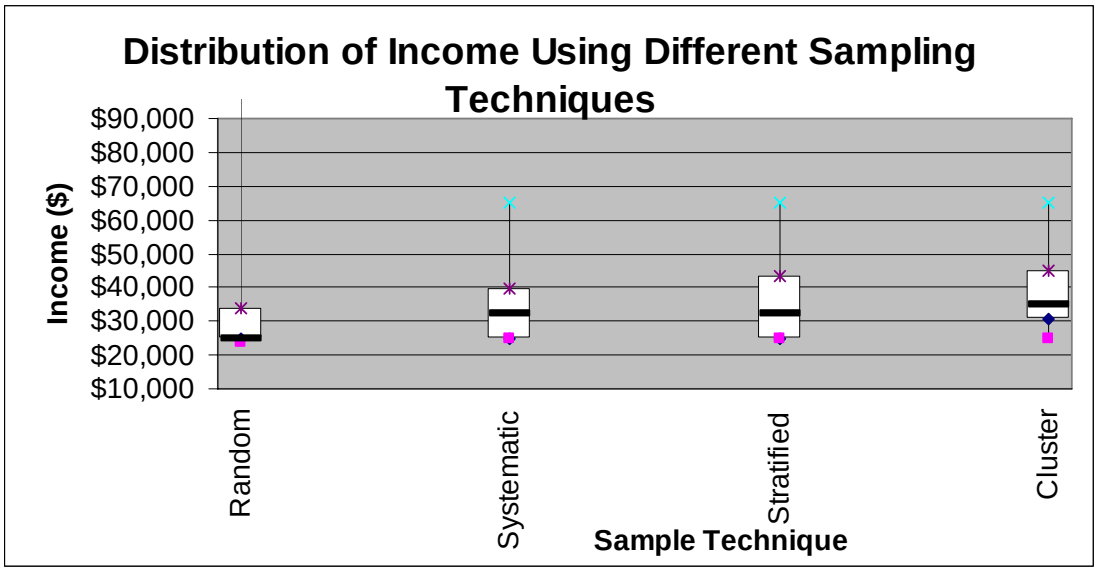
The majority of student questions now come from the section regarding stratified sampling. Some students are unsure what to do to calculate proportions to complete the supplied table. An explanation from the tutor to the whole class overcomes the problem. There is also data supplied to use alternative strata. One set of data could

be used for demonstration, while the other set of data could be used by the students for the exercise.

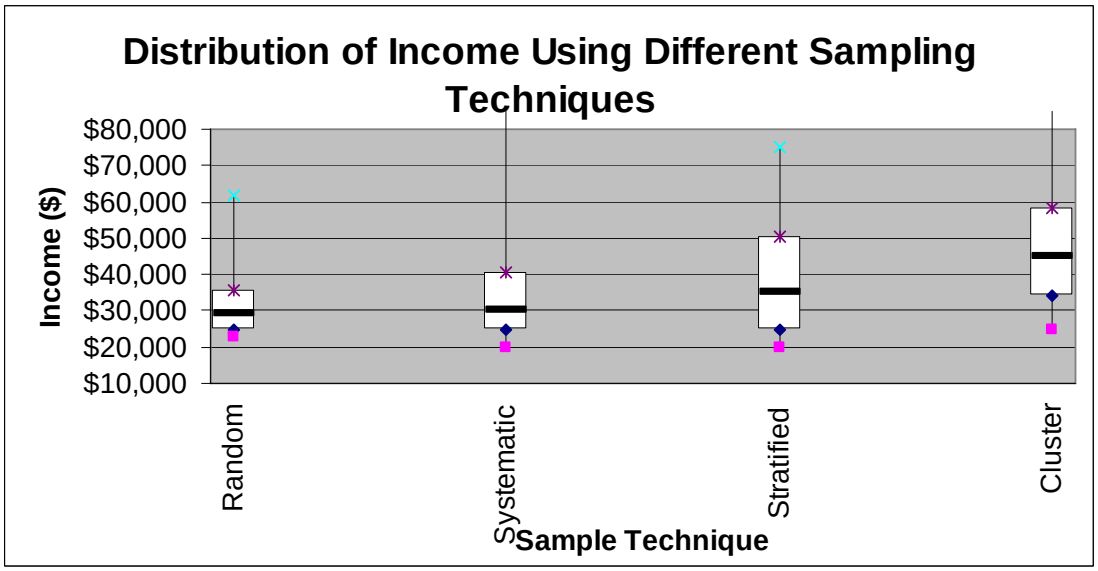
The exercise has been used successfully as a teaching tool and as an assessment exercise. The following results provide some examples from the output of summary statistics and descriptive statistics required from students. Students were required to complete the sample results sheet that included the collection of household data on the number of dogs per house, number of cats per house, number of people residing in the household, and household income. Results from any of the four variables could be illustrated; however, the course is for business studies students who are dealing with incomes rather than other characteristics of households. The following results relate to the household income variable, noting that the number of people in the household also gets used later in the course to illustrate correlation with income.

Students are asked to provide summary statistics as well as box plots illustrating the distribution of each of the sampling techniques. Students could also be asked to provide histograms of each of the sampling techniques, thus also comparing histograms with box plot distributions. Only the box plots are presented here for brevity. The results are presented below from four students (selected using convenience sampling).

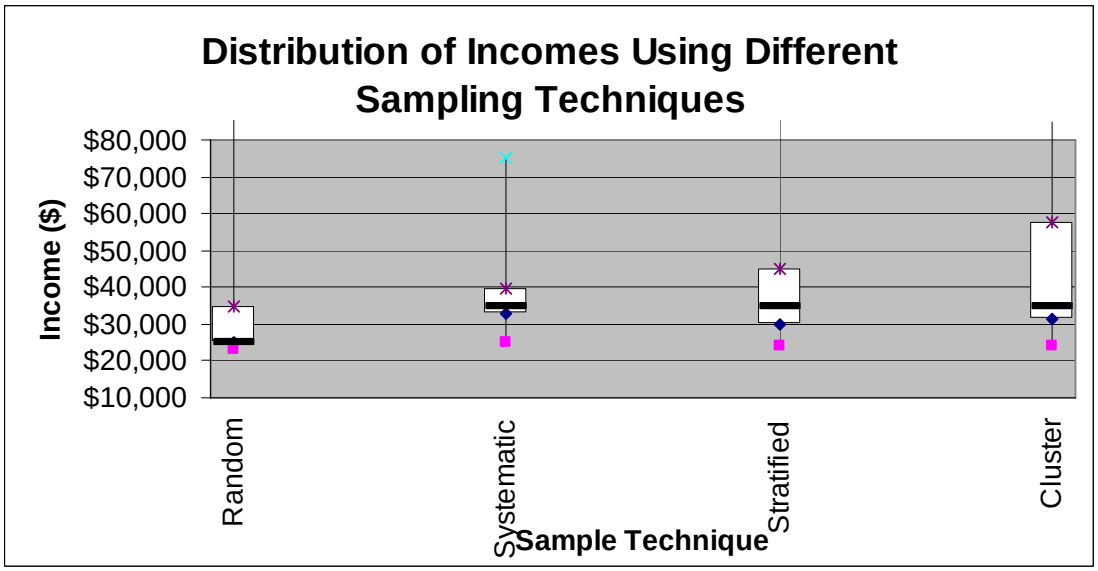
Student A



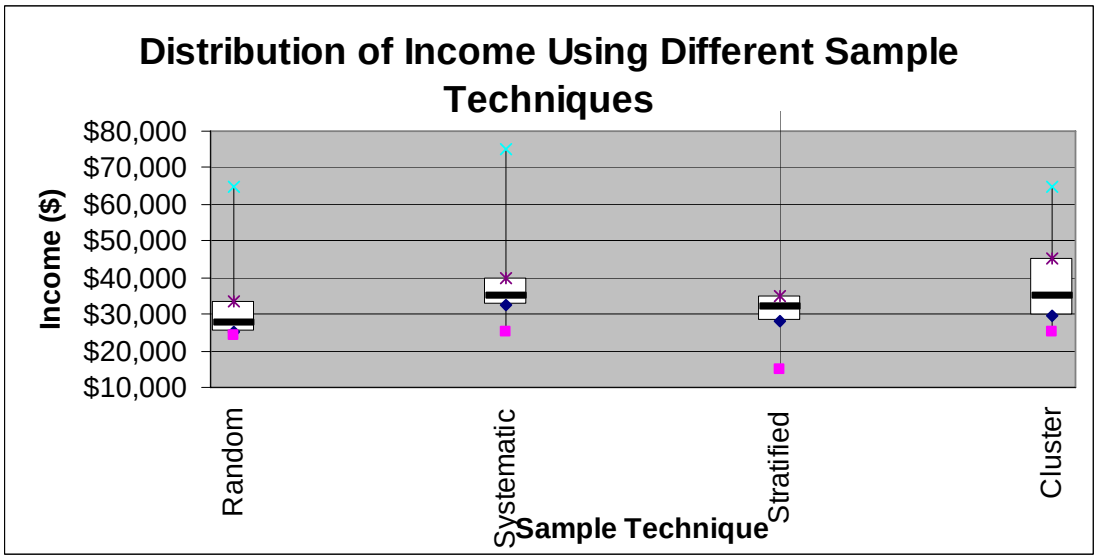
Student B



Student C



Student D



Students are requested to describe the distribution of data in general terms, that is, what all the samples typically illustrate about the data. Students are also asked to describe individual sample technique results and compare.

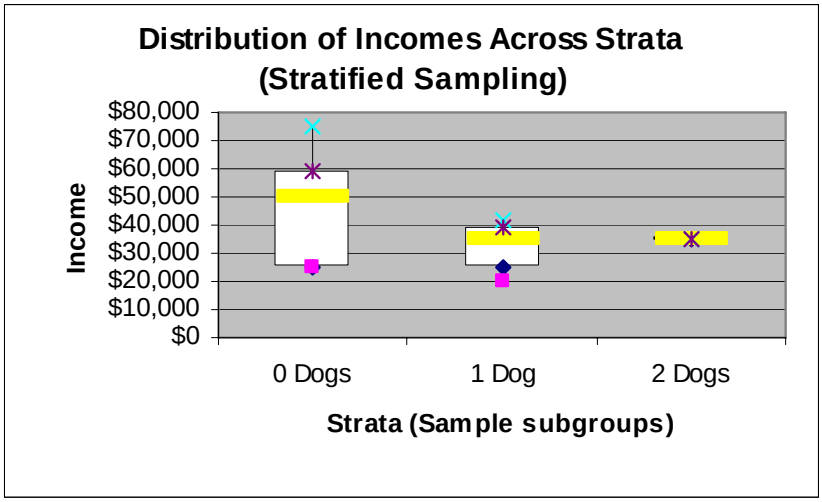
Students should be able to describe the central tendency of the data that typically is between $29,000 and $35,000, with some extremes at $25,000 (Student C) and $45,000 (Student C).

Students should be able to identify the positive (right) skewness of the data. The lower 50% of the data is less dispersed than the higher 50% of the data. The skewness is clearly visible in all four students' results. Students should also identify that the middle 50% of data is typically less skewed than the outer 50% of data.

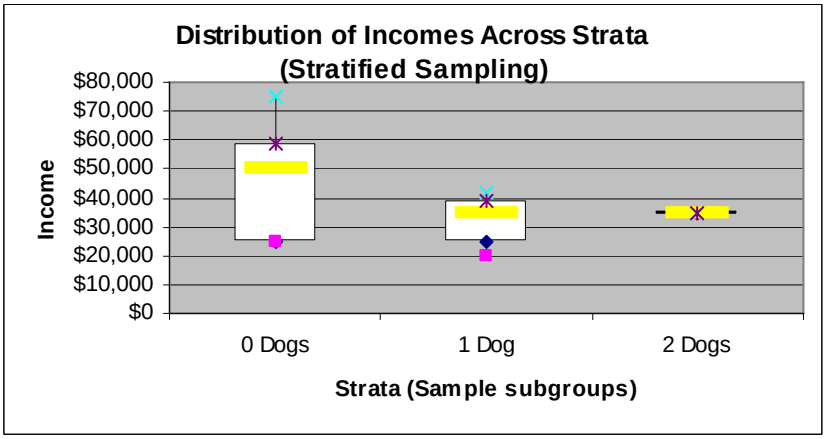
The specific differences between each of the sampling methods are more difficult to determine than the general patterns. Each student will provide different results. The results vary because of the small sample sizes. From the example student results systematic sampling has a higher central tendency than random sampling. Random sampling has the lowest central tendency out of all four sampling techniques. Cluster sampling tends has a wider distribution than random sampling, with random sampling one of the narrower distributions.

Students were also asked to provide summary statistics and box plots for each of the strata from the stratified sample. Only four students' box plots are provided here for brevity.

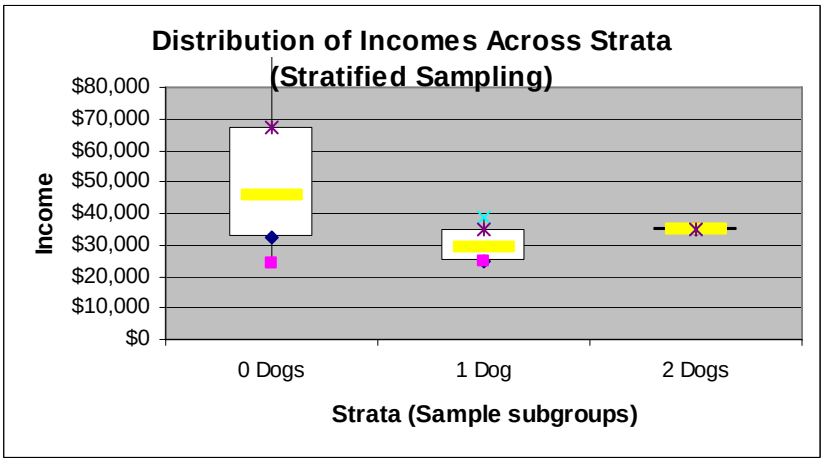
Student A



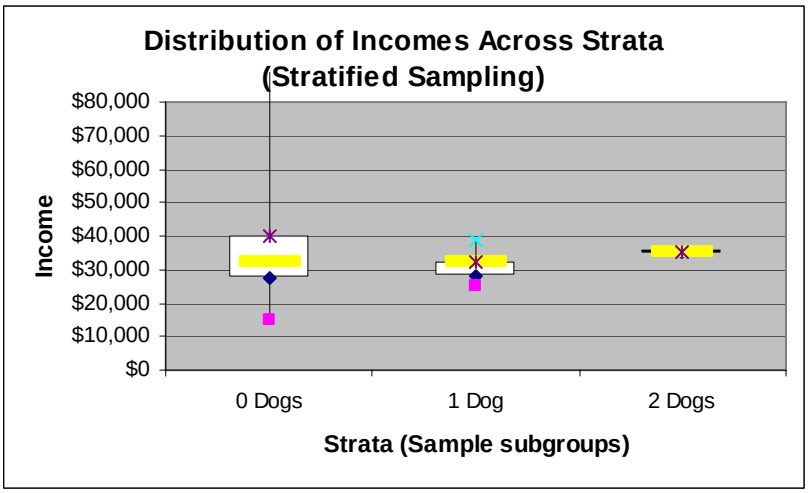
Student B



Student C



Student D



Students are requested to describe the distribution of data from each stratum in general terms, that is, what all the strata typically illustrate about the data. Students are also asked to describe and compare individual strata.

The results separated into strata are more difficult to compare than results of sample techniques mainly due to the low number of observations within each stratum. Students may be able to describe the central tendency of the data that typically is around $35,000.

Students should be able to clearly pick up the lower dispersion as the number of dogs increases. The lower dispersion is not a result of each stratum, but due to the lower sample size with an increase in the number of dogs. The number of observations in the 0 dog strata is eight, the number of observations in the 1 dog strata is five, and the number of observations in the 2 dog strata is two. With a decrease in sample size is a decrease in dispersion.

Student Feedback & Reflection

Formal and informal student feedback was gathered through personal observation, reflection, direct questioning, and questionnaires. However, as each class is small, as low as 10 students, statistically valid conclusions cannot be drawn from the questionnaires and informal student feedback may be the more appropriate to gather qualitative data with small class sizes.

Student comments and responses indicated that students found the exercise interesting and more helpful in providing a situation in which the students could learn and experience sampling than a textbook or lecture. Also students did not illustrate any of the reluctance to participate that may emit from exercises such as Davis (1997) or Lightbody (1997). A number of student comments over various semesters has been that they appreciate the tutor providing realistic and interesting examples.

The sampling exercise generated a lot of student activity and discussion between students. The author interprets the high amount of discussion enhancing the amount of student immersion and engagement with the sampling technique topic.

Suggestions

The survey block could be altered into an unstructured residential area with businesses and include curved roads and irregular street numbers. This suggestion of an unstructured residential area would provide more issues to students requiring more thought about survey data collection thereby detracting from the focus of sampling methods. An unstructured survey block may be more suitable for students at lower or higher levels of there qualification than at a first year degree course.

The learning outcomes of probability sampling were the focus of this exercise. Non probability sampling methods could also be introduced to the exercise to compare probability and non probability sampling techniques. The introduction of more sampling exercises would require more class time. The focus of the exercise needs to be established by the tutor before introducing more exercises to prevent undue class time issues.

The author has used the data generated from the exercise to demonstrate and engage students in other topics of the statistics course thereby consolidating students' learning and integrating the course. However, the exercise could also be used as an independent activity without the remaining statistics topics.

Conclusion

The exercise has been used in both degree and diploma students at first year so the learning outcomes of each needed to be the focus, that required the ability of students to describe and compare probability sample selection techniques. Students are able to

use the exercise to develop their understanding of sample selection techniques in a practical way with the supervision of a tutor. The students find the exercise enjoyable and the exercise integrates the whole statistics course together. The author will continue to use the exercise in class to develop student's deep understanding of probability sample selection techniques.

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