Reflections on an Academic Support Program

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Abstract Many university students require first year Mathematics and Statistics courses as compulsory credits towards a degree or as prerequisites for specific 2nd year courses. Of these students a great many lack confidence in their own ability to do mathematics and face the daunting task of passing a course for which they are under-prepared. An Academic Development Program (ADP) is offered as a support. This program runs concurrently with the traditional lectures and tutorials that make up the Mathematics and Statistics courses. This paper gives an account of the classroom practices used in the Mathematics and Statistics support course offered to students in the Faculty of Commerce at the University of the Witwatersrand. Reference is made to a workshop on 'counting methods and probability' as an illustration of the benefits, in particular, of small group work and journal writing.

The ADP students

Registration for ADP was entirely voluntary and open to all students. However, on enrollment, I asked students to commit to attending 4 tutorials per week and to undertake to submit regular written responses. The tutorials were initially planned to cater for small groups but as the course progressed numbers grew and class size tended to vary from 40 to 65 students at any one time.

Although students may only register for the Mathematics and Statistics courses if they have passed Mathematics at a matriculation level, many students who attempt the course might be considered mathematically weak or under-prepared. 20% of the students who registered for ADP were repeating Statistics for the second or even the third time. The majority of the first time students had not previously encountered any study of probability or general statistics.

Most of these students found it extremely difficult to engage in any mathematical discussion. They had difficulty explaining their thoughts and were insecure about responding to questions or offering their own ideas. There was a general lack of confidence and an unwillingness to participate in whole class discussion. This reluctance was probably accentuated by the fact that, for 90% of these students, English is not their first language.

Design of the course

As the support program progressed and the students and I got to know each other, I found that my main objective in planning classes was to try to convince the students that they could achieve some degree of competency in this course that Jili described as her '*stats nightmare*'.

Powell (1986:183) says that mathematics education should "aim to assist learners in becoming aware of the powers they possess and how they can construct meaning and procedural know-how. It can empower learners with self-confidence, self-realisation, and autonomous functioning in relation to mathematics while developing their competence."

I looked for ways to ensure that students would actively participate in constructing meaningful mathematics and focused on the following:

- Collaborative small group work.

Much has been written about the positive affects of collaborative small group work (Johnson and Johnson, 1994; Adey and Shayer, 1994) in primary and secondary schools. Journal entries from these ADP university students gave evidence that they found collaborative work rewarding and satisfying.

- Written responses and personal reflections.

Powell and Ramnauth (1992:12) discuss how writing is a powerful pedagogical vehicle that "can prompt students to reflect critically on their mathematical experiences and respond to mathematical situations and questions that are personal and of their own choosing". I introduced journal writing to encourage students to put their own ideas into words. At the end of each class I would ask students to reflect for a few minutes and then to write a personal response to questions such as: 'What did *you* learn in class today?….What questions do you still have about the content covered today?…..At this moment how are you feeling about your study of mathematics/statistics?' If I wanted focused criticism of the structure of the tutorials I would ask students to comment on the 'pluses' and the 'minuses' of the class.

What happened?

Initially students were reluctant to offer any contributions to whole class discussion. However, when they were asked to work in small groups the majority of students seemed to get involved very quickly. Working in small groups helped them overcome feelings of insecurity. Because of the large number of students attending ADP it was not possible for students to work in the same groups each week. However, as students worked with different people in each tutorial session they got used to each other and they became less reluctant to answer questions and more confident about volunteering their own suggestions in class discussion.

Generally at the end of each class, students were asked to reflect on the work they had been doing. This written feedback was extremely useful in the planning of consequent tutorials and gave me some idea of how students were progressing with the course work as well as with the other members of their groups:

> *Yesterday's workshop was very interesting even though sometimes a little bit confusing. I think if you can repeat that game, it will help us. It is so helpful sometimes to learn what you see but I think we need a revision about what we did yesterday. I think we are moving very fast.*
>
> *I get very muddled as soon as asked to work out probabilities with too much information and the questions, I get muddled and don't have a clue what to do.*
>
> *Yesterday's lesson was fun which kinda made me feel that stats is not really that bad but I found that my group gave up too easily on things we couldn't work which kind of demotivates you.*

Group discussion – fabulous!!

Almost all the students were as enthusiastic as Tsaki about working in small groups and other responses also bear witness to their positive attitudes towards collaborative work:

> *I liked working in groups. It helped bringing a light in the darkness.*
>
> *I enjoyed working with the others in my group. We all participate well together and are not shy with one another.*

They wrote about learning from each other, that different ways of doing problems lead to better understanding and that fellow students explained some things better than lecturers:

> *Working with a group helps because of the different angles at which we all look at the problems.*
>
> *Group work is a wonderful thing because you find that most of the things that were not clear to you are clarified by the people in your group.*

Many wrote about how problems were solved by pooling ideas and by working together, without calling for help from a lecturer:

I found that working in a group helped very much because we shared our ideas and sorted out what we did not understand.

Yes! I was in a group and we were working together, helping each other anyway we could. I found it very beneficial. A lot of things were made clear to me. Different ideas - and thoughts – gives me new ideas too.

It was so nice that the whole group was cooperating and that opened the channel of dialogue. We argued on some answers but we got good answers. Group work is a wonderful idea. I enjoyed working with different people besides myself.

Occasionally students would express disappointment after a session of collaborative work. Reena's entry summarises these comments:

Working in groups does help but only if everyone is willing to participate. The problem is where some people just keep quiet then its just as well as talking to yourself or working through the problem alone.

Often, if I was able to follow through after comments like this, I came to believe that much of the reluctance to join a discussion came from the difficulty that students had in trying to express mathematical ideas, as well as some feeling that answers that are not 'correct' might result in embarrassment.

It came to me like a flash of light!

After reading Ayanda's exclamation, following one of the early hands-on investigations, I focused more and more on workshops where students worked together, rather than on classes where I summarized and lectured.

Believing that students would be more easily drawn into activities when they have a "quality of play" (Thom, 1971: 696) I used counters, dice, poker dice and cards in the explorations of probability.

The following investigation was given in the introductory stages of the study of probability.

Permutations and combinations and probability

Experiment with the counters, dice and the poker dice. Then use your own diagrams and notation to illustrate your working and any conclusions.

1. COUNTERS

How many different ways can you line up 1 red and 1 blue counter? How many different ways can you arrange 1 red, 1 blue and 1 white counter? How many different arrangements can you make using 4 different coloured counters?

Investigate further.

2. COUNTERS OF TWO DIFFERENT COLOURS

First take 3 counters, say 2 red and 1 blue – how many different lines can you make? Secondly work with 4 counters and see how many arrangements you can make with 1 red and 3 blue – then with 2 red and 2 blue. Thirdly work with 5 counters – taking 1 red and 4 blue and then 2 red and 3 blue.

Investigate further.

3. DICE

Take two dice, one red and one white. What is the probability that throwing both will result in double six? If you throw three dice, what is the probability that you will get three sixes? What is the probability that you will get at least two sixes? Consider the five 'poker dice'. What is the probability of throwing at least a pair of aces?

Investigate further.

Mason advises caution in the use of apparatus in the classroom stressing that the true value of the apparatus lies in how it is used. In an attempt to be attentive to pupils' own reactions and realizations I ended the workshop without the usual summing up, and asked the students to use their own words and sketches to write about their discussion and conclusions before the next class.

Yesterday's lesson was very powerful

Tendani's reflection is representative of the many responses from students who expressed excitement about reaching some understanding of counting techniques and probability. Mfanelo wrote about deducing as much as possible from a few starting points and basic principles:

> *Yesterday's lesson, I can say I always struggled to understand and I just realized that I actually need to reinforce the small principles. Such as we did yesterday. Solving the problems with objects helped me with distinguishing how the counting principle works.*

Sidney highlighted how important it is, in considering probability, to start by finding out the number of ways that things can happen:

> *The practicals really opened my eyes and helped me to think to ask myself of all the possible chances. A lot of things were made clear to me. I learned the basics of everything instead of just learning the hard core stuff and we didn't know where it comes from.*

Ephraim wrote about his belief that the number of ways things can happen eventually leads to laws of statistics, discussing the possibility of starting 'small' and then trying to anticipate other situations by using those laws:

> *Working out problems practically was easier with smaller numbers, seeing the probabilities happening helped me understand more. It is easier for me to visualize problems and thus solve them. Although I now prefer using the formulas visualization has made my understanding of stats better instead of just cramming formulas without understanding.*

Graham and Nombulelo described how using counters and then diagrams helped them to discover patterns and to formulate and test their conjectures:

> *The use of the counters and the dice helped us visualize the actual situation and therefore helped in using application. At first we had a problem with how to multiply in probability but soon we got the hang of it. The jump from working with tables of outcomes to simply writing* $\frac{1}{6}\times\frac{1}{6}=\frac{1}{36}$ *or* $\frac{1}{6^2}$ *was difficult. We were a bit confused but once we drew the diagram it became clear. The notion of ways of arranging things was not problematic but when duplicate elements were introduced the jump from visualization to using a rule was difficult. Using the counters helped us to experiment.*

Problems - and the way ahead

I believe that students were often constrained by their (in)ability to put their ideas into words. Unfortunately the increasingly large size of the classes meant that one on one discussion was not possible. While journal writing gave me some idea of how students were faring, I was not able to reply to and to encourage each student individually.

Although I always found the students' responses valuable I concluded that for most of them it was difficult to engage in critical and coherent mathematical writing. Perhaps, it future, it may be effective to focus on a few of the many ADP students and to constantly take in their journals,

arranging one on one discussions to encourage them to pursue their questions and to generate new ones once the old ones are answered, so that their ability to communicate mathematical ideas is fostered and strengthened.

To some extent the students' reserve about entering into debate was overcome by working in small groups. As the weeks passed, some students felt confident enough to volunteer to report their findings to the whole class, but most preferred to discuss their own thoughts only within small groups.

Given time and the presence of all the ADP students it would have been beneficial to have dealt with the dynamics of group work in an attempt to maximize the benefits of small group work.

Conscious efforts still have to be made to set up conditions where students are encouraged to make friends with others so that they can organise work groups. Perhaps setting group homework assignments would promote more involvement.

Despite their reticence in whole class discussion, students made the best of the small group work and professed to have enjoyed it and to have gained by it:

> *Working in groups is nice because you get to understand some of the things better, and acknowledge your own problems.*

Students' enthusiastic involvement in the investigation with counters and dice showed that much can be gained by designing and implementing activities like this:

> *The workshop was fun and helped me to understand counting and probabilities. I have discovered that stats is actually fun if you understand.*

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