

THE IMPACT OF AN INVERTED TRADITIONAL TEACHING MODEL ON FIRST LEVEL STATISTICS STUDENTS

Fransonet Reyneke and Lizelle Fletcher

Department of Statistics

University of Pretoria, South Africa

fransonet.reyneke@up.ac.za

In the past decade various intervention strategies have been adopted by the Department of Statistics at the University of Pretoria to address the problem of low success rates of its first level Statistics students. In January 2013 we embarked on the challenge of inverting traditional teaching methods. The new generation students come to class armed with smartphones and tablets. Technological innovation can hence be roped in to facilitate the teaching and learning of Statistics. In a flipped classroom environment, the transfer of information takes place online in the form of podcasts or YouTube videos, as well as pre-reading and using the Aplia online-homework system. This approach allows for more quality time to be spent interacting with students inside the lecture hall, thus enhancing the deep learning process which takes place when students participate in tutorials to re-enforce and consolidate knowledge. The impact of the inverted teaching model will be discussed.

BACKGROUND

This paper only focuses on STK110, the first semester module of Statistics 1, for a large group of 2000+ mainly Commerce students. The various intervention strategies from 2005 to 2012, adopted by the Department of Statistics, had a positive impact on the success rate of the first level Statistics students (Reyneke et al., 2013).

An online interactive homework system - with immediate feedback, called Aplia, was implemented in the first semester of 2012 for STK110 (Wooten et al., 2013 and Tchantchane et al., 2011). The system is based on the current first level textbook. Aplia was introduced to help students to get more engaged with the difficult concepts of Statistics. Once the Aplia assignment is completed and graded, immediate feedback on mistakes made is available. It performs almost like a personal online tutor. A similar assignment to the first attempt, but with different questions, can be generated from the database. Up to three attempts are allowed. The average of the marks obtained for the number of attempts comprised the final assignment mark (Bransford et al., 2000).

Any new online homework system has its own teething problems and Aplia was no exception. It took weeks to get 2000+ students registered before the assignments could be graded for marks. There was a significant increase ($z = 2.26$, $p = 0.0119$) in the success rate of the 2012 cohort ($p_1 = 0.78$) compared to the 2011 cohort ($p_2 = 0.75$). As found in Nwoha et al., 2009, Aplia has made a substantial contribution to the higher success rate of 2012.

AN INVERTED TRADITIONAL TEACHING MODEL

In January 2013 we introduced the inverted traditional teaching model for STK110. The Aplia online homework system was used on a pre-class basis. It was based on the vision of Prof. Eric Mazur to “Flip the classroom” (Mazur, 2009). A flipped classroom inverts traditional teaching methods, delivering instruction online, outside of class and moving “homework” into the classroom (Mason et al., 2013). Our inverted traditional teaching model consisted of:

- Pre-reading of the textbook
- Pre-class Aplia online homework assignments
- Weekly tutorials in class
- An innovative tutoring system.

Although we had mostly positive feedback from the students, Aplia posed many challenges. First year students from high school need to take responsibility for themselves but this turned out not to be the case. They received a detailed program with due dates for Aplia, but still

wanted to be reminded of the assignments on a regular basis. Although they are the “technology generation”, they were surprisingly not clued up with basic software that had to be installed in order to use the Aplia system.

Weekly tutorials were put into place so that more quality time can be spent during lectures to enhance the deep learning process which takes place when sequences are designed that enable students to approach the same material in multiple ways (Millis, 2010). The aim of the tutorials was to consolidate and deepen understanding of difficult concepts.

It is apparent that students cannot passively receive material in class: they have to come prepared to class so that misconceptions can be corrected, difficult concepts be revisited and mastered, and deeper learning can take place in class.

Evaluating the Inverted Traditional Teaching Model

The impact or benefit for first level students from using this model needs to be investigated. Is the flipped classroom model effective in terms of students’ success rates, attitudes and retention compared to the traditional teaching model without/with the Aplia online homework system. The two important perspectives to measure effectiveness of the new model are:

- The impact of the inverted traditional teaching model on students’ performance.
- The students’ voice, in terms of satisfaction of the inverted traditional teaching model.

Based on the above research objectives, the impact or effectiveness can be evaluated by answering the following questions:

1. Is there a difference in pass rates of the three cohorts of students namely the traditional teaching model without Aplia, the traditional teaching model with Aplia and the inverted traditional teaching model (with Aplia)?
2. Is there a relationship between the marks distribution (<50%, 50 – 59%, etc.) and the different type of cohorts as mentioned in Question 1?
3. Is there a correlation between the average Aplia marks and the semester marks for the inverted traditional teaching cohort?
4. What does the students’ voice say?

Research Methods

Data were collected from the STK110 classes (Introductory Business Statistics) in the first semesters of 2011, 2012 and 2013. The three cohorts used the same textbook, course outline and content. The differentiation amongst the three cohorts was as follows: the 2011 cohort used the traditional teaching model without Aplia, the 2012 cohort used the traditional teaching model with Aplia and the 2013 cohort used the inverted traditional teaching method (with Aplia). Table 1 provides a summary of the three cohorts’ characteristics. The course dropout rate is the highest in 2011 comparing with 2012 and 2013. The exam admission for STK110 is a semester mark of at least 30%. The course’s “no admission” rate decreased from 6.3% in 2011 to 2.4% in 2013. This seemed to suggest that although Aplia has made a substantial contribution to the higher success rate of 2012, the Flipped Classroom is the way forward.

Table 1: Cohorts’ Characteristics

Cohort	Year 2011 (without Aplia)	Year 2012 (with Aplia)	Year 2013 (Flipped Classroom)
#Students registered	2688	2058	2002
#Dropout students	212 (7.9%)	79 (3.8%)	67 (3.3%)
#Students without exam admission	168 (6.3%)	81 (3.9%)	49 (2.4%)
#Students absent from exam	67	25	21
Module credit pending	2	0	3
#Students remaining	2239	1873	1862

Research Findings: Student Performance

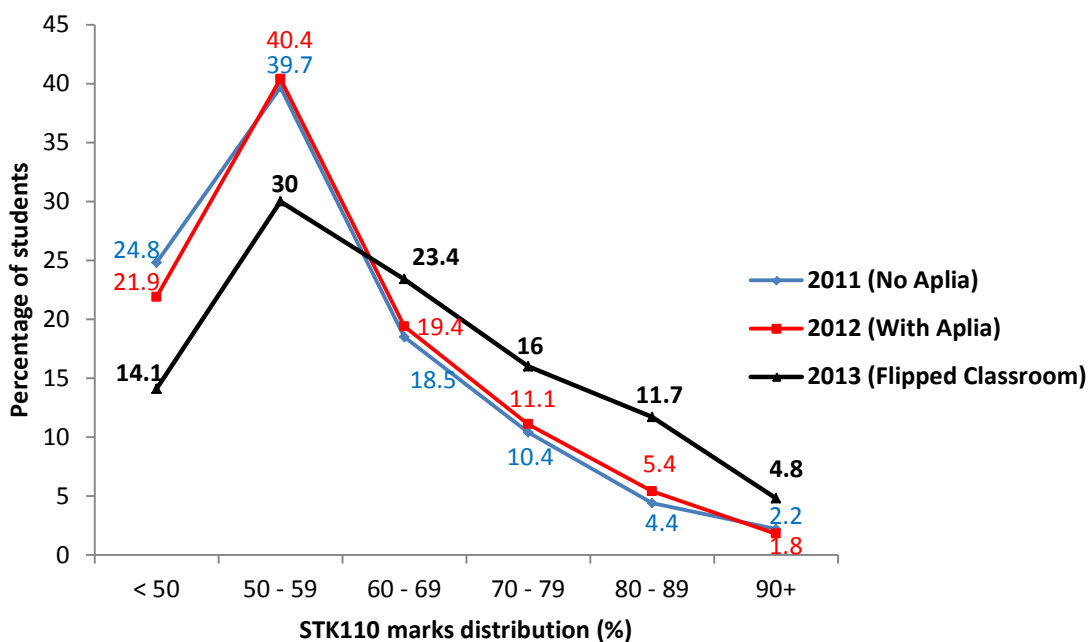
Question 1: *Is there a difference in pass rates amongst the three cohorts of students?* The descriptive statistics for the three cohorts are summarized in Table 2. Three pairwise comparisons were done to compare all different combinations of the cohorts. A Bonferroni correction was applied ($\alpha = 0.0167$ for each comparison to give an overall $\alpha = 0.05$). There was a significant increase ($z = 2.26, p = 0.0119$) in the success rate of the 2012 cohort ($p_1 = 0.78$) compared to the 2011 cohort ($p_2 = 0.75$). There was a substantial increase ($z = 6.363, p < 0.001$) in the success rate of the 2013 cohort ($p_1 = 0.86$) compared to the 2012 cohort ($p_2 = 0.78$). Lastly there was a highly significant increase ($z = 8.768, p < 0.001$) in the success rate of the 2013 cohort ($p_1 = 0.86$) compared to the 2011 cohort ($p_2 = 0.75$). These findings confirm that the Aplia online homework, and even more so the Flipped Classroom, is effective.

Table 2: Descriptive Statistics for the three cohorts

Cohort	2011 (Without Aplia)	2012 (With Aplia)	2013 (Flipped Classroom)
#Students remaining	2239	1873	1862
Mean	55.92	57.18	63.34
Standard Deviation	14.26	13.72	14.90
Pass rate	75%	78%	86%

Question 2: *Is there a relationship between the marks distribution and the different type of cohorts?* The STK110 marks distribution of the three cohorts is demonstrated in Figure 1 below. Although the final marks of the 2012 cohort were better than the 2011 cohort (traditional model with and without Aplia), the line graphs above look quite similar. The 2013 cohort's graph shows a dramatic improvement over the other two years. The percentage of unsuccessful students decreased by approximately 40% and the percentage of successful students improved substantially over the other categories. These findings show that there is a relationship between the marks distribution and the different cohorts. ($\chi^2(10) = 257.6723, p < 0.001$), confirming that the Flipped Classroom is effective in increasing the success rate.

Figure 1: STK110 marks distribution of the three cohorts



Question 3: *Is there a correlation between the average Aplia marks and the semester marks for the inverted traditional teaching cohort?* According to the results in Table 3 below the

pre-class Apla online assignments certainly benefited the students who took the effort to tackle them. The correlation coefficient between the average Apla marks and the average Semester marks for the 2013 cohort is 0.7778. This indicates that there is a positive linear relationship between the Apla marks and the Semester marks.

Table 3: Average Apla marks versus Average Semester marks for the 2013 cohort

Average Apla mark	Average Semester Mark
Less than 50%	42.9%
At least 50%	68.1%

Research Findings: Students' Voice

Question 4: *What does the students' voice say?* We surveyed the 2013 cohort to measure the students' attitudes towards the Flipped Classroom. The questionnaire was divided into three parts, namely the pre-class Apla assignments, the tutorials and the innovative tutoring system. The students were very positive about the pre-class Apla assignments. 67% of the students read the textbook before they attempted the assignments. The assignments were only available in English which was perceived as a barrier for the Afrikaans students. Almost 90% of the students had constructive criticism about the tutorials, although just 39% of the students had attempted the tutorials prior to class. The most popular part of the tutoring system was the weekly scheduled revision classes. Overall the students had a positive attitude towards the Flipped Classroom.

CONCLUSION

The Flipped Classroom with all its features has the potential for enhancing deep learning and encouraging first level students in STK110 not only to pass but to excel in the business statistics course. The pre-class Apla homework system helped the students to engage with the difficult concepts in Statistics prior to the lecture hall. The tutorials that are done during lectures, helped the students with typical difficult exam questions and are good preparation for tests. The next step is to use YouTube videos or podcasts and then start with MindTap, a cloud-based learning solution. It combines all of a student's learning tools – readings, multimedia, activities and assessments into a singular Learning Path that guides the student through the curriculum.

REFERENCES

- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience and school* (Expanded edition). Washington, DC: National Academy Press.
- Kyei-Blankson, L., Blankson, J., & Boateng, B. (2008). Student evaluation of faculty use of technology and its implication for technology integration in higher education. In K. McFerrin et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2008* (pp. 1126-1131).
- Mason, G., Schuman, T. R., & Cook, K. E. (2013). Inverting (flipping) classrooms – Advantages and challenges. *American Society for Engineering Education*.
- Mazur, E. (2009). Farewell lecture? *Science* 323, 50-51.
- Millis, B. J. (2010). Promoting deep learning. *IDEA paper #47*. University of Texas - San Antonio.
- Nwoha, O. J., Mokia, R., & Dia, B. (2009, October). *Does the use of Apla increase student's exam score in a business statistics course?* Paper presented at the ERCBEC Conference.
- Reyneke, F., & Fletcher, L. (2013). *Investigating success rates of first level statistics students in the new millennium. Technical Report*. University of Pretoria.
- Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*, 15(2), 171-193.
- Tchantchane, A., & Fortes, P. C. (2011). A multivariate survey analysis: Evaluation of technology integration in teaching Statistics. In G. Williams, P. Statham, N. Brown & B. Cleland (Eds.), *Changing demands, changing directions. Proceedings ascilite, Hobart* (pp. 1227 – 1238).
- Wooten, T., & Dillard-Eggars, J. (2013). An investigation of online homework: Required or not required? *Contemporary Issues in Educational Research*, 6(2), 189-197.