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# A case study comparing the flipped hybrid classroom and traditional classroom in a post-graduate chemical pathology module

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***Abstract***

*This case study compared student performance and experiences in a flipped hybrid classroom (FHC) and a traditional classroom (TC) in a post-graduate chemical pathology programme.*

*Nine students participated in the study. The final summative grades based on clinical case vignettes assessing high cognitive domains were 55.83% (±26.94) and 60.61% (±36.02) for the FHC and TC, respectively. Students obtained higher scores in the synthesis domain in the FHC compared to the TC. In contrast, higher scores were obtained in evaluating pathophysiology and biochemical test results in the TC. The thematic analysis of the open-ended questions identified three themes: (1) flipping is fun and informative; (2) TC is better with a bit of flip; and (3) we know what we like.*

*This study showed that the TC showed slightly better summative assessment performance, and that students are positive about flipped approaches but have their own preferences.*

***Keywords:*** *Flipped classroom; hybrid classroom; flipped hybrid classroom; traditional classroom; chemical pathology.*

## 1. Introduction

Chemical pathology is a specialist branch of medicine that involves the biochemical investigation of bodily fluids to help manage disease in patients. The biochemical tests require analysis and interpretation in conjunction with associated clinical information. Post-graduate studies in chemical pathology attract graduates from the basic biological sciences and medicine. At the University of Pretoria, South Africa, the Bachelor of Science Honours (BSc.Hons) degree introduces science graduates with biological science majors to chemical pathology. Clinical case vignettes teach knowledge of disease states and interpretation of biochemical tests. Case-based study is challenging for science graduates as they lack fundamental knowledge of clinical sciences. Therefore, alternative approaches to teaching chemical pathology may benefit their academic performance and learning experience.

## 2. Literature review

The flipped classroom inverts the traditional classroom (TC) by moving the lecture and self-study activities to out-of-class activities. Flipping can take many forms, and the format and definition of the flipped classroom are varied. The flipped classroom encourages the four phases of experiential learning: active experimentation, concrete experience, reflective observations and abstract conceptualisation (Kolb & Kolb, 2005), and may benefit an active construction of knowledge. Notably, the flipped classroom supports peer-peer and student-instructor interaction and facilitates problem-solving during the in-class activity (Kennedy, 2013). Also, flipped teaching models are claimed to afford flexible learning environments, improve in-class engagement with instructors, and develop critical thinking domains required in problem-solving (Kennedy, 2013).

Criticisms of the flipped class are high resource investment in developing teaching material, the need for new technology and instructor skillsets, and the need for students to develop active and self-directed learning skills. In addition, there are limited studies that rigorously compare TC to the flipped classroom, especially using performance outcomes (DeLozier & Rhodes, 2017; Kennedy, 2013), so its value in teaching and learning is questioned.

The use of e-technologies to engage students during out-of-class activities is attractive as various evolving platforms and computer software can be used to achieve learning objectives. Electronic technologies can be utilised in distinct areas of medical education such as electronic learning (online learning or e-learning), electronic teaching and electronic assessment (Ellaway & Masters, 2008). E-learning may encourage flexible (synchronously or asynchronously), engaging, learner-centred and interactive learning experiences (Ellaway & Masters, 2008).

Hybrid learning is a pedagogical approach that combines face-to-face instruction with computer-mediated instruction, for example, e-learning methodologies (Scida & Saury, 2006). Multiple modes of hybrid delivery exist with various mixtures and approaches to optimise learning goals.

Research demonstrates that classrooms utilising flipped and hybrid methods create rich learning experiences with favourable student preferences (Smith, 2021). The flipped hybrid classroom (FHC) has been applied in biochemistry teaching (Singh & Arya, 2020), which is the foundation of chemical pathology, but student performance was not assessed in that study.

Our study compared student performance and experiences between TC and a pilot FHC in endocrinology study units in the chemical pathology BSc.Hons programme at the University of Pretoria.

## 3. Methods

This study utilised a quasi-experimental cross-sectional case study design at a single centre. Two endocrinology study units in the BSc.Hons were taught to nine students, either by FHC (adrenal endocrinology) or TC (reproductive endocrinology). Each study unit spanned ten days.

Lecture notes were uploaded to the LMS after the delivery of a 90-minute lecture which explored core content knowledge and case vignettes. Students were encouraged to follow up on problematic concepts with the lecturer via email.

A three-stage FHC model was used and consisted of pre-class, in-class and post-class stages. The pre-class stage required students to complete all preparative activities and formative online assessment (with feedback) to access the 90-minutes in-class session and the summative assessment. Formative assessments were not scored, and unlimited testing attempts were permitted.

The pre-class stage consisted of various online activities (e-tivities) and teaching material uploaded to the LMS six days before the contact session. The e-tivities consisted of (1) PowerPoint™ slide presentation; (2) flashcards with questions and summaries designed on Cram™ with conceptual image and textual feedback; (3) word puzzles designed on Crossword Compiler 11™ interrogating essential biochemistry concepts; (4) a short five-minute "Conceptual Nugget" video on dynamic tests, self-created on an iPad and edited on the Apple Movies application; (5) a 10-minute video on an adrenal disease case study with formative assessment inserted in the video using EdPuzzle™; (6) an online case vignette on adrenal tumour with the discussion threads moderated by the instructor via the Blackboard™ LMS discussion tool; and (7) freeware webinar segments that explored screening tests in adrenal disease.

Conceptual problems that arose from engagement with all online preparative material and formative assessments were explored and clarified during the 90-minute in-class contact session. Furthermore, all students participated in consolidating problem concepts during a three-day post-class asynchronous consolidation session via the online discussion board.

A case study methodology used two sources of data: student performance and an online questionnaire. Student performance was assessed via an end-of-module, written, face-to-face assessment that used clinical case-based vignettes that evaluated high-order thinking. Students were required to integrate clinical history, physical examination findings, and laboratory results to diagnose and interpret biochemical tests and pathophysiology.

An online questionnaire was administered via Qualtrics$^{XM}$ after each study unit. The questionnaire was based on the course experience questionnaire instrument (Ramsden, 1991). The questionnaire was validated by experts and consisted of eight open- and seven closed-ended items, which used a five-point Likert scale. The summative examinations results were captured on an Excel™ spreadsheet. All quantitative scores were descriptively analysed and expressed as percentages (± standard deviation). Two researchers manually coded the open-response questionnaire items and used an inductive process to generate themes.

The study adhered to the principles of the Declaration of Helsinki and received ethical clearance from the Faculty of Health Sciences Research Ethics Committee at the University of Pretoria (ethics clearance certificate number 737/2019).

## 5. Results

Nine students completed the FHC questionnaire, and seven completed the TC questionnaire.

The final summative average scores were 55.83% (±26.94) and 60.61% (±36.02) for the FHC and TC, respectively. Students obtained higher scores in the synthesis domain of diagnostic questions in the FHC (80% ±34.96) than TC (60.00 ±51.63). In contrast, higher scores were obtained in analysis, interpretation and evaluation cognitive domains of biochemical tests and pathophysiology knowledge categories in the TC (66.33% ±32.24) than FHC (53.00% ± 29.07). In general, the standard deviation was wide across all scoring categories and reflected the sample group size and the abnormal distribution of the data.

The results from the questionnaire showed that most participants agreed that both FHC and TC improved analytical (FHC: 88.89%, N=8; TC: 82.71%, N=6) and problem-solving skillsets (FHC: 88.89, N=8; TC: 82.71%, N=6). The FHC showed stronger agreement on enhancing written communication skills (FHC: 88.89%, N=8; TC: 57.14%, N= 4). More participants agreed that the FHC improved their ability to plan their study (FHC: 44.44%, N=4 TC (63.43%, N=5). Also, more participants (88.89%, N=8) agreed that their self-confidence to solve clinical cases in laboratory medicine was enhanced by the FHC study

unit compared to the TC (71.43%, N=5). Most (FHC: 88.89%, N=8; TC: 85.72%, N= 6) agreed that lecturer was good (FHC: 88.89%, N=8, TC: 85.71%, N=6) and were satisfied with the overall quality of both module approaches (FHC: 77.78, N=7; TC: 85.72, N=6).

Thematic analysis of open-ended questionnaire items identified three themes.

**Theme 1: Flipping is fun and informative**

Participants emphasised personal enjoyment of the flipped e-tivities and could emphasise a wide range of potential academic benefits. Notable inclusions were: class preparation, engagement with the material, enhancing memory retention and testing their understanding. One student articulated the utility of focussing their attention on crucial information through formative assessment provided by online e-tivities.

> "*The electronic activities were set up in such a way, that reading was still required but, in my opinion, reading was made easier because one would read to specifically find the answer to complete the electronic activity*." (P4)

Participants found video material the most helpful, particularly webinar and EdPuzzle™ videos. They also named the online discussion board and the CRAM™ flashcards as useful for engagement, memorisation, and preparation for an in-class activity. Interestingly, participants considered the PowerPoint didactic lecture the least favourite online activity because "*The [lecture] material was a bit overwhelming, but the contact lecture gave a clearer of what was required*" (P3). But the view on the lecture notes was not necessarily shared but considered "*comprehensive and easy to follow*" (P1).

Participants emphasised that the in-class interaction with the lecturer was needed to support the flipped activities as "*face-to-face interaction with lecturer provides opportunities to ask questions when you missed something*." (P2). Poor internet connectivity was a barrier for some accessing the e-tivities – but the e-tivities were considered fun and worthwhile despite this challenge.

**Theme 2: TC is better with a bit of flip**

Participants attending the TC included reading the prescribed chapters from the textbook or independently sourcing out other learning materials on the topic as part of their preparation. Some participants engaged with the textbook, which was "*very informative*" and provided a "*foundation*" for the lecture (P5). Participants understood the material "*much better in the lecture*" (P9) if they had prepared ahead of class.

**Theme 3: We know what we like**

Participants were keen on a combined approach due to the perceived benefits: "*I actually prefer a combination of a traditional lecture with some additional activities. I find it beneficial to go through the lecture notes and do some extra reading before the lecture as*

*that enables me to listen with understanding and make notes where I may not have understood. I also, however, found it interesting to do the additional activities.*" (P1)

Other advantages of the combination of FHC and TC identified unique and overlapping features of each classroom approach. For example, preparation outside class would prepare them to ask questions during the lecture. The TC permitted participants to focus better on relevant issues without distraction by diverse activities that appeared to divide their attention across learning objectives. The contact session was identified as: "*… helpful because I was able to ask questions and get clarity of concepts I did not understand while I was reviewing the work alone*" (P5).

The introduction of e-tivities was resisted by those who had "… become accustomed to the traditional lecture format. I am not really a fan of electronic learning." (P8); and traditional lectures made it possible "*… to follow the lecture clearly" (*P7). Participants were very confident when stating their preferences: "*Although flipped classroom electronic activities is a more fun/enjoyable form of learning, I believe the best way to build knowledge and study is with traditional lecture format and reading*" (P6).

## 6. Discussion

This study compared student performance and experiences between TC and FHC in an endocrinology module in a BSc.Hons programme in chemical pathology. Studies that compare the flipped classroom to the TC are limited, particularly those regarding objective student performance. In our study, the TC summative scores were slightly higher than the FHC. Similar studies in health sciences have shown equivalent, inferior or improved performance (DeLozier & Rhodes, 2017).

In this study, participant experiences were generally positive and similar to other studies (Bishop, 2013). Participants reported that their analytical and problem-solving skills had improved (both FHC and TC), and as a result, they felt confident in solving case-based clinical cases. The ability to evoke higher-order cognitive thinking (Bloom, 1956) and develop critical thinking is vital in higher education to develop a "deep knowledge" of subject matter (John Biggs, 2011). However, the research is unclear whether a flipped model supports the development of critical thinking skills (van Vliet, Winnips, & Brouwer, 2015) or shows no improvement in critical thinking (Hwang & Oh, 2021). The student experiences in our study support improved analysis and problem-solving of clinical case vignettes by both TC and FHC modes.

It is also noteworthy that some participants attending the TC also prepared ahead of the lecture - an informal flipped approach. Participants motivated that preparation ahead of the in-class session improved their in-class engagement in both TC and FHC. In contrast, results of a pharmacotherapy course showed that students spent little time preparing for traditional

lectures without in-class accountability (DeJongh, Lemoine, Buckley, & Traynor, 2018). Therefore, the FHC in our study provided an expansion of an already existing informal student practice of pre-class preparation by providing scaffolded online activities and formative assessments.

Our study findings identified that video case-based teaching and webinars were the most preferred mode of e-tivity. The combination of the flipped classroom strategy and EdPuzzle™ has improved students' participation in learning activities and achievement in writing (Hidayat & Praseno, 2021). The preference for a combination of TC (with online activities) or solely TC emphasises students' needs for personal engagement with the lecturer. Bishop (2013) also identified student preference for in-person lectures compared to video lectures and interactive in-class activities compared to lectures. The unique contribution of the lecturer to resolve conceptual problems aligns with Vygotsky's concept of the zone of proximal development that identifies the supportive role of teachers in advancing students' learning (Vygotsky & Cole, 1978). In summary, this study supports online video e-tivities coupled with instructor in-person or online support to encourage multi-dimensional thinking (John Biggs & Collis, 1989) demanded by case-based study.

A limitation of this study is the small number of participants, which was unavoidable as this is a niched small group enrolment programme.

## 7. Conclusion

A comparison between the performance and experiences of the FHC and TC in small-group post-graduate chemical pathology module identified slightly higher summative scores in the TC method and positive learning experiences in both formats. In addition, the role of contact sessions and lecturer support was regarded as essential for learning. Any change to this programme needs more data to determine the optimal lesson plan. Future studies can investigate further novel combinations of elements from TC and FHC models to achieve the optimal balance for teaching and assessing chemical pathology.

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