

# An online multiple-choice microbiology game for under-graduate medical students: a case study

First submission: 11 July 2011

Acceptance: 11 October 2011

Educational games are increasingly used in medical curricula to enhance the process of mastering subject content. Students experience medical microbiology as an exceptional challenge because of unfamiliar terminology and the extensive volume of this field of study. Consequently, many students believe that medical microbiology could be a major contributor to failing an academic year. This article describes the use of an online multiple-choice game to improve students' performance in the Infections module of their medical training programme. The results show that an informal approach to learning may be beneficial to students, even in tertiary institutions.

## 'n Aanlyn veelvuldige-keuse mikrobiologiespeletjie vir voorgraadse mediese studente: 'n gevallestudie

Opvoedkundige speletjies word toenemend in mediese kurrikula gebruik om die leerproses van vakinhoud te verbeter. Studente ervaar mediese mikrobiologie as 'n buitengewone uitdaging as gevolg van die onbekende terminologie en omvattende volume van hierdie studieveld. Gevolglik glo baie studente dat mediese mikrobiologie 'n belangrike bydraende faktor tot die mislukking van 'n akademiese jaar kan wees. Hierdie artikel beskryf die gebruik van 'n aanlyn veelvuldige-keuse speletjie om studente se prestasie in die Infeksies-module van hul mediese opleidingsprogram te verbeter. Die resultate dui daarop dat 'n in-formele benadering tot leer selfs in hoërsonderwysinstellings van waarde mag wees.

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Although play is a powerful mediator for learning throughout a person's life, the word "play" can invoke many misconceptions.<sup>1</sup> Traditionally, play is viewed, for example, as applying only to young children and as something to be abandoned when adulthood is reached. The activity of play is also often regarded as irrelevant or inconsequential to either formal or informal learning (Rieber 1996).

In a discussion on the connection between the elements of play and education in Plato's dramatic dialogue *Republic*, Krentz (1999) pointed out that etymologically the Greek words for education (*paideia*), play/game/pastime/sport (*paidia*), and children (*paides*) have the same root. These three terms are also often encountered in the same context. Against this background, he also stated that the central aim of pedagogy (*paidagogia*) was to encourage learning as a form of play (*paidia*) and emphasised it as the most persuasive and effective approach to learning (Krentz 1999).

Dewey suggested that the ideal mental condition for learning to take place to an optimal extent requires being playful and serious at the same time (Rathunde & Csikszentmihalyi 1993). In her web-based article "The value of play", Mardi Lucich [*sa*] of the California Childcare Health Program argues about what play as an activity ultimately produces:

Play takes many forms, but the heart of play is pleasure. And with pleasure comes the powerful drive to repeat such activities. With repetition comes mastery. And mastery brings a sense of accomplishment and confidence.

Medical training is not regarded as a field of study leaving room for play. This point of view is not necessarily attributed to the complexity of concepts, but rather to the extensive volume of work that has to be mastered in a relatively short period of time. This usually involves five to six years of full-time lectures, discussions, assignments, clinical training and assessment.

In addition to everyday stress and challenges associated with medical studies, students may experience more anxiety when a particular subject is regarded as difficult, voluminous, and its content

1 The 2004 second-year MBChB students involved in the implementation of e-MMFWF as a compulsory directed learning activity are kindly acknowledged for their enthusiastic participation and gratifying feedback on the experience.

delivered in the form of unexciting, mediocre lectures. In the School of Medicine, University of the Free State (UFS), students described medical microbiology as in-teresting, informative, and an important part of their curri-culum. Nevertheless, the majority of students regarded it as the single most probable cause of failing a year of their training.<sup>2</sup> In addition to the emotional impact of poor academic performance<sup>3</sup> and repeating a year of study, students who either fail or do not maintain a high level of academic performance face serious financial implications such as potentially losing bursaries and/or study loans.

## 1. Context of the study

At the time of the study, the Infections module was part of the undergraduate medical students' pre-clinical training towards an MBChB degree (Baccalaureate in Medicine and Baccalaureate in Surgery), in the fourth semester of the curriculum (the second semester, July to November, of the second academic year). The module was presented for the first time in 2001 in the newly structured medical curriculum. The Infections module consisted of fourteen three-hour sessions presented separately in Afrikaans and English, the official languages of instruction at the UFS. Apart from Clinical Skills and a special research module, which were presented over a two-year period (second and third academic years), the fourth semester contained four other modules in addition to the Infections module, namely Urinary System, Immunology and Haematology, Cardiovascular System, and Mechanisms of Disease.

At the time of the study, according to UFS regulations and requirements (UFS 2004: 27), a module mark of 40% was mandatory for a student to be allowed to write the final examination at the end of the semester. A final mark of 50%, required to pass a module, was determined by calculating the mean of the module mark and the mark obtained for the examination paper. When a student failed to qualify for an examination – when a module mark of at least 40% was not obtained and the module was thus failed based on test results – the

2 Cf Beylefeld 1996 (unpubl data), Bezuidenhout & Nel 2002 (unpubl data), Bezuidenhout & Van der Westhuizen 2003 (unpubl data).

3 Cf Lloyd & Gartrell 1984, Reese 1968, Richardson *et al* 2005.

specific academic year had to be repeated in full (that is, all modules, including those that were completed successfully).

Entering the final examination with a module mark below 50% posed a substantial risk of failing the module, should the student's performance in the examination be compromised in some way, for example, due to unforeseen personal circumstances hampering the learning process. Therefore, students who obtained module marks ranging between 40% and 49% were regarded as critically at risk ("in serious trouble"), while students with module marks between 50% and 54% were considered to be at risk of not passing the module ("not safe"), although to a lesser extent than those below 50%. Although no formal investigation had been conducted into faculty members' convictions and opinions on this matter, the majority of the academic staff locally involved in student training would agree to this point of view, which became evident from spontaneous informal discussions at several Examination Committee and other meetings.

Two formal semester tests (carrying a weight of 40% each) and continuous assessment (carrying a weight of 20%) consisting of six ten- to fifteen-point class tests written on designated dates throughout the course of the semester were taken into account in calculating the module mark in the Infections module.

In August 2004, the second-year medical students wrote their first semester test (Test I) on sessions 1-6 of the Infections module. Although 15.1% (22 out of 146) passed with distinction ( $\geq 75\%$ ), 14.4% (21/146) of the group failed the test ( $< 40\%$ ).<sup>4</sup> A substantial number (25.2%, 26 out of 103) of the students who obtained a regular pass for Test I (between 40% and 74%) were evaluated as "in serious trouble", while 19.4% (20 out of 103) were regarded as "not safe". Thus, based on marks obtained for Test I, 67 out of 146 (45.9%) students were either failing, "in serious trouble" or "not safe". When taking into account that the class average dropped by up to 6% from Test I to Test II over the preceding three years (Struwig *et al* 2005), nearly

4 A mark of less than 50% is normally regarded as failing a test. In this particular context, however, a test mark of less than 40% was considered as failing, due to the fact that a student, who obtained an average of 40% for both tests, still qualified to write the final examination. In such circumstances, the student should then obtain at least 60% for the examination paper in order to pass with a final mark of 50%.

50% of the second-year medical students were at risk of not obtaining the required module mark to write the Infections examination in November of that year. Such an outcome would result in half the class either repeating their second academic year, or dropping out of medical school completely.

Investigating specific reasons for students' poor performance in Test I of Infections falls outside the parameters of this study. From the authors' experience, however, the predominant reasons usually given by students for failing a test or obtaining an unexpectedly low mark, include underestimating the amount of work that has to be mastered; underestimating the complexity of the work; and a lack of continuous study in the weeks preceding the test. From the authors' point of view, Test I of 2004 did not differ from previous years' tests regarding content and level of difficulty.

## 2. Background to the game

The leading author of this article, who was the module leader at that time, developed a medical microbiology board game (Med Micro Fun With Facts: MMFWF) as a supplementary learning instrument for students in the Infections module (Beylefeld & Struwig 2007, Struwig 2010, Struwig *et al* 2005). A detailed description of the board game, based on the principles of Trivial Pursuit™, has been published elsewhere (Struwig 2010, Struwig *et al* 2005). The database of questions was compiled from different sources, which included the study material provided for the Infections module, the prescribed textbook, and numerous other textbooks and atlases on medical microbiology and infectious diseases.<sup>5</sup>

Based on a concept for categorisation of medical board games proposed by Bochennek *et al* (2007), the MMFWF board game can be classified as a category IV, two-stage (IV/2) game, that is, a quiz game using a question-and-answer approach. In a two-stage model, the answer to a question is evaluated as either correct or incorrect and may result in discussion of the answer ("reflection") between players or teams of players before the next question is asked. Two-stage games offer a learning process that emulates a test- or exam-like situation,

5 Cf Struwig 2010 for an extensive list of sources.

and many games intended for learning subject content are based on this model (Bochennek *et al* 2007).

In response to recommendations by students and academic colleagues, the game was also converted by the third author into an online web-based application in multiple-choice question (MCQ) format. In the online/electronic version of the game (e-MMFWF), the database of 700 questions was categorised into sessions, corresponding with the content of each session of the module (Struwig 2010, Struwig *et al* 2005). The existing question-and-answer database originally developed for the board version of the game was expanded and converted into multiple-choice questions. For each question, there was one correct and three incorrect options. However, great care was taken to ensure that the incorrect options were not obvious, and that selection of the correct answer would require either sound knowledge of the topic or good reasoning skills to make the final choice. The online game was designed and programmed to show the number of times different sessions were played, as well as the minimum and maximum scores obtained for each session, for each student who accessed the application. Exhibits 1(a) and 1(b) show examples of the displays (screen shots) from the e-MMFWF web-based application.

Questions are presented in a randomised fashion, and due to the size of the database, randomisation prevents the presentation of the same questions in subsequent sessions of play.

### 3. Aim of the study

An unacceptably disproportionate failure rate at the end of the second semester of 2004, resulting from poor marks obtained in Test I, seemed highly probable. The primary objective of the investigation reported in this instance was to address the poor performance of a class of second-year medical students in the first semester test (Test I) of the Infections module.

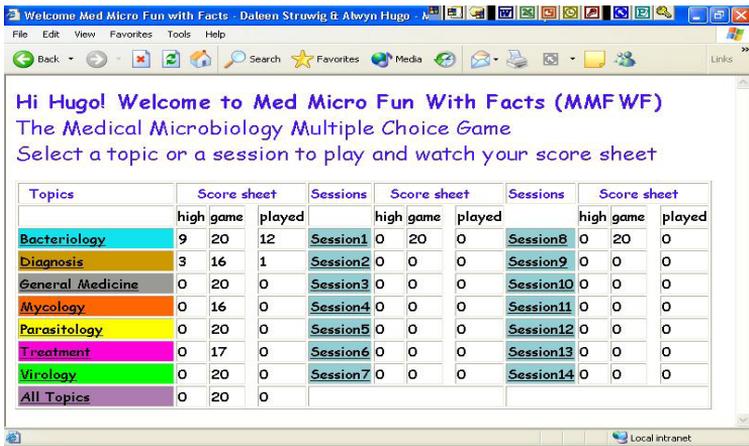


Exhibit 1(a): The e-MMFWF page displayed after logging into the game, showing the different options of categories and sessions available to be explored

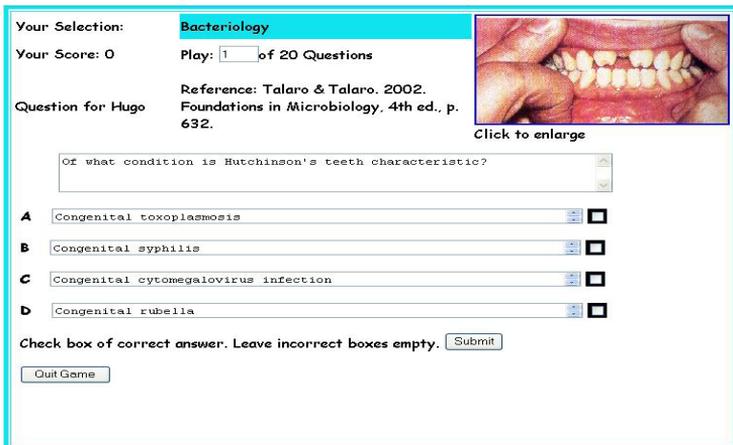


Exhibit 1(b): Example of a question page with a multiple-choice question presenting four possibilities from which the correct answer must be selected

A second objective was to compare the results obtained for the Infections module with the outcomes of other modules comprising the second-semester learning programme. This was done to determine whether implementation of the compulsory e-MMFWF learning activity (contributing a weight of 10% towards the module mark) in any way disproportionately skewed the final results obtained in the Infections module to the students' advantage.

A third objective was to determine the students' experience of the e-MMFWF game by means of a questionnaire, and to obtain their opinion on the possible role of the learning activity in their achievement in Test II of the module.

#### 4. Methodology

In order to address the students' poor performance in Test I, it was decided to introduce compulsory directed learning<sup>6</sup> in the form of playing e-MMFWF. After Test I results were made known to the students, the necessity and benefit of implementing compulsory directed learning was explained to them by discussing and emphasising the potential negative consequences of these results. In addition, a brief motivational talk was presented to encourage those students who performed poorly in the test. The process of gaining access and using the e-MMFWF website was demonstrated to the class. It was proposed to adapt the calculation of the module mark, with the two semester tests contributing 35% each, continuous assessment 20%, and the directed learning activity 10%. Students did not object to the implementation of compulsory directed learning or the adapted calculation of the module mark. The general impression based on their verbal feedback was that they felt encouraged and were looking forward to using the e-MMFWF web application (Struwig 2010, Struwig *et al* 2005).

The compulsory directed learning was implemented five weeks prior to the second semester test (Test II), which covered the work done in sessions 7-12 of the module, allowing ample time to use this learning opportunity. It was suggested that students who obtained a mark of 55% and above for Test I should play each session of the online game at

6 Directed (or self-directed) learning in this context refers to a learning activity performed in the student's own time (Harden 2001).

least twice, while students with a test mark below 55% were encouraged to play each session at least three times (Struwig 2010, Struwig *et al* 2005).

Students played the required six sessions (7-12) of the online game unsupervised in their own time in the weeks preceding Test II of the module, which was written by mid-October. In order to provide an opportunity for “last minute” access to the application, the system remained open until the time the test started. All students’ information regarding the number of times each session was played, as well as the maximum scores obtained for each session, were obtained from the e-MMFWF web application while they were busy writing Test II. This information was used to monitor whether the required number of times to play was honoured by each student, and to calculate their marks for directed learning.

Marks obtained for Test II were compared with Test I results. In order to determine whether the exposure to e-MMFWF had any influence on students’ achievement, the class average of both Test I and II obtained over four consecutive years (2001-2004) were compared (Struwig 2010, Struwig *et al* 2005).

The students’ marks were analysed to determine what the outcome would have been had the compulsory directed learning not been implemented prior to Test II of the Infections module. In the case of students who ‘should not have passed with distinction’ or ‘should have failed’ without the additional marks obtained for the compulsory directed learning, the final marks obtained for the Infections module were compared to those in other second-year modules. This was done to determine whether playing the online game and the adapted calculation of the module mark created a distortion of students’ performance in the Infections module. In addition, the academic records of students who would not have obtained a distinction or should have failed the Infections module were reviewed for three consecutive years (2005-07) to monitor their academic progress in their third to final year of study.

A five-point Likert scale questionnaire was used to evaluate the e-MMFWF application as a learning tool. Completion of the self-administered questionnaire after Test II results were made known was voluntary and anonymous. Using descriptive statistics, the

Department of Biostatistics analysed the data generated by means of the questionnaire (Struwig 2010, Struwig *et al* 2005).

This investigation formed part of a greater research project in medical education for which ethical approval was granted previously by the Ethics Committee of the Faculty of Health Sciences, UFS (Struwig 2010, Struwig *et al* 2005).

## 5. Results

The findings are presented in two separate sections, namely the outcome of the implementation of e-MMFWF as a compulsory learning activity on students' academic achievement in the Infections module, and students' evaluation of e-MMFWF as a supplementary learning tool.

### 5.1 The impact of e-MMFWF as compulsory directed learning on students' academic performance in the Infections module

The marks obtained by the students in Test II of the Infections module in 2004 were a major improvement on Test I results, with the class average increasing with 22% from 57% for Test I to 79% for Test II. The increase in marks from Test I to Test II ranged between 2% and 47%. Three (2.1%) students' marks for Test II were lower than for Test I, while one (0.7%) student obtained the same mark (44%) for both tests. Only one (0.7%) student failed Test II in comparison to 14.4% (21 out of 146) of the class who failed Test I.

Results of Test I and Test II are shown in Figure 1, illustrating the distribution of students across 10% mark intervals. The number of students who passed Test II with distinction was very similar to the proportion of the class that obtained a regular pass in Test I, namely 68.5% and 70.5%, respectively (Struwig *et al* 2005). In Test II, only 2.1% of the class obtained a mark of less than 50%, while 30.8% and 22.6% obtained marks in the 80-89% and 90-100% intervals, respectively (Figure 1).

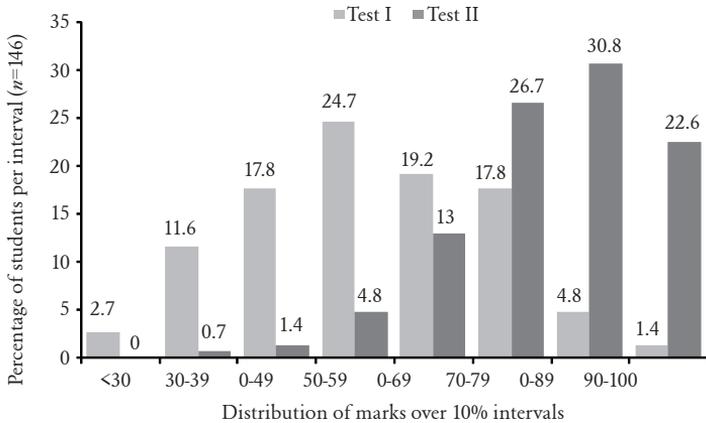


Figure 1: A comparison of the distribution of students over 10% mark intervals for Test I and Test II of the Infections module in 2004

The results of Test I and Test II, written in the Infections module in 2004, were compared to the test results of the pre-ceding three years (2001-03). During this period, the class average was either the same for both tests (2001) or decreased in Test II (with 2% in 2002 and 6% in 2003), compared to the 22% increase in the class average from Test I to Test II in 2004 (Struwig *et al* 2005).

The increase in students' module marks in 2004 ranged between 8% and 10% from what it would have been without the compulsory directed learning. One student's mark for directed learning increased his module mark by 8%, eight students (5.5%) had an increase of 9%, while the remainder of the class (137 out of 146, 93.8%) were able to increase their module marks by 10%.

When the marks obtained for the directed learning activity were excluded from the calculation of the module mark (in other words, if the two semester tests had contributed 40% each and continuous assessment 20%), five students (3.4%) would have failed outright to qualify for the final examination due to module marks below 40%, 15 out of 146 (10.3%) would have entered the examination with an "at risk" module mark between 40% and 49%, while 21 students (14.4%)

would have written the examination with an “unsafe” module mark of 50-54%. It could therefore be deduced that 41 students (28.1%) from the total class potentially would have faced the possibility of repeating the second academic year due to their performance in the Infections module. The five students who would have failed due to not obtaining the required module mark ultimately did fail the second academic year, but that was due to poor performance in other modules.

Twenty-two (15.1%) students played each session of the game the required number of times, while the majority (122 out of 146, 83.6%) played more frequently. The two students (1.4%) who did not play the e-MMFWF application the required number of times both obtained less than 60% for Test I. One of these students obtained the same mark (44%) for both tests and failed all the second-year modules with the exception of the module on Immunology and Haematology. The other student obtained 52% for Test I and improved to 80% in Test II. He graduated in December 2007 with an average of 69% and two distinctions.

Only one of the three most prolific players (mean 12.3 times played) completed his studies in the minimum required number of years. Despite being regarded as an “unsafe” candidate after Test I of the Infections module, this student displayed academic consistency throughout his medical training and obtained an average final-year mark of 61%. The other two prolific players, who played 6.3 and 7.5 times on average, failed the second and the third academic year, respectively.

In order to ascertain whether students’ marks obtained in the Infections module were skewed as a result of the compulsory directed learning activity, the final marks of all five modules presented in the fourth semester were compared. In addition to the Infections module, the modules presented in the fourth semester were Urinary System, Immunology and Haematology, Mechanisms of Disease, and Cardiovascular System. Figure 2 shows the comparison of the mean marks as well as the highest and lowest marks obtained by students in each of these five modules.

Eight students were excluded from these calculations. Their feedback was, however, included in the analysis of the question-naire results. Four of them were repeating their second academic year and

received exemption from examinations in all the modules passed in the previous year, therefore final marks were not available for all their 2004 modules. Three did not obtain the required module mark for all their modules and due to not writing the examination papers, final marks were not available for these modules. One student died in a car accident before she could write her final examinations. She did, however, participate in the evaluation of e-MMFWF.

No failures occurred in Immunology and Haematology, three (2.2%) in Urinary System, five (5.6%) in Mechanisms of Disease, and twelve (8.7%) in Cardiovascular System (results not shown). Seven (5.1%) students still failed the Infections module after their module marks were adapted, which is similar to the failure rate in the other modules of that semester.

Twenty-two (15.1%) students were identified who would not have passed the Infections module with distinction, had they not improved their module marks by means of the directed learning activity. The final second-year results of these students were evaluated in order to determine whether these distinctions were deserved and justified. This group of students obtained a total of 146 distinctions, including the Infections module, out of a possible 198, and passed on average 6.6 of their nine second-year modules with distinction. Table 1 shows the distribution of distinctions between these students. Besides this group, 22 more students passed the Infections module with distinction; thus, in total, 44 distinctions were obtained in the module.

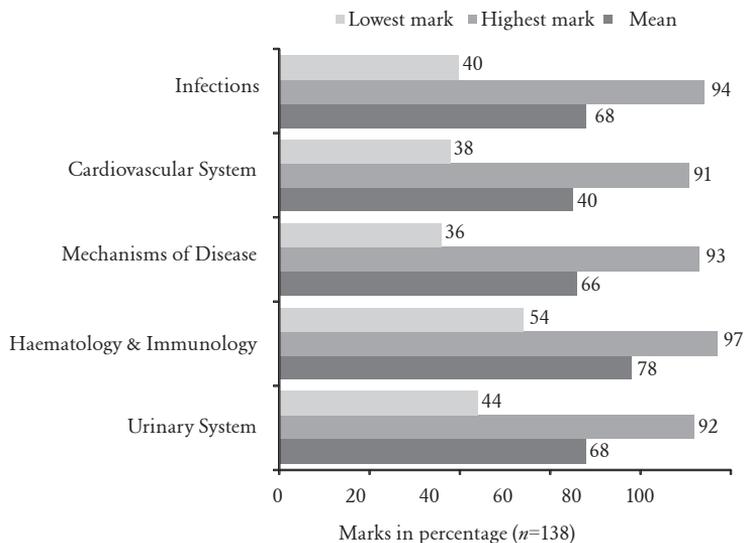


Figure 2: Comparison of the Infections module to the other semester 4-modules with regard to mean, highest and lowest marks obtained by students in each module

Table 1: Distribution of distinctions obtained in the nine second-year modules by students who ‘should not have passed the Infections module with distinction’

Number of distinctions including Infections	No of students (n=22)	% of group
Two distinctions	1	4.5
Four distinctions	3	13.6
Five distinctions	3	13.6
Seven distinctions	7	31.8
Eight distinctions	4	18.2
Nine distinctions	4	18.2

Eighteen (81.8%) of these students who “should not have passed the Infections module with distinction” passed their second academic year with five or more distinctions. The average second-year mark for this group of students, with inclusion of the Infections module, was 78.1%.

The difference between the mark obtained for the Infections module and the mean mark for the other eight second-year modules was calculated for each of these students. This was done to evaluate the mark obtained for the Infections module in comparison to the student's performance in the remainder of the modules. The difference between the mark in the Infections module and the mean of the other modules ranged between -2 and 6%. The mean difference was 2%. Five students had no difference between their marks for the Infections module and the other modules' mean mark, while another five students had a lower average (1% to 2% lower) than the mark obtained for Infections. Of those students who had a higher average overall than the mark obtained for Infections (12 out of 22, 54.5% of the group), the difference ranged between 2 and 8%.

These students all completed their medical studies successfully in the minimum period of five years and graduated in November 2007. Figure 3 shows the distribution of distinctions obtained in the final academic year by students who "should not have passed the Infections module with distinction". The average mark obtained by this group of students in their final year of study was 69.8%, only 8.3% lower than the average mark obtained at the end of their second year.

Four students, who would have qualified to write the supplementary examination instead of obtaining a straight pass in the Infections module, were identified. Their final marks for Infections module would have been between 45% and 49%, had the directed learning mark not been taken into account. In the event of a supplementary examination the stakes are even higher, with the module mark, first examination mark and second (supplementary) examination mark each contributing one third to the final mark.

These students' final second-year results were evaluated and compared to their Infections marks in order to determine whether their straight passes were justified. They all passed the other eight modules with an average ranging between 56% and 61%. Based on their academic progress reports reviewed at the end of their final year, three of these students had successfully completed their medical studies with an average mark ranging between 58% and 66%. The other student failed the third year and no further academic progress reports were investigated.

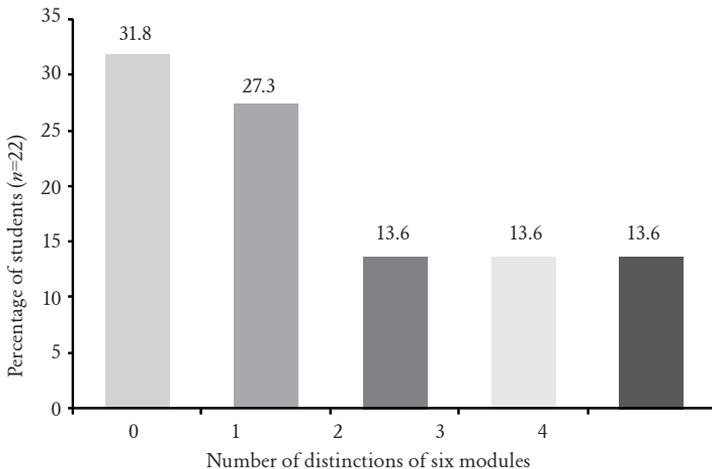


Figure 3: Distribution of distinctions in six final-year modules among students who 'should not have passed the Infections module with distinction'

Two students, who qualified for the supplementary examination and passed the module, should have failed the Infections module if the directed learning mark had not increased their module marks. One of them had a second (supplementary) examination in three other modules, of which two were successful. The student failed one module (Cardiovascular System) and had to repeat the second academic year. No further follow-up on this student's progress has been performed.

The other student, who successfully wrote the supplementary examination in the Infections module, instead of failing the module, however, failed the Cardiovascular System module. Since he had already repeated his first academic year, he was not allowed to continue with his medical studies.

## 5.2 Questionnaire results: students' evaluation of e-MMFWF

From an overall perspective, students evaluated e-MMFWF as a very positive and meaningful experience. Selected results on their evaluation

of e-MMFWF by means of a self-administered questionnaire have been published (Struwig *et al* 2005). Figure 4 shows the results not published previously.

Ninety-two per cent of students indicated that the exposure to e-MMFWF made them realise that they still had a great deal to learn about medical microbiology, while 89.7% was made aware of the extreme vastness of the subject as a field of study. Eighty-five per cent of respondents were convinced that the exposure to e-MMFWF as compulsory directed learning made a positive contribution to the increase in their marks obtained in Test II.

Open-ended questionnaire items invited suggestions and recommendations for the improvement of e-MMFWF, as well as any other comments that students wished to make. No negative responses to the open-ended questionnaire items were received. For the sake of presenting an unbiased, balanced report, and in order to explain that the students' experience of e-MMFWF was not exclusively positive, negative feedback received on the structured questionnaire items is shown in Figure 5.

Responses selected on the questionnaire as "uncertain" are shown in addition to the responses representing "yes" (complete agreement, or agreement to a fair degree). This was done to make the reader aware that the participants' outright negative experience of e-MMFWF could potentially have been higher, did they not have the 'uncertain' option on the questionnaire. From a more optimistic and confident point of view, however, respondents who chose this option might have selected a response reflecting a more positive experience.

Although 81.7% of students indicated that e-MMFWF had a positive influence on their perception of medical microbiology, 20.7% of respondents were "uncertain" whether playing the application made them feel more enthusiastic, and 13.8% gave a negative response to the questionnaire item pertaining to increased enthusiasm about medical microbiology.

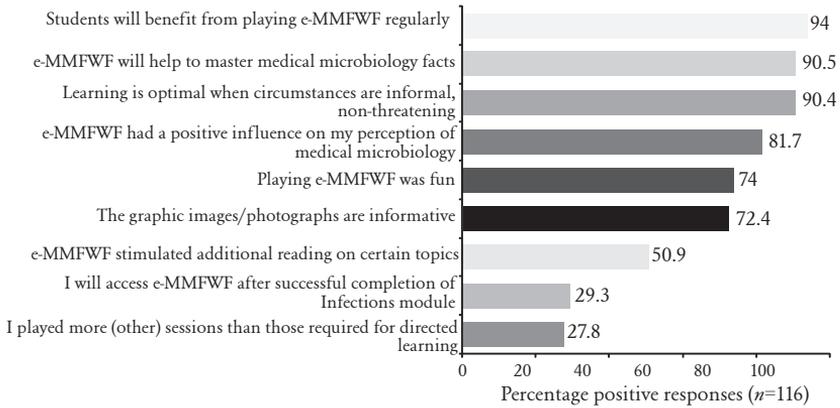


Figure 4: Students' positive feedback on selected aspects of e-MMFWF

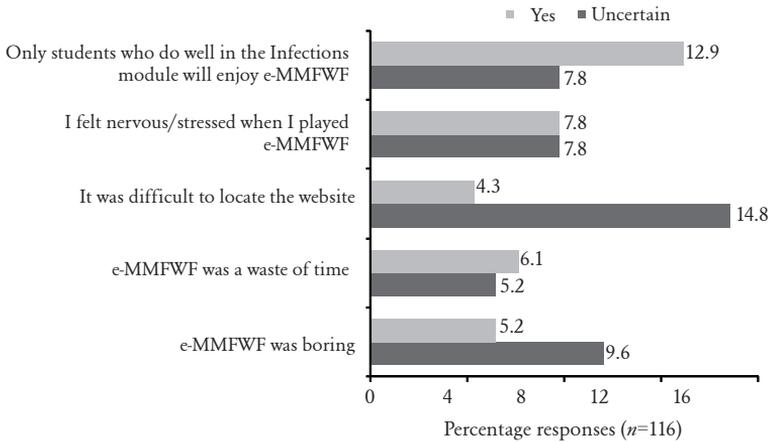


Figure 5: Students' feedback on negative aspects of e-MMFWF

Students who were either “uncertain” (13%) whether they had fun, or gave an outright indication that they did not have fun playing e-MMFWF (13%) were initially considered as part of the 25% of students who mentioned that they did not like computer games in

general. It was ascertained, however, that these two groups did not represent the same students.

A discrepancy noted in the questionnaire feedback merits attention. Sixty-eight per cent of the participants agreed with the statement that accessing the e-MMFWF website on a regular basis would probably help them to develop lifelong learning skills in medical microbiology. However, only 29.3% indicated that they would access the website after successful completion of the Infections module.

The following remarks are representative of students' feedback on the open-ended questionnaire items requesting suggestions or recommendations for improvement or other comments:

The computer tests were an excellent innovation that has since enabled me to better my marks.

Computer game was of great importance and benefit to me as it helped me understand module better [...] Therefore, game be continued [*sic*] for betterment of coming students.

I recommend that the computer tests are taken as a serious aspect of the module.

The introduction of e-MMFWF was the most helpful method for the course. It made it easy to remember terms and new names.

Thanks for the e-MMFWF programme [...] Use this next year and you will see excellent results.

e-MMFWF was particularly helpful in the mastering of facts.

The microbiology game was extremely informative and helpful.

Make the computer game compulsory; let it count 15% of the module mark.

## 6. Discussion

The implementation of e-MMFWF as a compulsory directed learning activity to address students' poor performance in Test I of the Infections module was a once-off intervention that necessitates further investigation. Its positive impact on students' academic achievement in the module and their perception of medical microbiology in general emphasises the supposition that e-MMFWF could be employed successfully as a supplementary learning instrument in the module dealing with infectious diseases. In addition, e-MMFWF had a favourable influence on students' perception and experience of medical

microbiology, while the majority (86.2%) were positive towards the prospect of play being employed in a meaningful way as a learning opportunity.

Based on these findings, it could be construed that implementing e-MMFWF as a compulsory directed learning activity and adapting the calculation of the module mark accordingly did not distort the final outcome of the Infections module in any way. When the final results obtained in the Infections module were compared to the outcomes in the other modules comprising the second semester, it was evident that students' performance in the Infections module was on par with the rest of their modules, with the exception of Immunology and Haematology, in which the mean final mark was 78% (*cf* Figure 2). If this intervention had not been put into practice, several students, who were deserving of either passing the module or obtaining a distinction, would have been deprived of the successful outcome they anticipated in view of their overall academic performance.

Since the majority of students played e-MMFWF more than the requisite number of times, it was difficult to ascertain whether the number of times the designated sessions were played had an influence on students' achievement in Test II of the Infections module.

The group of 22 students, who passed the Infections module with distinction due to the positive impact of e-MMFWF on their module marks, obtained between one and eight distinctions in other modules. In addition, these students all completed their medical studies within the minimum required number of years and graduated in December 2007. It could thus be argued that the distinctions they obtained in the Infections module were justified and deserved, considering that 68.1% of this particular group of students passed at least one of their final-year modules with distinction.

Seventy-four per cent of students indicated that it was fun to play e-MMFWF, compared to 90% of participants who had evaluated the board game version of MMFWF the previous year (Struwig *et al* 2005). This lesser degree of enjoyment could be explained by the fact that students who played the board game had already completed the Infections module successfully, while those who played the online version had to do it as compulsory directed learning in an effort to improve their marks. The online players still had to complete

the Infections module, and the stress created by their overall poor performance in Test I of the module could probably contribute to a completely different approach to the activity.

Another explanation for the lesser extent of enjoyment experienced by the online players is that playing the MMFWF board game occurred in small groups, with six students participating in each group. The groups consisted of three teams of two students each to allow for collaboration within teams as well as competition between teams. Group dynamics were excellent when students played the board game, with 99% of participants reporting active group interaction, and 83% reporting spontaneous group discussion during play (Struwig *et al* 2005). This feature was absent from e-MMFWF, which was played by students on an individual basis. It should be mentioned, however, that three students at one stage visited the module leader to discuss problems regarding the Infections module. As part of addressing their concerns, an informal session of playing e-MMFWF ensued in the module leader's office, and the spontaneous interaction, vibrant discussion and exchange of ideas and arguments that occurred in the process was a most gratifying experience. Therefore, it is likely that all the positive attributes of playing the board game in small groups could potentially have been experienced, should students collaboratively engage in e-MMFWF as an informal activity. This argument, however, is purely speculative.

Both groups (board game as well as online players) felt positive that play in general could be applied as a meaningful learning opportunity, although fewer online players (86.2%) agreed to this statement compared to the board game players (95%) (Struwig *et al* 2005). This slight difference could be ascribed to the lack of small-group dynamics as argued earlier.

Games offer many advantages and have the potential to meet most of the characteristics of intrinsic motivation. Although the education profession has long been ambivalent about the value of games as an instructional tool or strategy, games and simulations are often employed in other educational settings, such as corporate and military training environments (Rieber 1996).

A notable number of studies reported in the literature endorse the use of games as supplementary learning tools in various disciplines of

medicine.<sup>7</sup> The primary objective of utilising innovative techniques in teaching is to improve and maximise learning by making the process more fun for both the learners and the teacher (Handfield-Jones *et al* 1993). Medical educators are challenged not only by the necessity to provide continuing education that supports excellence in clinical practice, but also to find innovative approaches to create more stimulating, motivating and entertaining learning opportunities. Many obstacles to learning can be overcome by exciting and atypical educational techniques (Howarth-Hockey & Stride 2002). As Lock (Bandaranayake 2001: 408) asserted in 1981:

[L]earning may be enhanced if a variety of presentation methods is used with students [...] Learning occurs when students use a combination of senses.

## 7. Conclusion and recommendations

In conclusion, it could be stated irrefutably that playing e-MMFWF as part of these medical students' preparation for Test II of the Infections module improved their module marks and academic success in the module without distorting the distribution of their final marks. In addition, it had a positive influence on their experience and perception of medical micro-biology and infectious diseases as a basic preclinical science, judged by their agreement that e-MMFWF (and play, in general) could be employed as a meaningful learning opportunity.

A critical question that remains unrequited at this stage is how long – if at all – the factual knowledge acquired by playing the game would be retained as part of the students' later clinical reasoning skills. However, this important matter is beyond the scope of this study, and therefore more research to investigate the long-term retention of knowledge obtained by means of the game is strongly recommended. It could further be suggested that follow-up tests be administered at different intervals after playing the game (for example, after three, six, 12 and 24 months) in order to determine the approximate period of retention of knowledge.

7 Cf Bochennek *et al* 2007, Duque *et al* 2008, Mann *et al* 2002, Rosser *et al* 2007, Skiba 2008, Zakaryan *et al* 2005, Zisook *et al* 2005.

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