

The Effect of Facial Expressions on Students in Virtual Educational Environments

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Abstract—The scope of this research was to study the relation between the facial expressions of three lecturers in a real academic lecture theatre and the reactions of the students to those expressions. The first experiment aimed to investigate the effectiveness of a virtual lecturer's expressions on the students' learning outcome in a virtual pedagogical environment. The second experiment studied the effectiveness of a single facial expression, i.e. the smile, on the students' performance. Both experiments involved virtual lectures, with virtual lecturers teaching real students. The results suggest that the students performed better by 86%, in the lectures where the lecturer performed facial expressions compared to the results of the lectures that did not use facial expressions. However, when simple or basic information was used, the facial expressions of the virtual lecturer had no substantial effect on the students' learning outcome. Finally, the appropriate use of smiles increased the interest of the students and consequently their performance.

Keywords—emotion, facial expression, smile, virtual educational environment, virtual learning, virtual lecturer

I. INTRODUCTION

VIRTUAL environments may be used for a plethora of pedagogical purposes [1] such as distance education [2]. There is an increase in virtual schools worldwide [3]-[7] and it is suggested that education mediated by computer is considered very important for the future [8]. However, a major drawback of present virtual schools is reported to be the large number of drop out students [8].

There are many areas that need to be studied and improved concerning the effectiveness of the virtual lectures, and it is believed that more studies are needed in order to establish the 'ingredients' in an educational virtual environment that can motivate the students [9]. In particular, different researchers suggest that the visual representation of the participant in a virtual environment, and therefore possibly in a virtual classroom, increases the potential for person-to-person collaboration and interaction [10]-[11]. An on-line student also suggested that motivation in a virtual class is very important and probably new ways for motivating students should be explored [12].

This research was specifically focused on the facial expressions of the virtual lecturer and the role they play in the

virtual lecture. The aim was to motivate students and to keep them interested and enthusiastic during the virtual lectures.

A preliminary study, carried out as the first part of this research, indicated that there is a direct connection between the facial expressiveness of the lecturer and the facial expressiveness of the students.

The main hypothesis of the first experiment that followed this study proposed that the facial expressions of the virtual lecturer would positively affect the performance of the students.

The second experiment studied the effect of a single facial expression, (the smile) performed by the virtual lecturer, on the students' learning outcome, while attending virtual lectures.

II. CONDUCT OF STUDY

A study was conducted for observing three lecturers' facial expressions and the students' reactions in real academic lecture-environments. The scope of the study was to establish whether there is a relationship between the lecturer's and the students' facial expressions. Also examined was whether the facial expressions of the lecturers kept the students motivated and interested during the lectures.

The first stage of the study consisted of the observation of a total of twenty-three hours of lectures. Twelve lectures were attended, equally distributed across three lecturers (i.e. four lectures per lecturer). The lecturers were labelled as lecturer A, B and C, in random order, for confidentiality purposes. Seventy-nine students were present during each lecture.

An observer attended all the lectures, playing the role of a student. Therefore, neither the lecturers nor the students were aware of the real role and intentions of the observer, in order to maintain the reliability of their behaviour, and ensure that unbiased data was collected.

The role of the observer was to study the expressions of the lecturers and the equivalent reactions of the students. The above facial expressions and reactions were recorded in an observations table.

During the last lecture of each lecturer, questionnaires were handed out to the students in order to collect additional data.

III. STUDY RESULTS

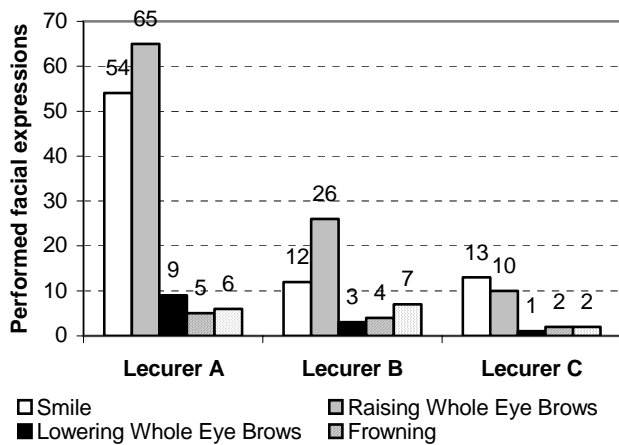


Fig.1 The five most frequently performed facial expressions by the lecturer.

According to the observations, lecturer A was the most facially expressive compared to lecturers B and C (Fig.1). The three most frequently used facial expressions in his repertoire were the 'whole eyebrows raising' (65 times), 'smile' (54 times). Other expressions that the lecturer used during the lectures were the 'whole eyebrows lowering' (9 times) and the 'eyes wide open' (6 times).

Lecturer B was the second most expressive of the three lecturers, according to the total number of his facial expressions that were observed throughout the study (Fig.1). The most frequently used facial expression was again the 'whole eyebrows raising' (26 times). The use of 'smile' did not appear frequently (12 times), compared to lecturer A, and for ten of these the smiles were soft. A strong smile or laughing was not used by this lecturer.

Lecturer C was the least facially expressive of the three lecturers (Fig.1). However, the same patterns appeared when studying the data collected from the observations. There are direct similarities between his facial expressions and those of lecturers A and B. In particular, lecturer C tended to often use 'raising the whole eyebrows' (10 times) and 'smile' (13 times) expressions.

The lecturers tended to smile while asking questions, encouraging the students to think, and also when they were listening and accepting the comments and answers of the students. Hence, a smile could be considered to be a medium for calming and motivating students, by eliminating at the same time intimidation.

The 'raising the eyebrows' expression was mostly used while asking questions or stating something important. Hence, it was used for emphasising points and encouraging students to think, occasionally depicting anticipation.

Studying the data of the completed questionnaires, it was observed that most of the students enjoyed experiencing the lecturers' facial expressions. Furthermore, the students seemed to strongly agree that the lecturers' expressions increased their attention during the lectures.

It was important to establish whether there was a relation between the facial expressions of the lecturers and the equivalent reactions of the students. In order to examine the degree of association between these two variables Pearson's correlation coefficient was calculated, followed by a t-test to determine the statistical significance of this. For all three lecturers 'the total number of times an expression was performed by the lecturer' and 'the number of times the students' reacted to these expressions' were found to be positively correlated.

The above statistical analysis strongly suggests that the students were directly affected by the facial expressions performed by the lecturer. In particular, the more expressive the lecturer was the more the students engaged with the lecture and the lecturer.

IV. EXPERIMENT I - PROCEDURE

The main aim of the experiment was to observe students while they were attending four different virtual lectures, and then to evaluate their performance.

Four different virtual lectures were created for the experiment:

- Lecture 1: difficult content, virtual lecturer with facial expressions.
- Lecture 2: difficult content virtual lecturer without facial expressions.
- Lecture 3: easy content virtual lecturer with facial expressions.
- Lecture 4: easy content virtual lecturer without facial expressions.

The virtual lecturer was represented by a three-dimensional animated head, created using the 3DMeNow software application. Once the lecture material was created, it was digitised into four sound files and then embedded into the virtual lecturers. The facial expressions were then added to the animated talking virtual head manually using the same application (Figure I). Hence, four different virtual lectures were created that could be 'virtually' attended by using the 3DMeNow player.

Twenty-four students sat in front of a computer screen, wearing a pair of headphones. Each student attended four virtual lectures and at the end of each one, the student had to complete a set of questions based on the teaching material of the lecture. At the end of the final set of questions the students were asked to complete a final questionnaire based on the experience of participating in the virtual lectures. In order to avoid a biased result, twenty-four combinations for attending the above lectures were generated and randomly allocated to the participants. Hence, no student attended the four lectures in the same order as another student.



The emotions expressed by the lecturer during the virtual lectures of the first experiment.

The experiment took place in a room containing only a PC, the student and the instructor-observer. The experiment was conducted twenty-four times, once for each participant with an average duration of thirty minutes each.

All students participated in the experiment individually. None of them had had any similar experience in the past. After briefing them on the procedure, they attended the four lectures and completed the equivalent questionnaires. The instructor also played the role of the observer, something that the students were unaware of in order to avoid deliberate changes in their behaviour. He took notes on the reactions and behaviour of the participants during the attendance of the lectures. The students were also unaware of the importance of the virtual lecturer's facial expressions throughout the experiment.

The aim of the experiment was to study the effect of the virtual lecturer's facial expressions on the students, during their attendance in the virtual lectures. One of the main parameters that needed to be observed and discussed was the relation between the learning outcome of the students and the facial expressions of the virtual lecturer.

Hence, the main hypothesis stated that the students would in general be more attentive during the difficult-text lecture with the presence of facial expressions. Therefore, it was expected the students would obtain higher marks during this type of lecture as compared to the one with the absence of facial expressions. However, it was hypothesised that the marks between the two easy-content lectures would be quite similar, and would also probably be higher than the marks of the difficult-text lectures.

V. EXPERIMENT 1 -RESULTS

The marks obtained from the lectures of the difficult content were totalled, resulting in 1646 for the lecture with the presence of facial expressions, and 885 for the lecture with the absence of facial expressions. The difference between these sums is 761. Therefore, the students managed to score almost double the marks in the difficult lecture (with the facially expressive virtual lecturer) than they achieved in the second (with the facially non-expressive virtual lecturer). These two lectures were characterised by the same level of difficulty in respect of their content - the only difference was the presence of facial expressions of the virtual lecturer.

Also noted from the first two lectures was that twenty students (out of twenty-four) managed to gain higher marks during the first lecture compared to those of the second lecture. One managed to achieve the same marks in both lectures and only three students achieved higher marks in the second lecture.

The marks obtained during the lectures of the easy content with the presence and absence of facial expressions equivalently were also studied.

TABLE I
STUDENTS' SCORES AT TEST QUESTIONS

	Difficult content lectures		Easy content lectures	
	With facial expressions	Without facial expressions	With facial expressions	Without facial expressions
Sum of students' scores	1646	885	2187	2131
Mean score	68.58	36.87	91.125	88.79
Difference of sums	761		56	

The total and average marks the twenty-four students scored at the questionnaires related to the lectures' content of the first experiment.

In Table I, the sum of the marks of the first easy lecture, with the presence of facial expressions, is 2187 and the sum of the second easy lecture, with the absence of facial expressions, is 2131. The difference between these two totals is 56. Hence, the difference is relatively small compared to the previous difference, which was 761. Half of the students managed to obtain higher marks for the lecture with the presence of facial expressions as compared to those of the second lecture.

In the general comments section students clearly stated that they were impressed with the quality of the appearance of the virtual lecturer. Interest and enthusiasm was also expressed for the general use of virtual lecturers and they also recommended that only facially expressive lecturers should be used. They further suggested that the introduction of a virtual body, and hence body language, could make the lectures more interesting and appealing. It was also stated that the non-facially expressive lecturer eventually became boring. In

general, the participants thought that the use of virtual lecturers was a very interesting idea and that it demonstrated an impressive use of media.

At the end of the experiment each student was asked to complete a general questionnaire about their experience of attending the virtual lectures. For the first eight questions a scale from one to six ('1' representing 'Not at All' and '6' representing 'Very Much') was used as the method for the student to give their answers.

The students replied with an average 4.2 when asked if they were enthusiastic about the lectures. Their enthusiasm was also demonstrated by comments that will be discussed later. In Question 2, they considered that the lecturer was only moderately enthusiastic (with an average of 3.3). This is mainly because most of the students noted the fact that the lecturer's monotonous and robotic voice was not very engaging. However, they thought that the lecturer's facial expressions were more than adequate and enjoyable to watch (a score of 4.1 for questions 4 and 5). The students also agreed that they felt motivated to be attentive (with an average score of 4). In Question 6 students confirmed that the lecturer's facial expressions increased their attention (with average 4.3). They also felt actively engaged in learning (with average 4).

Although the students enjoyed the lecturer's expressions and felt engaged by them, twenty of the participants suggested that the lecturer should be even more facially expressive.

VI. EXPERIMENT 2 – PROCEDURE

The aim of this experiment is to study the role of the virtual lecturer's smiling on the students' performance. The students that participated in the experiment had to attend the pre-rendered virtual lectures. At the end of each lecture they were asked to answer a number of questions related to the lecture's content. At the end of each lecture the students were also asked to complete a final questionnaire with general questions related to their experience of attending the virtual lectures. During the attendance of the lectures an observer was taking notes recording the behaviour of the students. The final stage of the experiment involved the analysis of the data, concluding with a discussion of the results.

For the new experiment four different virtual lectures were created. The results of the first experiment clearly stated that when students attend a lecture of easy content, their performance is not affected significantly by the facial expressions of the virtual lecturer. Hence, for the second experiment the four lectures were only of difficult content. The only difference between the four lectures, apart from the content, was the variation of the number of times the smile is depicted in each one of them by the virtual lecturer (Figure II).

Table 1 shows the four different virtual lectures. Since no studies have been found related to the number of times a facial expression should be used, the number 'x' was defined by studying the data of the initial study. In particular, the number

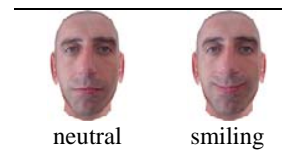
of times the lecturers smiled during the lectures helped to ascertain that the number 'x' is approximately equal to 5.

TABLE II
DESIGN OF THE FOUR LECTURES

Number of times smiling is performed	Lecture 1	Lecture 2	Lecture 3	Lecture 4
$2x = 10$	A			
0		B		
$(\frac{1}{2})x \sim 2$			C	
$X = 5$				D

The four different Lectures (A, B, C and D) for the second experiment.

FIGURE II



The only facial expression used by the lecturer during the virtual lectures of the second experiment was the smile.

Each participant had to attend all four lectures (i.e. lectures A, B, C and D - Table II), but no participant attended the lectures in the same order as the any other. There were twenty-four different ways of attending the four lectures and therefore twenty-four participants were needed for the experiment.

The participants were seated in front of a computer and the procedure was briefly explained to them. However, they were not told that the aim was to examine the effect of smiling in order to avoid biased data. The subjects had to use headphones in order to avoid noise from the environment interfering with the virtual lecturer's voice.

The experiment did not exceed the thirty minutes for each participant. Additional time was given when it was needed to complete the questionnaires. Each student participated in the experiment individually.

VII. EXPERIMENT 2 – RESULTS

All the questionnaires from the twenty-four students were collected and the data were imported for analysis.

In the first experiment, two virtual lectures were of difficult content and two of easy content. Since it has been established that the facial expressions of the virtual lecturer are more effective when used during the lectures of difficult content, the four lectures of the second experiment were all of difficult content.

The students managed to obtain higher marks while attending Lecture 1 with an average of 52.5 (Table III). For Lecture 3 the average mark was 47.4. In Lecture 2 and 4 the students managed to obtain average marks of 25.6 and 23.7 respectively.

TABLE III
STUDENTS' SCORES AT TEST QUESTIONS

	Lecture 1	Lecture 2	Lecture 3	Lecture 4
Number of smiles performed	10	0	2	5
Students' mean score	52.5	25.6	47.4	23.75

The average marks the twenty-four students scored at the questionnaires related to the lectures' content of the second experiment.

In Lecture 1 the virtual lecturer smiled ten times, in Lecture 3 two times, in Lecture 2 he did not smile at all and in Lecture 4 he smiled five times. Therefore, for the lecture with the highest number of smiles performed by the virtual lecturer, the students managed to score the highest marks (mean 52.5). On the other hand, for Lecture 2, where the virtual lecturer did not smile at all, the students scored an average mark of 25.6.

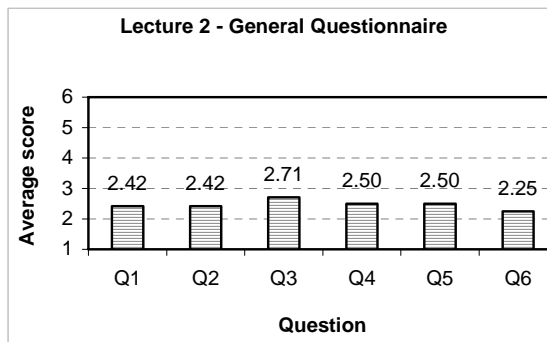
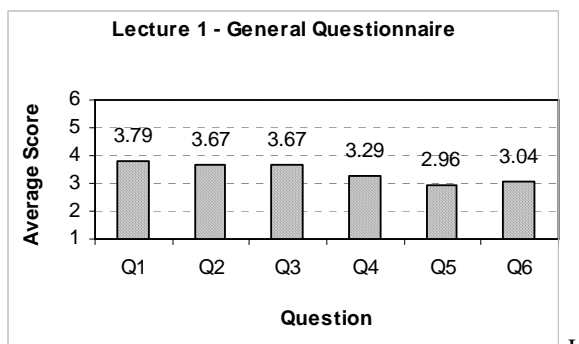
The students agreed that the facial expressions of the virtual lecturer kept them motivated and interested in attending Lecture 1. This is reflected by the highest average score of 52.5.

Although in Lecture 3 the virtual lecturer smiled only twice, the students commented that regarding the seriousness of the lecture's content ("the problem with young offenders") the number of times the lecturer smiled and the occasions that he smiled were quite appropriate.

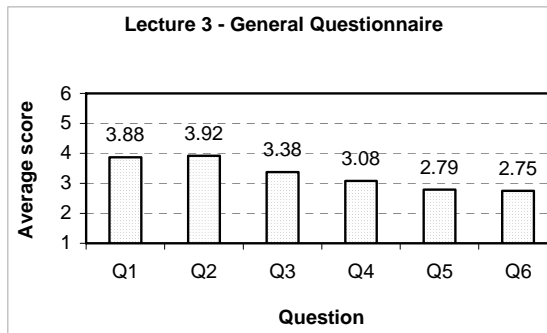
However, although in Lecture 4 the virtual lecturer smiled five times, the low average score of the students could be explained by the students' comments. They observed that the lecture was boring and the lecturer's voice monotonous and hard to follow because its pace was fast.

The average score from the first experiment of the lectures of difficult content was 68.58. In this experiment the average mark for Lecture 1, where the lecturer was the most facially expressive, was 52.5 which is lower than the average score above. This was expected since in the first experiment a wider range of expressions was used, contributing to creating a more interesting, more exciting and more realistic experience for the students. By only using smiling in Lecture 1 during this experiment, the students were still motivated and interested but not as highly as they were with the presence of many different facial expressions.

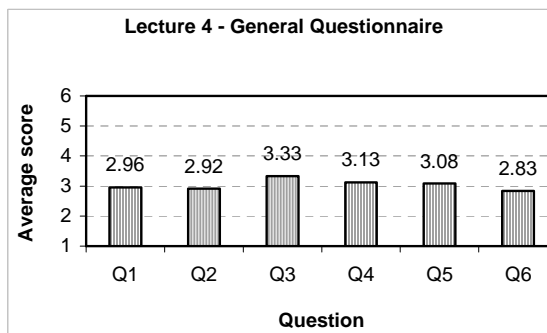
CHARTS I-IV



II



III



IV

The average scores of the students' answers to questions 1-6 of the general questionnaires.

- Q1. I was enthusiastic during this class.
- Q2. In this class I felt motivated to be attentive.
- Q3. The virtual lecturer was adequately facially expressive.
- Q4. The virtual lecturer was enthusiastic during the virtual lecture.
- Q5. I enjoyed the virtual lecturer's facial expressions.
- Q6. The virtual lecturer's facial expressions increased my attention.

Chart I shows the mean values of the students' answers to the first six questions of the general questionnaire. For Lecture 1, with the most facially expressive lecturer, the students were fairly enthusiastic during the lecture, felt fairly motivated to be attentive and suggested that the virtual lecturer's facial expressions were fairly adequate. The students thought that the lecturer was also fairly enthusiastic during the lecture, but they strongly suggested that the computerised voice of the lecturer retained his enthusiasm at low levels.

However, the students' average score is 2.96 when asked if they enjoyed the lecturer's facial expressions. This is not a low score considering that only one type of facial expression

was used during the lecture. The students suggested that by increasing the types of facial expressions of the virtual lecturer their interest and enjoyment during the lecture would increase too.

They also suggested that the facial expressions of the lecturer had a fairly positive effect on them, acting to the increment of their attention. This can be confirmed by the, relatively high average scores they obtained on the test question.

In Question 7 more than half of the students agreed that the lecture was quite interesting, informative and lively. However, although more than half of the students did not find the lecture to be boring, about one third of the students suggested that it was *fairly* boring. This result could be interpreted by the comments of some students that they found the lecturer's voice to be monotonous and not very interesting.

In Question 8 the majority of the students said that the lecturer was at least fairly happy throughout the lecture. The majority of the students also noticed that fear, sadness, disgust, surprise and anger were not expressed during the lecture. The fact that some of the students thought they observed some of the above absent emotions, means that the students could have connected those emotions with the content of the lecture.

Question 9 reveals that 62.5% of the students wanted the lecturer to be more facially expressive. In Question 10 students suggested that all emotions should be expressed by the lecturer, but they showed a strong preference towards the emotion of happiness. They also showed a slight resentment towards negative emotions such as fear, disgust and anger.

Chart II shows the average scores of the students to questions 1 to 6 of the general questionnaires of Lecture 2.

In Lecture 2 the virtual lecturer did not use any facial expressions depicting emotion and this resulted to the low scores of the questions. Therefore the students were not very enthusiastic during the lecture, did not feel very motivated, thought the lecturer was not very enthusiastic, did not enjoy the lecturer's expressions very much, and did not think that the lecturer's expressions increased their attention.

A slightly higher score of 2.71 was obtained in Question 3. Although this score is still not high, the students did not think that the lecturer was absolutely not adequately facially expressive. This is because the virtual lecturer, apart from smiling, also performed some other natural moves of the face such as raising the eyebrows and moving the head, which combined with the content of the lecture they may have been misinterpreted by the students as facial expressions. These small animations were performed by the lecturer during the four lectures to add realism to his performance.

In Question 7 the majority of the students thought that the lecture was not interesting and alive, but although it was still fairly informative, it was also very boring. The students commented again that the absence of facial expressions and the monotonous voice was a combination of factors that made the lecture hard to attend to.

Question 8 confirms the fact that there were not facial expressions used during this lecture, since the majority of the students said that none of the enlisted emotions in the question were expressed during the lecture by the lecturer.

Question 9 shows that 79.1% of the students preferred the lecturer to be more facially expressive. In Question 10 the majority of the students wanted the lecturer to express happiness quite often and surprise very often. These emotions could make the lecture more interesting and the lecturer appear more enthusiastic and energetic, when used appropriately. Although some students preferred most of the emotions to be expressed during the lecture, many students did not want the less positive ones (anger, disgust, fear and sadness) to be expressed by the lecturer.

During Lecture 3 the students were fairly enthusiastic and felt fairly motivated (Chart III). Although the lecturer smiled only twice throughout this lecture, the students suggested that the facial expressions of the virtual lecturer were fairly adequate. Again this could be explained by the fact that the topic of the lecture was quite serious ("the problem with young offenders"). The students did not think the virtual lecturer was very enthusiastic about the lecture, and they did not enjoy his expressions very much, nor did they consider that these expressions increased their attention to any great extent.

Question 7 shows that although the majority of the students found the lecture to be interesting and informative, at least half of them thought it was fairly boring.

Because of the lack of many smiles performed by the lecturer and due to the content of the lecture, one fifth of the students said the lecturer did not express happiness at all, whereas almost half of the students said the lecturer expressed happiness only occasionally.

Most of the students suggested that fear, disgust and anger were not expressed during the lecture. However, according to some students, sadness was occasionally expressed by the lecturer. This could be explained again because of the seriousness of the lecture's content.

In Question 9 81.8% of the students would like the lecturer to be more facially expressive. For this lecture, students would prefer the lecturer to express sadness and disgust more often, since the subject of the lecture was a serious social problem. However anger and fear should not be expressed often. Once again students thought that happiness should be expressed more often by the lecturer.

Students were moderately enthusiastic during Lecture 4 and felt moderately enthusiastic about it (Chart IV). Although they found the lecturer's facial expressions to be fairly adequate and the lecturer to be fairly enthusiastic, they suggested the expressions did not increase their attention as much. Many students commented that the lecturer's voice was monotonous, hence making the whole experience less interesting and found the topic of the lecture quite hard to follow.

Studying the results of Question 7 it can be deduced that the students did not find the lecture to be very interesting and alive, although they thought it was fairly informative. The

majority of the students, however, found the lecture to be quite boring.

Question 8 suggests that most of the students correctly suggested that the lecturer did not express anger, fear or disgust, but that he was expressing happiness fairly often.

Question 9 confirms again that most of the students, 81.8% in total, would prefer the lecturer to be more facially expressive. In particular, Question 10 shows that the students suggested the lecturer should express happiness and surprise more often and less fear, anger and disgust.

In the general questionnaire, the students had the opportunity to write additional comments or suggest ways of improving the lecturer's performance.

Many of the comments were related to the lecturer's voice. Students strongly suggested that the lecturer's voice was very monotonous and although in Lecture 1 the facial expressions were fairly adequate, the voice of the lecturer made them less interested in attending the lecture. They further commented that the voice should be more natural and colourful. This would enable the lecturer to vocally emphasise important key-points as well as visually by using facial expressions. The voice was characterised as occasionally 'flat', 'monotonous', 'electronic', 'inexpressive' and 'unenthusiastic'. Two students also suggested that the lecturer should aim to make longer pauses between sentences or paragraphs. Instead, the lecturer sounded like he was reading from lecture notes instead of lecturing.

The particular electronic voice was chosen for this series of experiments for practical reasons. If this teaching method, using virtual lecturers, is to be used successfully in future by teaching staff, they should be able to easily convert their notes to voice by importing the text into a text-to-voice computer software application. It is also believed that in the future the electronic voices will be more natural, resembling the quality of the real human voice. Another advantage of using this method to create the virtual lecturer's voice is the availability of a wide range of voices and accents that these applications provide. This will meet any particular need or preferences of the lecturers or especially the students.

Additional comments of the students suggested that for improving the virtual lecturer's performance, a virtual animated body could accompany the virtual head. Gestures and postures could make the experience richer, more interesting and realistic.

VIII. DISCUSSION

In conclusion, there are strong indications that being more facially expressive can increase the interest and motivation of the students. This could positively affect the learning outcome, because of the students' enthusiasm towards the lecture. Therefore, the interest and motivation of the students are directly connected with the facial expressiveness of the lecturer.

The main hypothesis of the first experiment proposed that the presence of facial expressions during the difficult-text

lecture would increase the attention and improve the learning outcome of the students. This was supported in a number of ways:

- Marks: scores show that during the difficult-text lectures the students performed better by 86% in the test for the lectures with the presence of facial expressions compared to those with the absence of facial expressions. The students performed better by 2.6% at the equivalent easy-text lectures.

- General Questionnaires: the answers to the first questions suggest that the students thought the facial expressions were interesting and engaging.

- Observation: most of the students looked away from the screen at least once during those lectures which did not employ facial expressions. They were more attentive during the lectures with the presence of facial expressions.

The second hypothesis was strongly supported by the fact that the improvement in students' learning outcome during the attendance of the easy text lecture with the presence of facial expressions was only 2.8%. This suggests that for conveying basic information in a virtual environment, the facial expressions of the virtual lecturer have no strong effect on the learning outcome.

The scope of the second experiment was to study a particular expression (the smile) during a virtual lecture, and the effect of this expression on the students' performance.

In Lecture 1 the virtual lecturer was more facially expressive, since he smiled ten times. The average score of the students on the test questions was 52.5, which was the highest mean score compared to the other three lectures' mean scores. Students also commented that the appropriate use of facial expressions increased their interest and kept them motivated throughout the lecture. However, 62.5% of those students wanted the lecturer to be more facially expressive and about 50% of the above students would have liked to see the lecturer express happiness quite often. Since the emotion of happiness is chosen more often than any other emotion for all four lectures, it is evident that students prefer to work in a happy, positive and enjoyable virtual academic environment. Therefore, smiling (depicting happiness) is very important for the students in order to keep them motivated and enthusiastic, resulting to a better learning outcome.

In Lecture 2, where there were no smiles used by the virtual lecturer, a poor performance of the students supported the results of the first experiment, that the absence of facial expressions has a negative effect on the students' interest in the lecture, and hence negatively affects their performance. Although the students found the lecture informative they also thought it was boring and uninteresting.

In Lecture 3 although the lecturer smiled twice, the students managed to obtain the second higher mean score (47.44). The students commented that the appropriate use of facial expressions in this lecture, made their participation more interesting, and kept them motivated and enthusiastic during the lecture. However, they still thought that a wider range of facial expressions could improve the virtual lecturer's performance.

In Lecture 4 the lecturer smiled five times. The students managed to obtain the lowest mean score (23.75) compared to the scores of the other lectures. Many students commented that the monotonous voice of the lecturer was instrumental in decreasing their enthusiasm and motivation. Hence, although they agreed that the facial expressions of the virtual lecturer were fairly adequate, it was hard for them to follow the difficult content of the lecture. This also supports the average score (2.83) of Question 6, where the students claimed that the facial expressions of the lecturer did not greatly increase their attention.

The students expressed a general antipathy against the negative emotions such as anger, fear, disgust and sadness. However, they suggested that occasionally, when required by the content of the lecture, the virtual lecturer could express the above emotions (e.g. during an acting class). This could make the students' experience in the virtual environment more interesting and rich.

Therefore, the use of smiles depicting happiness during a virtual lecture has a positive effect on the students' performance, when used appropriately. However, an inappropriate use of smiling, e.g. when discussing a very serious social problem, could have a negative effect.

Although it had been planned to make observations of the students and record them during the experiments, in practice there turned out to be little obvious reaction from the students during the virtual lectures in both experiments. Some students in the first experiment smiled occasionally, but in general the students attended the lectures quietly and passively. It is assumed that this was due to the fact that the students were consciously aware of the fact that the lecturer was virtual and not interactive, and even if they were reacting to his expressions they knew that they would not get a reaction back.

IX. FUTURE WORK

The results of the initial study combined with the results of the two experiments, will contribute to designing further experiments. These experiments could be conducted in order to examine the effect of other individual facial expressions of the virtual lecturer on the students' performance.

The improvement of the virtual lecturer's voice could have a positive effect, improving the performance of the lecturer and keeping the students more interested and enthusiastic during the virtual lectures.

Other changes, such as the addition of an animated body to the virtual lecturer, would also enhance the students' experience in the virtual academic environment.

X. CONCLUSION

During the initial study, it was shown that the correlation between the facial expressiveness of the lecturers and that of the students in a real academic environment, a traditional lecture theatre, was positive. This suggests that the more facially expressive the lecturers are, the more facially expressive the students become. It was additionally observed

that the lecturers' frequent use of facial expressions maintained the students' attention and responsiveness.

The results of the first experiment strongly suggest that the use of facially expressive virtual lecturers leads to a more interesting and motivating virtual educational experience, and that the students become enthusiastic about the subject of the lecture, thereby positively benefiting their learning outcome.

The results of the second experiment showed that the appropriate use of smiling during the virtual lecture contributed to the increase of the students' interest and motivation, and hence to the increase of their learning outcome.

Students in general prefer the virtual lecturer to express happiness during the lectures. However, the inappropriate use of smiling could be considered insensitive and have a negative effect on the students' performance. The results from Lecture 3 showed that even when discussing serious topics, careful use of smiling will be appreciated by the students and will improve their performance.

Since virtual environments will inevitably be used more frequently in the future to serve educational purposes, the use of facially expressive virtual lecturers will undoubtedly be one way to help guarantee the success of the medium.

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