Entertaining users through multi-modal game based learning

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Abstract: Game based learning is used today to engage and to teach children in primary or secondary education level, as well as learners in higher and advanced stages. The process of developing an excellent game that engages users and lets the player discover new structure bearing in mind pedagogical factors associated with different types of game design is not an easy issue. Therefore this study aims to investigate the role of game within multi-modal context in improving users' attention and interest in e-learning environment. The study evaluated four multi-modal interfaces constructed to be edutainment platforms. The multi-modal features such as speech, earcons and avatars were incorporated to enrich the gaming environment with entertainment elements which is necessary to make the users satisfied with the level of interaction. These four games based-learning interfaces were designed and built each with disparate multi- modal attributes. The first game was introduced with text and speech only (TS); the second was with text and earcons only (TE); the third game integrated with text, speech and earcons (TSE); finally the fourth game was with text, speech, earcons and avatar (TSEA). The usability attributes represented in user achievement and user satisfaction were measured within each game. Users showed significant enhancement on their performance and expressed their positive sensation during and after their experimental session. Furthermore TSEA was the preferable condition compared to the other platforms.

Keywords— Avatar, Edutainment, Entertainment, E-learning, Multi-modal.

I. INTRODUCTION

THE main target for any educational instructor is to attract learners and prompt learning. This is essential in e-learning where students and instructor are invisible to each other [1] . Background literature determines that to obtain a good result and higher quality thinking, e-learning systems must provide the users with a challenging environment that enables them to process new information given, and creates a bridge with the experiences they have already acquired [1]. This is why different approaches and strategies should be adopted and applied to prompt the online learner's curiosity to discover and deeply process the information. In addition increased concerns about pedagogical issues, such as the

number of poor e-learning systems, enforces instructional developers to rethink the possible solutions to this problem. One solution suggested is that the old educational standards that were used in the classrooms should be applied to the online learning, whereas others did not agree and developed new guidelines that might substitute these old ones[1]. In a way humour is one of the pedagogical factors that have been used by teachers in the classrooms to obtain better performance and to decrease the sensation of boredom, especially in teaching scientific subjects [2], [3], [4], [5], and [6]. Humour was also used by educational designers in many projects to overcome the problem of poor web based text design [7], [8], [9], [10] [11], [12], [13] and [14]. In fact the term humour or sense of humour includes several types of activities and actions. It could be physical or mental actions, and the feeling of pleasure depends on the situations and circumstances where it happens and with whom. It also differs between people of various age ranges and educational levels. In reality humour is a kind of positive feeling people get from their interactions with many objects in this world, whatever might have been the motivation. It might be from solving problem, reading a novel, riding a bicycle, even talking to someone, or playing a specific game. Therefore whatever was the motivation, the important thing is to experience a good feeling and to continue receiving this feeling is more important to building a general idea and processing information effectively [15].

Therefore this study focused on entraining users in their advanced level of education, as well as evaluated student's reactions and progress by using four multi-modal e-learning games. The games were built utilizing several tools such as Authorware, flash, Crazy Talk and combines a number of attributes such as earcones and avatars, also creating entertaining medium enriched by jokes, body gesture and other funny mimics. The purpose was to measure effectiveness and user satisfaction, and to evaluate how memorable and educationally valuable were certain aspects of edutainment. The results obtained from the experimental studies were compared and discussed in order to produce empirically derived conclusions as to which platform is the preferable standard for e-learning applications.

II. PREVIOUS WORK

Studies that process the impact of integration of multi-modal features of educational interfaces and to enhance usability of the e-learning systems are many. These studies mostly targeted to find the effective way to combine modules

and to reduce redundancy of different types of web based interfaces. Different models such as earcons, speech and even avatars were tested and gave effective results and helped to improve usability of interfaces and users performance [16], [17], [18], [19], [20], [21] and [22]. On the other hand studies that combine multi-modal metaphors with entertainment features expressed to users by avatar are few. Fabri [22] compared two versions of instant virtual messengers , one is used expressive avatar (Animated 3D character) to entertain two users during their discussion where as the avatar was absent in the other one. The main aim of this study was to investigate the user's reaction to those messengers' interfaces and the role of integrating expressive avatars in increasing user's enjoyment, involvement and measuring emotional state during experiment. The study implemented on 32 users and mostly where from computer background. The users experienced both conditions and each user has to meet or chat with other user without knowing the identity of that person for 8 to 35 minutes. Moon survival scenario was the topic of the discussion and none of users had knowledge about it. The real experiment (discussion) starts when the users completed practicing the interfaces and get familiar with them. In the end of experiment, participants completed a questionnaire. The study achieved 5 measurable attributes, user's involvement in the task, enjoyment felt during the task, sense of presence, performance and usability. This experimental study concluded that users experienced the virtual messenger represented with avatar gained slightly higher scores in terms of enjoyment and performance results than the typical condition. Although identical scores was acquired in both conditions by users for sense of presence, users in expressive avatar interface were more happy, active and obviously expressed their positive feedback after the task given and they liked to perform it again. Regarding usability issue, the results showed that both conditions scored sufficiently high with 77.5% for expressive avatar and 78.4% for non expressive avatar. Finally the author concluded that "The experiment have shown that the emotionally expressive avatar had some positive effect on participants' experience, but probably not as dramatic as we expected".

III. HYPOTHESIS

Actually as stated above four platforms (games) with different multi-modal metaphors are tested in this experiment, and they are as follow:
TS = A game with Text + and Speech only
TE = A game with Text and Earcons only
TSE = A game with Text, Speech and Earcons.
TSEA = A game with Text, Speech, Earcons and Avatar.

The Null hypostasis H0 is shaped as follow:
H0 = "Multimodal E-learning and Edutainment Game will be the same (does not enhance students enjoyment)".
H1= "Multimodal E-learning and Edutainment Game will be not the same (does enhance students enjoyment) ".

IV. EXPERIMENT PROCEDURE AND TASKS

To verify proposed hypothesis, four games based-learning interfaces designed and built, first game introduced with text and speech only (TS), second was with text and earcons only (TE), and third game integrated with text, speech and earcons (TSE) and finally fourth game was with text, speech, earcons and avatar (TSEA). The users must use these four games (dependent group) as shown in Table I and they have to decide which interface is the best and enjoyable through questionnaire where they have to write their feedback.

Moreover four lessons rotated between the four platforms, each lesson kept the same amount of information. Moreover four lessons rotated between the four platforms, The Table II summaries the rotation system. Each lesson kept the same amount of information; this was done by counting the number of words per lesson to ensure that the four lessons are equal and to minimize difficulty of tasks as summarised in Table II too. All four interfaces introduced to the users with selected topics from geology, lesson one was "what is volcano", lesson two was "earthquakes facts", lessons three was "types of rocks" and lesson 4 was "how oil is formed".

Each user was provided with four tasks (questions) to perform in each platform. Concerning difficulty level of tasks was moderate. Nevertheless, the system provided users with three attempts for every task with a built-in clock. Each user was allowed to take up to 60 seconds to complete the task.

V. PLATFORMS DESIGN

A. First interface: A game with text and speech only (TS)

In this experimental design the user has to read and listen to specific lesson and directly must go to tasks (questions) which are designed to be game. The mechanism of this game starts when the users click specific button to start the game, the first question appears as text with speech in the middle of the circle shape in the centre of the screen. As the user read and listen the question, straightaway the first answer comes out as text with speech in another circle on the top of the screen for about 3-4 seconds.

As soon as the second answer becomes visible with text and speech in another circle, the first answer (circle) disappears and so on with the remaining six answers. The correct answers are distributed randomly within random circles in specific task. By fast click on the chosen answer, the system generates immediate feedback notifying if this was the right or wrong answer. The system automatically jumps to the next question if the user answer was right and all circles disappears, and if the user answer was wrong , the game continues until the maximum time consumed, prompting user to go to next question and the game starts over with the second task. This game can be seen as wall watch and the answers rotate in clockwise direction. Snapshots of proposed game showed in Fig. 1.

Table I Experimental platforms

Platforms (Games)	Multimodal features	Lessons
Platform 1	Text + Speech	L1,L2,L3,L4
Platform 2	Text + Earcons	L1,L2,L3,L4
Platform 3	Text + Speech + Earcons	L1,L2,L3,L4
Platform 4	Text + Speech + Earcons + Avatar	L1,L2,L3,L4

Table II Lessons and interfaces rotation

Learning materials:	Interfaces (conditions)	Number of Words
L1 = Lesson 1 (What is a volcano)	• Text + Speech. • Text + Earcons. • Text + Speech + Earcons. • Text + Speech + Earcons+ Avatars.	494
L2 = Lesson 2 (Earthquake Facts)	• Text + Speech. • Text + Earcons. • Text + Speech + Earcons. • Text + Speech + Earcons+ Avatars.	500
L3 = Lesson 3 (Types of Rocks)	• Text + Speech. • Text + Earcons. • Text + Speech + Earcons. • Text + Speech + Earcons+ Avatars.	513
L4 = Lesson 4 (How Oil Is Formed)	• Text + Speech. • Text + Earcons. • Text + Speech + Earcons. • Text + Speech + Earcons+ Avatars.	498

A. Second interface: A game with text and earcons only (TE)

As described in the first interface, the same design is repeated, but here speech was replaced with earcons and also the way the game starts here are differs from the previous game.

In this game the user must click on the middle of the circle to see the questions and click on the tone button to hear the tone and start the game in the same time, bearing in mind that the question tone will be heard only once by user.

The tone used in these earcons was generated by software called visual music, by half the tones to two portions, the first half allocated to question and the other half assigned to the answer. In this design the user has two ways to answer, first by reading the text only or by using or click on the tone button grouped with each circle or answer. The remaining first game procedures described and time restrictions were used with this game as well. Snapshots of proposed game showed in Fig.1.

B. Third interface: A game with text, speech and earcons (TES)

This game is similar to interface two, but speech was included. In this game the user must click on the middle of the circle to see and listen to the question and click on the tone button to hear the tone and start the game in the same time, bearing in mind again that the question tone will be heard only once by user please refer to Fig1 as well.

Two ways are available to the user to accomplish the tasks provided, first by reading the text and listing or by using or click on the tone button grouped with each circle or answer. Other features exactly were equivalent to the first game design as detailed earlier.

C. Fourth interface: A game with text, speech, earcons and avatars (TSEA)

Fourth interface or game is a third interface enriched with an avatar. The avatar (sound and human like expressions) with the other modals (text, speech, earcons) used in this platform to introduce the edutainment aspects displayed simultaneously on the screen. Besides reading to the user the questions and answers, avatars are designed and targeted to entertain the learner by jokes, some funny expressions and gesture. These avatars were integrated with Crazy Talk V5.1 software with the author speech and personal and other friend's photographs.

VI. RESULTS AND ANALYSIS

Overall 48 volunteers took part in the study, which was over 8 weeks mostly in the Bradford University research laboratory. All of users utilized the four lessons and four edutainment conditions (games). Both conditions and lessons were distributed randomly for each user.

A. Users Profile

Users mostly were aged 25-44 and 100 % were males. The average age was 36 years with a standard deviation of 25.46%. Users were generally high educated level, Doctoral degree was 45.65%, and Masters was 58.70%. In terms of area of study, 39.18% of users were from computing and informatics department, 21.74% were from engineering in general, whereas communication and networking were 15.22 %. The remaining users were from different schools and department. 100% are using computer more than 10 hours per week. Whereas 95.65% using Internet more than 10 hours per week. 4.35% of users only had excellent knowledge about Geology, 23.91% were good, 58.70% limited, and 13.04% had no knowledge at all. Users who had knowledge about e-learning were 28.26%. Concerning avatar 63.04% had not knowledge, 28.26% limited, 8.70% were good, 0% were excellent.

B. Tasks Achievement

Fig. 5 shows that the mean user achievement for TE, TSE and TSEA conditions was a little higher in comparison to TS platforms. Respectively, the figures are 91.67%, 93.48%, 95.65% and 96.73. The proportion of users who completed their tasks was as follows: TS 79.17%; TE 86.96%; TSE 91.30% and TSEA 91.30%. Whereas users who do not completed their tasks were respectively 16.67%, 13.04%, 8.70% and 8.69%. The proportion of users whom completed their tasks is illustrated in fig. 6 and was as follows: TS 79.17%; TE 86.96%; TSE 91.30% and TSEA 91.30%. Whereas users whom do not completed their tasks were respectively 16.67%, 13.04%, 8.70% and 8.69%. Nevertheless the figure showed also missing data in the experimental platforms which was also respectively 4.35%, 3.26%, 2.17% and 3.26%. Regarding each task on its own, as shown in Fig. 7, the mean percentage of students who completed the four tasks was identical in all conditions.

In general enhancement is noticeable for the performance of student in task 2 in condition TE and also task 3 in condition TSEA which was 100%, but still the other conditions the results are comparable.

C. Satisfaction

As we know satisfaction is a measurement of user's pleasure and enjoyment, this has been done throughout questionnaire provided. Likert five-point scale with 10-items as general feedback presented asking to express their agreement with standard statements [23].

The average score for condition TS was 67.13%, TE was 70.72%, TSE was 72.83% and TSEA was 86.12%, please refer to Fig. 6. In addition to standard statement, the Likert five-point scale enriched by extra 5 and sometimes 8 statements that also expresses user opinion scored as normal average shown in Fig. 7. In condition TS the average user score was 3.37, TE was 3.75, TSE was 4.02 and TSEA was 4.53. Overall the results showed positive affect in condition TSEA.

D. Users responses

The experiment traced and recorded the user's reaction for each interface via Toshiba laptop built-in webcam with Camtasia software where the users executed the experiment. Movies produced by the software were analyzed and converted in forms of numerical data. The criteria adopted from [24] to measure the users positive and negative reactions such as users smile, laugh, expressing vocally, and other features. Fig. 8 concludes these facial appearances were the smile bar feature obtained the highest total number in all conditions, particular was the highest in condition TSEA which was 334, followed by TS condition 266, in TSE were 196 and TE was 151.

Moreover laugh attribute is also gained the second order about 109 laughs in condition TSEA, TSE was 64, TE was 50 and TS was 39. Expressing vocally featuring is the foremost in condition TSEA followed by TE. The other face features are very rare in condition TSEA, and to some point appeared in condition TSE, TS and TE but in small numbers.

VII. DISCUSSION

The focus of this experiment was to investigate the user involvement whilst experiences the edutainment features in multimodal e-learning systems, this was throughout two quantitative aspects, in particular user achievement and user satisfaction score, bearing in mind that the experimental circumstances is controlled to guarantee the validly, either by the platforms rotation method used or by lessons distribution mechanism provided. The experimental dependent variables measurements have been managed in order to acquire accurate results, that is has been done by incorporate fitted time design in all systems , and webcam camera facilitated to capture users response and recording their other any expressions. The outcome reported was positive and the tests accomplished also resulted significant outcomes.
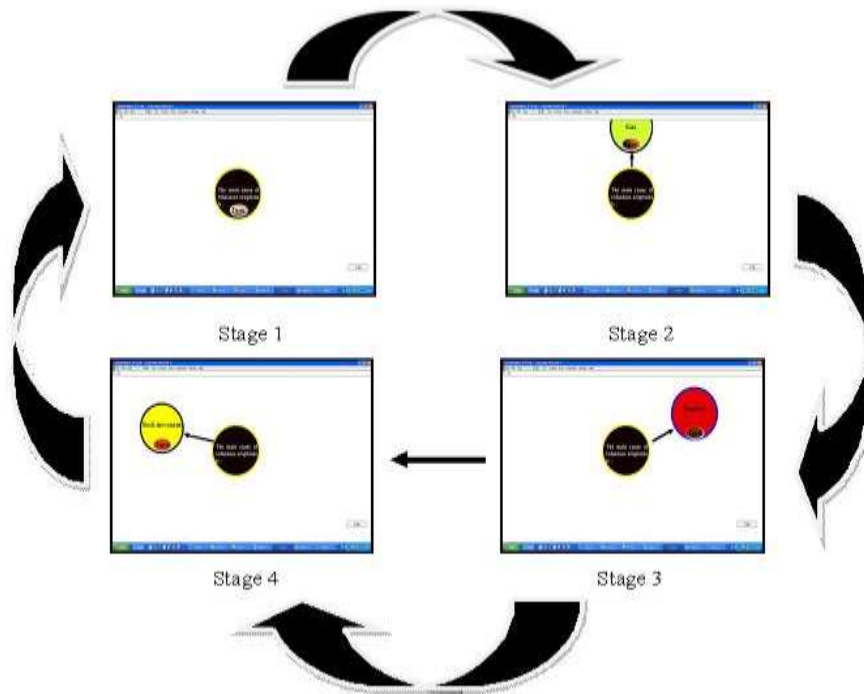
Fig. 1 example of first , second and third game (stage 1) the game when the first question appears (stage 2) the game when the first answer appears (stage 3) the game when the second answer appears and (stage 4) the game when the sixth answer appears.
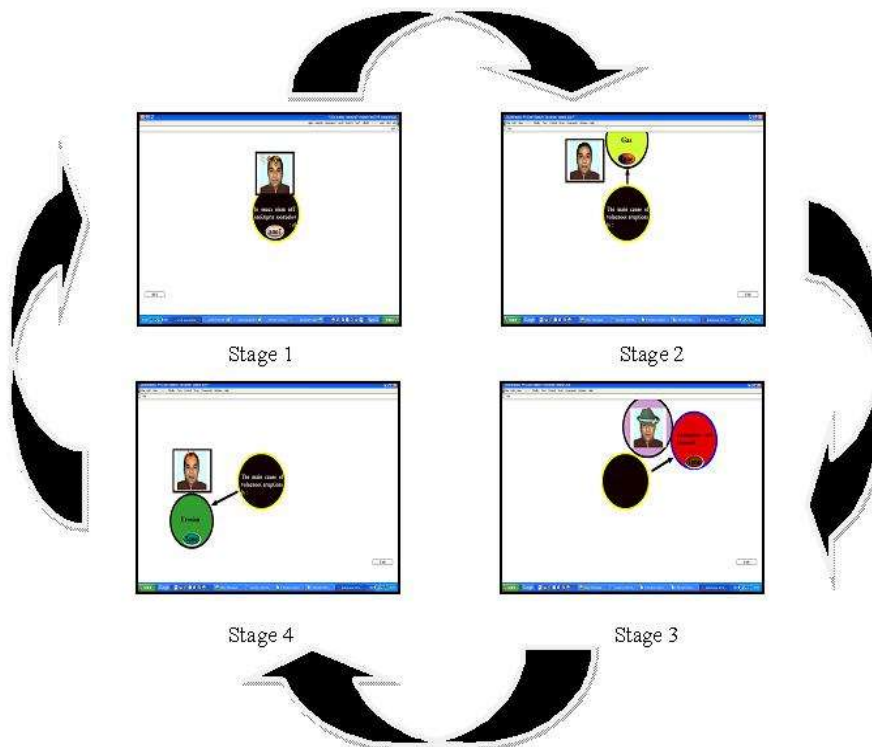

Fig. 2 example of forth game (stage 1) the game when the first question appears (stage 2) the game when the first answer appears (stage 3) the game when the second answer appears and (stage 4) the game when the fifth answer appears.
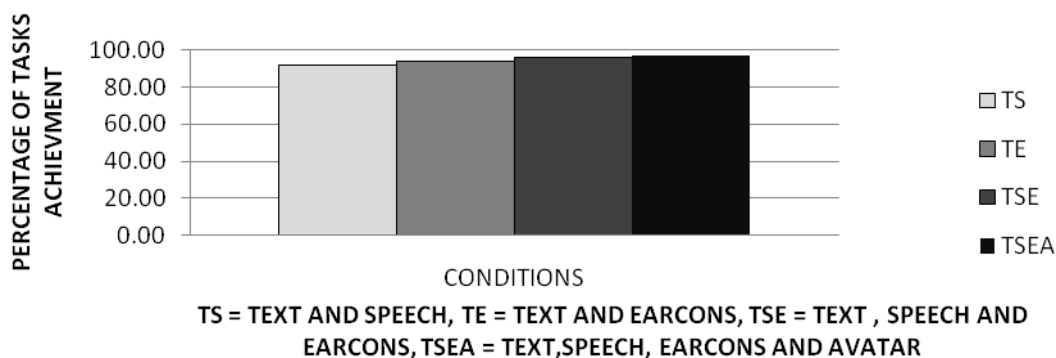
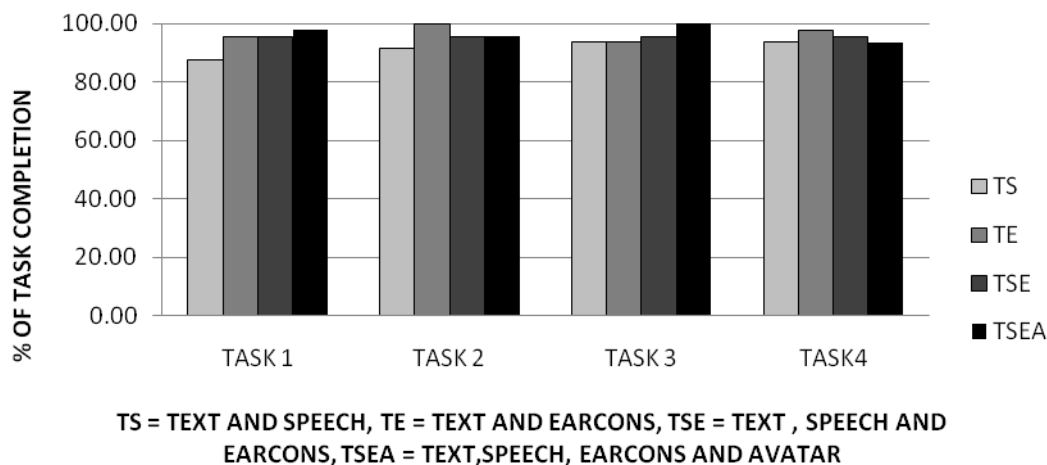Fig. 5 General user achievement for all conditions

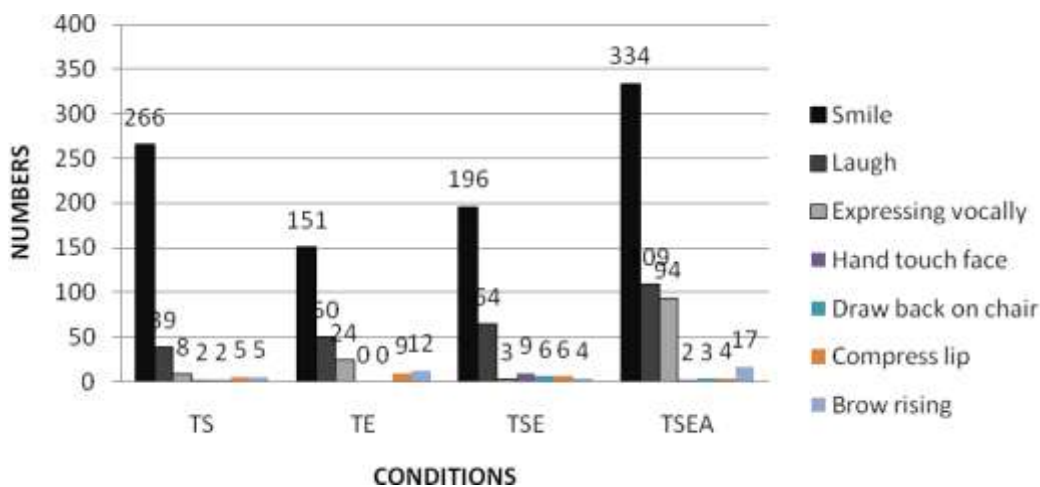Fig. 7 Tasks Achievement for all conditions for each task
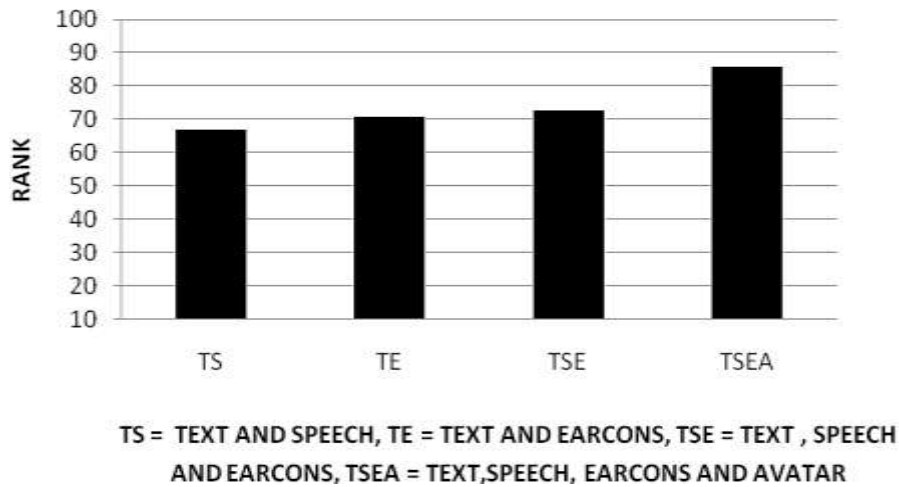

Fig. 8 Number of users reactions

TS = TEXT AND SPEECH, TE = TEXT AND EARCONS, TSE = TEXT , SPEECH
AND EARCONS, TSEA = TEXT,SPEECH, EARCONS AND AVATAR

Fig.6 SUS Scale results

TS = TEXT AND SPEECH, TE = TEXT AND EARCONS, TSE = TEXT , SPEECH
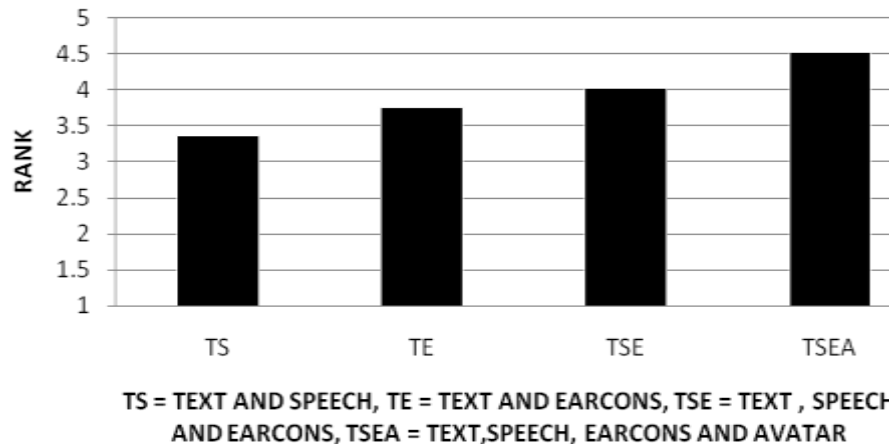AND EARCONS, TSEA = TEXT,SPEECH, EARCONS AND AVATAR

Fig. 7 Normal satisfaction results

Analyzed data collected award us many excellent points to be covered here supported with in depth explanation.   Users tasks achievement progress were elevated; in general there were no big differences of average users' achievement between all conditions, but the TSEA condition gained the highest average measured up to condition TS, TE and TSE.

Respectively in condition TS was 91.67%, condition TE was 93.48%, condition TSE was 95.65% and condition TSEA was 96.73%.

Whereas the users whom completed their tasks without any mistake was in condition TS was 79.17%; TE was 86.96%; TSE was 91.30% and was TSEA 91.30%. In general enhancement is noticeable for the performance of student in condition TSE and TSEA but still in condition TE result is not bad, where in condition TS less valuable. Nevertheless the figure showed also missing data in all experimental platforms which was also respectively 4.35%, 3.26%, 2.17% and 3.26%.

A comparison of SUS scores between all four interface systems, found subjects rated condition TSEA higher than the other conditions. The average score for condition TSEA was 86.12%, condition TSE was 72.83, condition TE was 70.72% and TS was 67.13%.   Moreover the additional statements provided were also higher around 4.52 in condition TSEA, then condition TSE 4.02, condition TE was 3.75 and lastly condition TS 3.37.

The users responses analyzed showed helpful indication of what is users mostly enjoyed. In general users smiled and laughed more in condition TSEA where the avatar is the mean modal used and less scores gained in the other conditions especially in condition TE where the users feeling was bored and in this situation rarely were they smiles and laughs. Condition TSE and TS on the other hand its observations less valuable since there was less enjoyment feature.

Therefore the indication of the results obtained showed that the condition TSEA (The game with test, speech, earcons and

avatars interface) was the The second platform was TSE (The game with test, speech, earcons interface), third position was for TS (The game with test, speech interface) and finally TE (The game with test, earcons interface) was the most undesired platform.

VIII. CONCLUSION

The focus of this experiment was to investigate users' achievement and users satisfaction, where exposed to an edutainment in a multimodal e-learning environment through four different platforms in order to explore deeper the affect of entertainment in cumulative students' enjoyment.

The four "edutainment" environments evaluated here were TSEA (The game with test, speech, earcons and avatars interface), the second platform was TSE (The game with test, speech, earcons interface); third position was for TS (The game with test, speech interface) and finally TE (The game with test, earcons interface). These four interfaces and four lessons are randomly rotated between dependent groups of users. Users' effectiveness and satisfaction results were collected and analysed and Likert five-point scale with 10-items table were also analysed and reported. The experimental results showed that the TSEA (The game with test, speech, earcons and avatars interface) interface outperformed all other interfaces in terms of users' achievement, correctness and satisfaction.

Although all users enjoyed all conditions as power of the game in conveying the learning materials, however users preferred TSEA for the reason that of avatars which incorporated to add the fun elements that get better the user's mode and reduces the stress during playing and increased user satisfaction and enjoyment that assisted in achieving the users' aspirations.

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