ASSESSING THE POTENTIAL OF COLABORATIVE VIDEO-GAMES TO IMPROVE EDUCATION IN LA MIXTECA REGION OF MEXICO

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ABSTRACT

The study presented in this paper shows how collaborative learning games can be used to improve primary education for children aged eight to ten in la Mixteca region of Mexico. We developed a series of three collaborative games to develop mathematics, language and reading skills. Each game uses elements of either Mixtec or Mexican national culture to encourage the children to identify with different sides of their identity. The children were tested before and after playing the games, observed during gaming sessions and interviewed to assess the impact of the games on their learning. Results show that educational video-games can be used to promote learning and team working skills as well as directly achieving learning objectives in mathematics.

1 INTRODUCTION

There are around one million persons of Mixtec origin (Mixtecos) living in the world today. Around 800,000 of these live in la Mixteca, a region of southern Mexico covering northern Oaxaca state as well as parts of western Guerero and southern Puebla. Around 300,000 Mixtecos live in the state of Oaxaca where they form part of a rich cultural tapestry together with large populations of other indigenous peoples such as the Zapotec, Mazateco, Chinanteco and Mixe. In all, around 48% of Oaxaca's population is indigenous, accounting for 53% of the total indigenous population of Mexico [1]. These groups have tended to survive and preserve their native culture better than other communities in Mexico due to the isolating effect of rugged mountainous terrain [2]. Since being conquered by the Spanish in the 16th century the Mixtecos have maintained a strong ethnic identity and many aspects of the mixtec culture, such as craftwork and Mixtec art, are highly visible today. The Mixtec language is also still prevalent, being spoken by around 300,000 people (normally together with Spanish as a first or second language) [3].

Despite the rich cultural heritage and resilience of the Mixtec people, they are currently faced with a variety of serious social and economic challenges. Primary education is particularly problematic with Mixtec municipalities accounting for the majority of the 80% in Oaxaca not adhering to minimum requirements set by the Mexican government [4]. Only 5% of indigenous persons in the state attain a grade beyond primary school level and over 21% of the overall state population is illiterate [4]. These problems can be attributed to a number of factors including low family income [5], disruption of family structures due to high rates of migration [4, 5] and the large percentage of the population that live in remote rural areas [2]. There is also the significant problem that many indigenous teachers have not received formal training [6] and a strong sense that the education system is not properly adapted to best serve the indigenous population. There is strong evidence that indigenous Mesoamerican peoples have a cultural disposition to collaborative learning rather than the traditional directed approach [7] and children from this background may not adapt well to the more authoritarian European-American classroom model [8]. Other factors such as the limited availability supervision and equipment, both in schools and at home, suggest that collaborative learning [9, 10] could be part of a realistic solution to improve the education of indigenous children in the state of Oaxaca.

2 METHODOLOGY

Our experiments to investigate how collaborative video-games might be used in la Mixteca involved six groups of three children aged eight to ten years. Each group spent two hours in total playing three educational videogames. Games were played on a forty-two inch multi-touch screen angled at forty-five degrees and raised between waist and head height to be ergonomically accessible. The children were observed through two-way glass with audio and video recorded throughout the sessions to give us a permanent record of results. The groups consisted of four groups all female and two groups all male.

Each child was tested immediately before, immediately after and four days after their session. The exams used for testing included three five minute sessions testing mathematics, languages and reading. The students were also asked to fill in questionnaires to provide us with more subjective information relating to how they felt about the games and working as a team. In addition to this, observations made during the tests allowed us to assess the dynamics of the

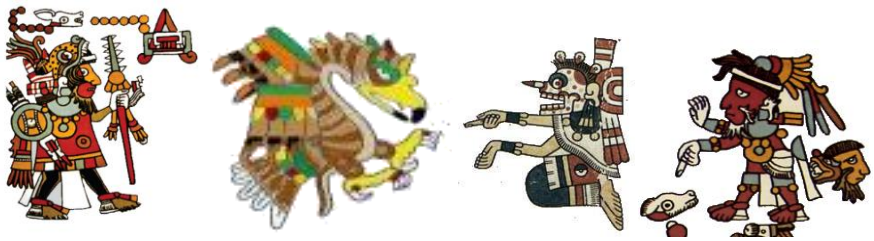

Figure 1: *Mixtec codices used as characters in the mathematics and languages videogames: Jaguar, eagle, muerte and mixteco.*

groups telling us how the students interacted and how collaboration strategies evolved.

3 VIDEOGAME DESIGN

The three educational games developed for our experiment supported the learning of mathematics, languages and reading. In order for the games to be both accessible and challenging for children with different levels of learning, we incorporated a gradually increasing levels of difficulty for each game. Other key aspects of game design were cultural relevance and age appropriateness. Here we tried to ensure that the games were non-violent and did not enforce gender stereotypes while encouraging the children to identify with elements of their native Mixtec and Mexican culture.

Two of the three educational videogames developed for the project (those designed for mathematics and language learning) make use of graphics based on Mixtec codices (see figure 1). Codices are a form of colorful hieroglyphic used by the early Mixtecos to record their history. While these are no longer used today for writing, they remain a strong symbol of Mixtec culture used in logos, books and t-shirt designs. Parts of the costumes seen in the codices are also used in traditional ceremonies and festivals. The codices used in the games are; the jaguar, the eagle, the muerte and the Mixtec man. Muerte can be literally translated as death and the character used in our game represents a dead friend or relative returning to visit the living. To western eyes this might seem as a morbid character to include in a video game for young children but the Mixtecos have a somewhat different attitude to the symbolism surrounding death. Mixtecos consider the 'day of the dead', when the dead are said to return to visit their loved ones, as a happy occasion to be celebrated with bright colors and loud music.

The mathematics game developed for the project (figure 2 left) is a simple 'tower defense' type game where the students have to solve mathematical equations to fire eagles and prevent the muertes from reaching the perimeter wall of their 'tower' and draining their energy. The character of the user, the jaguar, sits at the left hand side of the screen. Below this character is a keypad and to the right a list of sums. To the right of the sums is a vertical wall and beyond the wall are the muertes. Each muerte advances slowly from right to left toward a sum and if a muerte reaches the wall it stops and begins to drain the health of the user. When the health of the user reaches zero the game is over. In order to stop muertes reaching the wall the user can answer sums to fire eagles. The user can press on different sums to answer them using the keypad. If a sum is answered incorrectly health is drained and if a sum is answered correctly an eagle is fired from the wall toward the right hand side of the screen. When a muerte is hit by an eagle it is pushed back

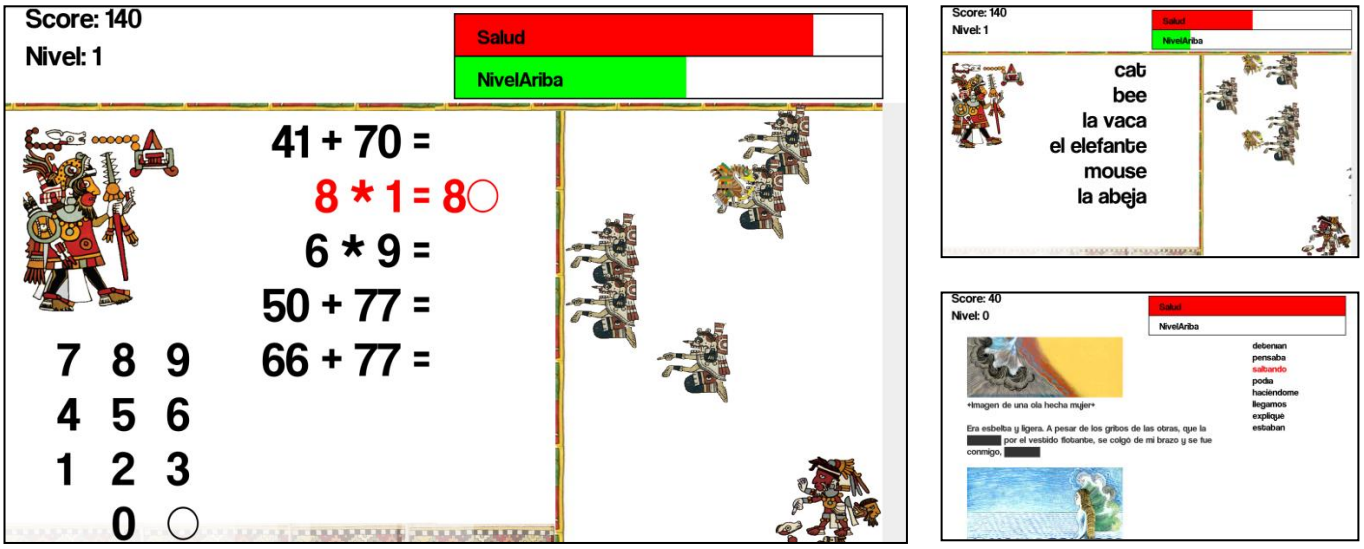

Figure 2. Screenshots of the educational videogames; left mathematics, top right languages and bottom right reading.

away from the wall. Pushing back muertes also adds to the users score and causes the level-up bar to rise. When the level up bar is full, every sum fires an eagle to push all the muertes back and the user progresses to the next level. As the level increases, the muertes begin to speed up and it becomes gradually more difficult to do all the sums on time to keep the muertes away from the wall.

The languages game help students to learn the names of animals in English (figure 2 top right). This game is another 'tower defense' type game similar to that used to learn mathematics described above. However, instead of doing sums to fire eagles the students have to match words in English to their Spanish translations. When words are matched correctly eagles are fired from both words and health is drained when words are matched incorrectly. The game begins with a small number of words for more common animals such as cats and dogs. As the game advances the difficulty level increases with a wider variety of gradually more obscure animal names. If the children are not already familiar with the names of these animals in English, they can normally find the translations out by trial and error and learn from their mistakes.

The reading game (figure 2 bottom right) aims to help the children with reading by asking them to complete a story by replacing missing verbs. Literature and authors are held in particular esteem in Mexico, and Latin America in general, with popular authors often considered as national heroes. This game encourages the children to explore the Mexican national side of their identity by using an adaptation of the short story 'Mi vida con la ola' by Mexican Nobel laureate for literature Octavio Paz.

4 RESULTS

Our experiments provided us with three types of results. Firstly, short exams taken by the students immediately before, immediately after and four days after the experiments allowed us to assess how the games contributed towards specific short-term learning objectives. In addition to these exams, the students were asked to fill in questionnaires to provide us with more subjective information relating to how the students felt about working as a team throughout the sessions. Finally, observations made during the tests allowed us to observe the dynamics of the groups and how strategies evolved during the sessions.

4.1 Exam results

Table 1 summarizes the improvement in the children's performance in the exams after the session with the educational games. Here we can see that the children's performance did not improve significantly, or deteriorated, immediately after their session with the games. This was most likely due to the children being tired and over-stimulated after playing the games for two hours. When the students were tested again, four days after the tests, there was a significant improvement in their performance. This improvement was particularly marked for mathematics where the student's performance showed an increase of 21.9%. The improvement for languages was 4.3% and the students regressed slightly in their reading (by 2.1%). In order to statistically validate our results and account for inter-sample variance we performed a single-tailed t-test. This gave a p-value of 0.016 for the second test to indicate that it was highly likely the children's improvement was due to their exposure to the games rather than variation of the children's scores overall. The p-value for improvement in the mathematics test was 0.0018 indicating a greater probability that the children's improvement was due to their exposure to the games. The p-value for the language test was marginal at 0.20 (0.089 for the boys) indicating that there is insufficient evidence to conclude that exposure to the games caused an improvement in the children's results (using the standard p-value threshold of 0.05). Results also indicate that there is insufficient evidence to conclude that the *drop* in reading performance was due to exposure to the reading game (with a p-value of 0.38).

4.2 Questionnaire results and observations

The questionnaires filled in by students and observations made during the experiments provided us with more subjective information regarding the benefits of our educational games. The first thing we noticed was the short time the children took to learn how to play the games. On average it took around two minutes for the children to develop an understanding of how each game worked. During

		Improvement in performance							
		Immediately after the test				four days after the test			
		Maths	Languages	Reading	All	Maths	Languages	Reading	All
girls	%	10.00%	0.96%	0.00%	3.65%	22.08%	2.56%	1.04%	8.56%
	p-value	0.111	0.421	0.500	0.243	0.012	0.215	0.500	0.393
boys	%	9.17%	-0.64%	-25.00%	-5.49%	21.67%	7.69%	-8.33%	7.01%
	p-value	0.065	0.468	0.005	0.130	0.012	0.089	0.282	0.016
all children	%	9.7%	0.4%	-8.3%	0.6%	21.9%	4.3%	-2.1%	8.0%
	p-value	0.067	0.458	0.148	0.439	0.002	0.198	0.387	0.031

Table 1. Improvement in child performance assessed by exams administered after a session with collaborative educational games.

the following five or ten minutes the children would develop basic game strategies and continue developing these while playing the games. The students also developed collaboration strategies such as coordinated turn taking, task delegation and thinking aloud. In general, the boys tended to prefer the mathematics game while the girls preferred the reading game. The boys and girls also tended to use different strategies for the reading game. The girls would read larger sections of the text aloud, following the story. Boys tended to use a more direct strategy of reading individual sentences and trying to use grammatical rules to choose a word. The boys also tended to be more competitive, celebrate more when an answer was correct, and argue more over whose turn it would be to operate the interface. All of the student groups spent around about equal time playing each of the different games and tended to spend around twenty minutes or half an hour playing a game before moving on to the next. The positive feelings the children had toward the games were reflected both in observed behavior and questionnaire results. At the end of the sessions the children wanted to continue playing even after two hours. In the questionnaires the children told us they enjoyed the gaming sessions and would be very happy to use the games for future learning. The children particularly enjoyed being able to learn together with their fellow students and found the graphical nature of the games stimulating. They recognized the characters from the codices and felt this helped them relate to the games. The story used in the reading game was not familiar to the students but those who followed the text in the session expressed an interest in learning more about the story.

5 CONCLUSION

The results of the evaluation presented in this paper demonstrate the potential of collaborative games to improve the educational experience of children in la Mixteca region of Mexico. To support our study we developed three games incorporating elements from the childrens' native Mixtex and Mexican national culture. These were designed to help children with mathematics, languages and reading. The children played the games during two hour sessions in groups of three.

Evaluating exam scores before and after gaming sessions showed a statistically significant improvement of over 20% in results for mathematics. Results for the languages were positive though not conclusive due to the small sample size and natural variation between student grades. While the exam results did not show an improvement for reading, a number of children involved in the study felt encouraged to develop an interest in the story presented during the game. The games also allowed the children to develop important team working skills and encouraged them to identify with different aspects of their native culture.

As an extension to this initial study we plan to annotate and further analyze recordings of our experiments in order to gain a better understanding of the processes involved when children collaborate to achieve learning objectives. This in turn should help us understand where collaborative learning is most effective and allow us to improve the design of future collaborative learning interfaces.

Acknowledgements

The authors of this paper would like to acknowledge the help of the following persons whose contributions were crucial in realizing the experiments described in this paper. Firstly, we would like to thank the teachers, students and the parents of students at Escuela Primaria Rural Benito Juárez in Acatlima Oaxaca for participating in and facilitating our experiments and tests. We would also like to thank Carlos Martinez and Mario Moreno for helping us to use the excellent UsaLab facility at the Universidad Tecnológica de la Mixteca. Also at the UTM, we would like to thank Rodolfo Palma Guzman and his team at Encargado de Taller de Metal Mécanica for the design and construction of the adjustable large screen display stands used in the experiments.

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