Impact of *Moodle* on the academic performance of eight grade students in Chemistry

Abstract

The aim of this quantitative quasi-experimental study was to determine the effect of using *Moodle,* both inside and outside the classroom, on the academic performance in Chemistry of a non-randomized sample of 46 eighth grade students in an educational institution in Colombia. Results showed that the intervention with the proposed educational technology tool in this particular sociocultural context had a statistically significant positive impact on the academic performance of the students in the experimental group, and that the male students achieved a higher growth in their performance as compared to the female students in the same group.

Keywords: educational technology, academic performance, Moodle, Chemistry, eight grade

1. Introduction

Integration of ICT in the classroom has permeated the different models of teaching and learning, revolutionizing the way students and teachers interact, facilitating the way people communicate, and allowing new dynamics in teaching and learning.

In this scenario, web-based interactive tools are particularly important, supported obviously on the formality and rigor with which the educational community incorporates them, making it possible to transform academic processes (Almenara, 2002). In this particular research, the *Moodle* platform was the technological tool with which the experimental group was intervened in an eighth grade Chemistry course, using it to distribute educational material inside and outside of the classroom since this class met only once a week and there was not a selected textbook, so it became necessary to deepen the potential of this platform and the educational possibilities that it offers to users through its virtual teaching environment which is easy to use and promotes active, constructive, intentional, contextualized, and reflective learning (Llorente, 2007).

Given that the platform was already installed at the institution where the research was conducted, learning objects were built to interact with students and analyze the impact on the academic performance of the experimental group, as compared to the performance of a control group belonging to the same grade level that continued working under the traditional class format that the two groups had before the intervention with the technological tool.

2. Theoretical Framework

2.1. Academic performance

In order to analyze the implications of the academic performance within the context of this research study, it is worth mentioning that there are endless discussions around the definition of the term, as there are a variety of studies debating whether academic performance is the same as academic achievement. Regarding these differences, Delgado, Raul and Palos (2007) and García, Cuevas, Vales and Cruz (2012) citing

González (2002), consider that there are two distinct categories: those who view performance and achievement as synonyms, and those who view them as different terms, so that achievement is listed as a demonstration of performance.

Navarro (2010) and Martínez and Heredia (2010) argue that there is no difference between these terms, cataloging discussion as purely semantic, because on a day-to-day basis, teachers use them as synonymous. However, Navarro (2010) disagrees and claims that it is not possible to limit performance to measurement and evaluation, considering that there may be more factors involved in academic performance and quality of education. Similarly, the aim of addressing this issue is to assess all how much was learned, what the level of learning of was and what skills the student developed in the educational process, or what difficulties arose and what were their causes.

Studies like Zembar and Blume's (2009) on academic performance by gender, quoting Jacobs (2002), show that girls do better in academic performance during middle school, performing better than boys in areas such as language and reading at certain ages, and that beyond 12 years, the area of science is strengthened; likewise, boys in certain age perform better than girls in specific areas. In this sense Vidales (2009) states between ages 14 and 19, girls perform better than boys in areas such as language and reading, while boys are stronger in math and science.

2.2 *Moodle* platform to support the teaching-learning process

Although research on this platform is limited, there are a number of studies relevant to the issue at hand (Martínez and Fernández, 2011; Rubio, García and Millet, 2010; Sánchez, Sánchez and Ramos, 2012; Valenzuela and Pérez, 2013). In a study conducted by Núñez, et. al. (2011), the authors point out to the need of further research on those differences that exist in the personal work of the students, who make some of them more successful than others in their educational process, particularly in the case of *Moodle* tool. Other studies on the subject are summarized by Jaramillo, Castañeda and Pimienta (2009), whose article is a comprehensive compendium of the possibilities of media when implementing new technologies in educational contexts, sharing data on perception and usage such tools.

One of the most relevant articles for the study presented here, in which Llorente (2007) widely evaluates and scrutinizes *Moodle*, highlights the methods and means by which this tool may be implemented and being an open source platform, it emphasizes its nature of "permanent construction" and its possibilities as far as education is concerned.

3. Methodology

3.1. Experimental design

Education, in its continuing effort to discover pedagogical practices that strengthen the teaching-learning process, studies the educational contexts in which students may perform better. Hence, what is sought in the study presented here is to answer the following research question: what are the effects on academic performance of students using *Moodle*, as compared to the performance of those who do not make use of this technological tool?

In particular, this study aimed to assess whether the use of *Moodle* somehow impacted student learning in the Chemistry subject area, both generally and in the light of the gender variable.

The approach used for the study was quantitative, with a quasi-experimental design, and it involved two groups of students from a private school in the municipality of Barrancabermeja in Colombia: an experimental group, on which the independent variable was manipulated, that is, the use of *Moodle* as a support tool, and a control group, which served as a benchmark to identify potential changes that occurred in their performance.

The educational institution where the research was conducted has an evaluation and promotion system of both qualitative and quantitative nature, in which students are considered as promoted starting at the basic performance level, as shown in *Table 1* below.

Table 1. Qualitative and quantitative evaluation and promotion institutional scale

Ministry of Education National Rating Scale (qualitative)	*Institutional* *numerical scale*
Superior performance	6.50 - 7.00
High performance	5.00 - 6.49
Basic performance	4,50 - 4.99
Low performance	1.00 - 4.49

3.2. Population and sample

At the time of the study, the school had a total population of 710 students between 3 and 18 years of age, of which 383 are girls and 327 boys. The sample was selected by convenience and included 46 students, the total enrollment number in two of the eight grade sections, 8B (experimental group) and 8C (control group).

The research was conducted in Chemistry class, since it meets for a 1-hour session per week only and there is no textbook. Participant groups were composed as shown in *Table 2* below:

Table 2. Enrollment and gender distribution in the participant groups

Group	Female	%	Male	%	Total	%
Experimental	12	54.5	10	45.5	22	59
Control	15	62.5	9	37.5	24	41

3.3. Procedure

3.3.1. Educational resources for the eighth grade interactive Chemistry class supported by *Moodle* were planned and designed.

3.3.2. Experimental group was exposed to the interactive materials for an 8-week period, during which the control group continued working under a traditional approach.

3.3.3.The evaluation report was requested to the school's IT department, including the final results of academic performance of the experimental group and control group.

3.3.4. Data was tabulated and relevant statistical tests were conducted to validate the results.

4. Results

The most relevant findings derived from the study are presented and discussed below:

4.1. Comparison of student performance: experimental vs. control group

We will begin the discussion by comparing student performance in the experimental group, which worked with *Moodle,* against student performance in the control group, which worked in a traditional way.

Table 3 below summarizes the results obtained by the participants in the experimental group and the control group, as assessed before and after the intervention period:

Table 3. Student performance of the participants before and after the treatment

Grades	Group *N*	Mean	Median	Mode	*Standard deviation*
Pre-treatment grades	experimental	6.3509	6.4800	6.9600	0.5413
Post-treatment grades	N=22	6.759	6.800	7.000	0.276
Difference		.4082	0.2750	.7500	0.5097
Pre-treatment grades	control	5.871	5.990	6.200	0.6126
Post-treatment grades	24	5.841	5.750	5.500	0.4510
Difference		0.030	0.1650	-0.2300	0.4984

Table 4 below shows the result of Student's t-test for independent samples, the experimental group compared to the control group.

Table 4. Student's t-test for independent samples, experimental vs. control group

	Independent Samples Test						
	Levene test		*t-test for equality of means*				
Post-treatment grades	*F*	*Sig.*	*T*	*gl*	*Sig. (bilateral)*	*Mean Diff.*	*Diff. standard error*
Equal variances	9.602	.003	8.367	44	.000	.91742	.10964
Unequal variances			8.558	37.131	.000	.91742	.10720

Comparing the two groups based on the mean of the post-treatment grades, we can see in Table 4 that both the Levene test (F) and the t-test resulted in a statistically significant

difference in the student performance of the experimental group over the control group (t = 8.367, gl = 44, p = .000> 0.05).

Figure 1 shows the means of the student grades in the experimental group and control groups both before and after the treatment, in order to visualize the extent in which these variations occurred.

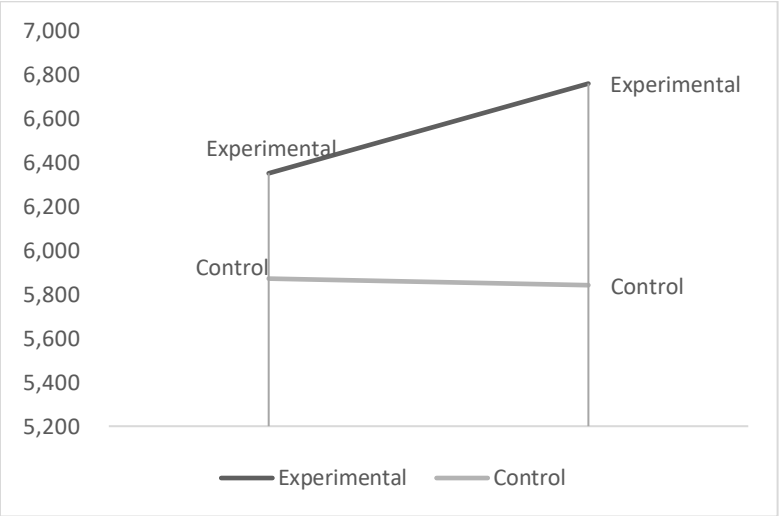

Figure 1. Comparative means in the experimental and control group

Regarding the behavior of the grades in the groups, it can be added that before the treatment, the difference between means was 8.16%. However when comparing the means after the intervention with *Moodle*, the difference was 15.70%, which is equivalent to a variation of 48%. Most importantly, students in the control group showed a decrement of 0.51%, in their performance before and after the 8-week period, which is insignificant when compared to the difference that occurred between the means after the treatment.

4.2. Analysis of the results within the experimental group

Table 5 below summarizes the academic results of the students in the experimental group before and after the treatment:

Table 5. Student grades in the experimental group

Grades in experimental group	Pre-treatment	Post-treatment	Variation
Mean	6.3509	6.7591	.4081
Median	6.4800	6.800	.2750
Mode	6.9600	7.00	.7500
Standard deviation	.54133	.2575	-.2837

Apparently and at first sight, there are no significant differences in the group's performance before and after intervention with *Moodle*. However, in order to validate the accuracy of

this observation, a Student's t-test was performed and the results are shown in Table 6 below:

Table 6. Student's t-test for related samples - experimental group

	paired differences							
				95% confidence interval				
Grades	*Mean*	Std. Dev.	*Std. error*	*lower*	*top*	*T*	*gl.*	*Sig. (bilateral)*
Pre- and Post-treatment	.40818	.50968	.10866	.18220	.63416	3.756	21	.001

Based on the data above, it may be inferred that overall the use of the *Moodle* tool effectively resulted in significant differences between the two means in the experimental group (t = 3.756, df = 21, p = 0.001 <0.05). As it can be seen in Figure 3 below, the mean of the grades in the experimental group after the treatment, is greater than the mean of the same group before integrating *Moodle* into the classroom, although the group in general terms already had a good average.

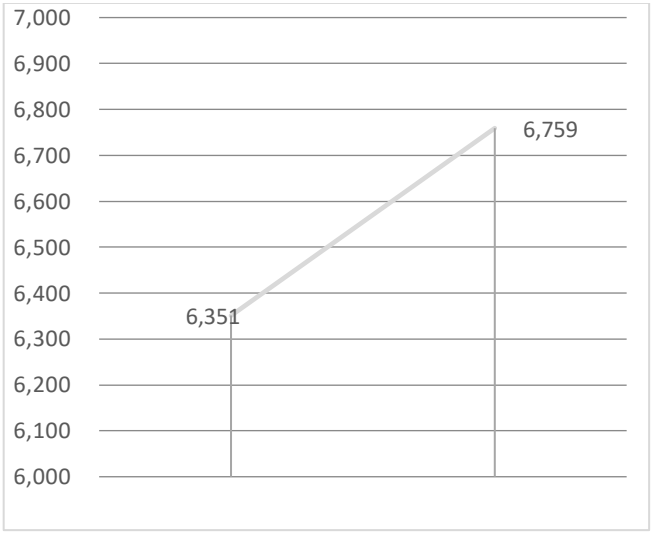

Figure 3. Student performance in experimental group, pre- and post-treatment

4.3. Analysis of student performance by gender in the experimental group

Given that the institution where the study was conducted is co-ed, it was considered important to identify whether any differences in student performance were observed considering student gender as a variable in the analysis. Table 7 below shows the results of the experimental group by gender:

Table 7. Results of the experimental group by gender

Grades	*Gender N*	Mean	Median	Mode	*Standard deviation*
Pre-treatment	female	6.5483	6.700	6.960	0.4552
Post-treatment	N=12	6.8000	6.900	7.000	0.2412
Difference		0.2516	0.200	0.040	-0.2140
Pre-treatment	male	6.1140	6.065	NA	0.5622
Post-treatment	N=10	6.7100	6.700	7.000	0.2806
Difference		0.5960	0.635	NA	- 0.2815

Following the same order of analysis used for the overall results in the experimental group, Table 8 below details the results for female participants:

Table 8. Student's t-test for paired samples, female students in the experimental group

	paired differences							
				95% confidence interval				
Ratings	*Mean*	*Std. Dev.*	*Std. Error*	*lower*	*top*	*T*	*gl.*	*Sig. (bilateral)*
Pre- and Post-treatment	.25167	.49594	.14317	-.06344	.56677	1.758	11	.107

According to Table 8, there is no evidence that suggests that use of *Moodle* resulted in a significant difference among female students (t = 1.758, df = 11, p = 107> 0.05). Therefore, it can be inferred that the changes that occurred between the means are more probably attributable to individual student differences, rather than to the use of *Moodle*.

Note also that according to the data in Table 7, female students achieved a decrease in the standard deviation of 47%, which shows that the group had greater homogeneity in their grades, although once again this cannot be attributed to the intervention of the class with *Moodle*.

Proceeding with the analysis of the results of the experimental group in the light of the gender variable, Table 9 below shows the results obtained by the male students:

Table 9. Student's t-test for paired samples, male students in the experimental group

	paired differences							
				95% confidence interval				
Grades	*Mean*	*Std. Dev.*	*Std. Error*	*lower*	*top*	*T*	*gl.*	*Sig. (bilateral)*
Pre- and post-treatment	-.5960	.48340	.15286	.25050	9.4180	3.899	9	.004

By analyzing the results of the t-test in Table 9 (t = 3.899, df = 9, p =. 004> 0.05), it can be seen that the performance of male students significantly improved when *Moodle* was included in the classroom.

Moreover, as it can be seen in Table 7, the group of male students managed to decrease its standard deviation by 50%, showing that the group was less dispersed and their grades were closer to the average of the group who received the technology-based treatment, and even outperforming the female student group that achieved a 47%.

It was also found that when comparing the average of the male students with the average of the female students, male students had narrowed the difference in grades they had before the treatment, which was 7% to 1% after the group was intervened with *Moodle*.

Finally, the results of the female students were compared to the results of the male students as independent groups to verify if there was actually an improvement in their performance after using *Moodle*. For this purpose, a Student's t-test for independent samples was used and the results are shown in Table 10 below:

Table 10. Student's t-test for independent samples, male vs. female students in the experimental group

	Independent Samples Test.						
Post-treatment grades	*F*	*Sig.*	*T*	*gl*	*Sig. (bilateral)*	*Diff. means*	*Diff. Std. error*
Equal variances	1.118	.303	.809	20	.428	.09000	.11120
Unequal variances			.798	17.930	.435	.09000	.11281

As it can be seen in Table 10, results of the F-test and t-test indicate that the variation between means is not statistically significant, so it can be concluded that when considering the two groups (male and female students) independently, the sample is not large enough to demonstrate the improvement in the performance that occurred in the experimental group as a whole.

5. Conclusions

Although findings derived from this study are satisfactory, it is important to consider the opinion of Almenara (2005) who, regarding the mediation of technology in education, claims that these are only means in the educational process and making it clear that by themselves, they do not generate any type of learning, emphasizing the role of the teacher in the teaching-learning process of students.

Another relevant finding in the study was taking into account the gender variable in the experimental group, where it was found that although girls were academically stronger than boys before and after the intervention with *Moodle*, the boys managed to take more advantage of the technological tool, as they greatly reduced the gap they had against the girls before the investigation.

As it is evident from the various investigations around technology's impact on student performance, it is advisable to consider extending the time of the treatment as much as possible to be able to collect more data and assess technology effects over time, ruling out any false results derived from novelty; but also so that other qualitative aspects beyond quantitative performance can be measured, such as detecting any student skills that are strengthened and the teacher's role when *Moodle* is used.

Finally, this was a study with its own limitations and constraints that took place in a specific educational context, and as such, its findings might not be generalized. However, the researchers hope that it serves as reference for other educators to further the research on the impact of technology in the teaching-learning process, both overall and in light of the gender variable, and that innovative educational strategies that strengthen student learning and therefore an improvement in their academic performance may emerg as a result.

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