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Exploring the Influence of Facial Verification Software on Student Academic Performance in Online Learning Environments*

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In spite of the advances in technology in the e-learning field during the last decades, there is still a gap of software and tools that actually improve the assessment of this kind of education by preventing students from cheating when they perform their activities online. Currently, most learning management systems do not offer enough tools or characteristics to check that students are who they assure when they carry out their exercises or online tests.

Facial verification software can be considered an interesting tool to answer this need. This facial software helps to verify the identity of the students when they perform their activities, with the intention of confirming whether they are who they claim to be. However, its use could modify the academic results of the students due to psychological factors (e.g., they could feel spied, ashamed or too controlled).

The aim of this article is to investigate whether the utilization of facial verification software can modify the academic performance of students in their online activities. In this work, the grades of 70 master students were analyzed and the conclusions pointed out that the academic performance obtained by the students is similar for both groups: those who have used facial authentication and those who did not use it.

Keywords: e-learning; glossary; test; Moodle; facial authentication; online learning; academic performance

1. Introduction

In recent years, virtual campuses of e-learning [1] have spread all over the globe, gaining ground against face-to-face education. Nevertheless, the comparison of different Learning Management Systems (LMS) enable to conclude that they have some limitations that do not permit a totally real student evaluation and one of them is the lack of appropriate mechanisms to avoid tricks that students may use in the activities [2, 3].

Thanks to biometrics [4], especially facial verification, there is a possibility of verification of absence or tricks while the students perform their tasks in LMS environments.

Jain et al. [5] indicate that biometrics is a method used in order to recognize people based on physiological or behavioral characteristics. Farshchi et al. [6] use facial authentication in e-learning to verify dearth of ruses while the students do their activities in the platform. The first step in facial authentication is the acquisition of a real image: the system determines the face alignment over the nose position, the mouth, and so on and so forth; after this, the system generates an only facial template that may be compared to the photographs of the student that the university stores in its database. As Ribaric et al. [7] affirm, face-based authentication belongs to a system that permits the identification and/or verification of a human being as well as the morphological and behavioral characteristics of each individual.

The main goal of this work is to demonstrate that this technique of facial verification in e-learning will not imply a drop of the students' academic achievement in their activities. In other words, students' grades should not decrease because of using facial verification software in their tasks. For that, an experimental trial was carried through with students at the Madrid Open University (UDIMA) in two specific Moodle tools [8].

The remainder of this article is organized as follows: the next section introduces the background research related to the current work, mentioning the improvements over the existing literature; section 3 presents the method to test the influence of facial authentication software on students' academic performance and introduces the software that has been used for this purpose; section 4 presents the analysis of the results, extracting the most relevant facts that need to be taken into account related to academic performance of students; section 5 discusses the main results of the current work; and section 6 mentions the conclusions and future research.

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2. Related works

This section provides a review of the relevant literature that is related to academic performance of students and facial recognition applied to education.

Focusing on the Moodle platform, there are different scientific works related to the student learning achievement. Núñez et al. [9] carried through a project in which their main objective was to provide students with a group of strategies that enable them to tackle the learning processes more competently and with autonomy. The program was implemented in the Moodle and the design used was quasi-experimental, with an experimental group (n = 167) and a control group (n = 206). The data obtained revealed that students who participated in the training program, compared to their partners from the control group, got statistically significant improvements in academic achievement.

Using a similar approach, Minocha et al. [10] states that the integration of tools such as wikis, blogs, web pages and teamwork improves students' productivity and efficiency. Furthermore, the authors indicate that the use of collaborative tools will provide students experiences and the development of transferable skills to be able to work with tools 2.0.

According to Xiao et al. [11] the popularity and growth of the online education is in line with the rise of students' dishonesty and cheating in the open and virtual environment of e-learning courses. These authors investigate and compare current possible techniques and solutions for authenticating distance learning student and/or their work remotely for the e-learning programmes: Proctored examination (human or automated supervision of examinations), user identifier and password, biometrics (finger print, face recognition, voice recognition, or signature recognition), challenge questions or commercial products like ProctorU [12], Secure exam Remote Proctor [13], BioPen [14] and Kryterion Webassessor [15]. They propose a mixed solution that will be integrated into Moodle.

In the same line, Gil et al. [16] proposed the combination of traditional authentication (password and username) with biometric technology, specifically fingerprint authentication. They describe the changes that are necessary to introduce in the learning management system in order to use the fingerprint as data in the process of authentication.

On one hand, the previous works do not study whether the authentication methods modify the academic results of the students. One of the reasons of this drop in academic achievements could be psychological aspects (e.g., they could feel spied, ashamed or too controlled). In this sense, Stupnisky et al. [17] present a work that confirms that students' academic achievement may decrease when students feel too controlled. This demonstrates the importance for the students to not feel too controlled by control mechanisms. It is important to highlight that this aspect will be considered in the present work.

On the other hand, automatic facial verification with computers is an area of investigation in full development. Identifying a person through a face image implies the emulation of the cognitive process that human beings realize when they recognize their pairs. Different investigations have been carried through about this discipline applied to education. For example, Agulla et al. [18] accomplish an investigation with a facial authentication software called Bio Tracker in e-learning in order to ensure that the students online are really who they say, and to know the amount of time spent in front of the laptop doing their online tasks.

In addition, Ullah et al. [19] suggest a mechanism of facial verification to ensure that students are not impersonated in order to improve their grades in virtual tests. It is suggested the use of a framework of authentication based on profiles (called PBAF) together with a user's identification and the password demanded during the distance examinations for the recognition of the students.

Web-based e-learning is different from the learning in traditional classrooms, where teachers take the course of the class. In this sense, Chen [20] thinks that the recognition of facial expressions can be used in order to understand student feelings during the learning process and, therefore, evaluate the learning attention. This study used video capture for facial verification in order to detect automatically facial expressions of the students to analyze their emotional development and human states during the learning process, trying to determine the degree of attention paid to learn and to provide the appropriate assistance and stimulation for the educational benefits of e-learning. Kuo et al. [21] focused on the behavior and the achievement of asynchronous learning through a system of facial verification to explore the students' conduct. The conclusions of this study showed that: (1) The satisfaction and participation of students in distance learning were high; (2) male subjects log more often in distance learning websites than female; and (3) subjects above 40 years old log in the morning more often than students from 30 to 39 years of age. In this same line of work, Riveron et al. [22] tried to determine the distinctive features of facial authentication of feeling in students of the third year of the degree in Psychology at the Central

University of Las Villas. They used a sample of 35 subjects, aged from 20 to 23. This study generated as main results: positive emotions (i.e., happiness) and neutral emotions (i.e., surprise) and negative feelings (i.e., contempt, anger, disgust, fear and sadness).

It is important to note that these works do not analyze whether there is any variation in academic results when facial verification software is incorporated. If students feel spied or ashamed they could develop their activities under non-optimal conditions and their academic achievement could vary as well. Thus, the main goal of this work is to analyze the repercussion on the academic achievement of the students when using facial authentication software into an e-learning system.

3. Method

This work is based on authentication in e-learning within Moodle platform, through facial recognition software. In this way, the teachers could verify the identity of who is doing each activity, and if the students perform activities in groups with friends or relatives. When authenticating students' identities, it is expected to know if the academic achievement of each of them changes when authentication software is used; because, the students may feel spied or ashamed and their grades may decrease, or on the contrary they feel comfortable and their grades stay similar.

The students used two Moodle activity tools: (1) test, which consist of a set of questions randomly chosen from a large set to self assess from a certain part of the syllabus; and (2) glossaries where students had to carry out the setting out of two entries for each concept chosen by them. Both of them are very common and useful tools (see for instance the work of Hirschel [23]).

Data were collected in two groups of 35 students each one (i.e., control group/experimental group) for tests activities and two groups of 25 students each one for glossaries activities. In the first group (experimental) facial authentication software was implemented, while in the second group (control) this software was not implemented. Afterwards, the data was gathered, analyzed and compared in order to obtain conclusions and results to know if this software harms or helps the student performance.

The program used to compare student's face with the existing database of students is called SMOWL [24]. This is aimed at companies that demand high security levels, such as financial companies, but also other sectors such as online education where it is essential to check the identity of the user in order to avoid frauds in the obtaining of educational degrees. This software has been implemented as a plugin that it can be installed on the Moodle platform.

The authentication service starts just after the user begins a session and without any trouble for them. During the time the facial authentication system can follow the user; all the biometrical information captured is stored in the user record. The authentication results will lead to a report which is updated constantly with information about each student. The captured images have an exclusive barcode given by the university for each student. In other words, the program will have the resulting report at the university's disposal, not the pictures of the students. The Fig. 1 shows the SMOWL control board, where the instructor can observe the tracking of the students.

The Fig. 1 shows how from the 30 images that the software took of each student, 66.67% of these were the correct user. Regarding the images that do not pass the test, SMOWL classifies the different stages, such as (1) the user denied the permission to activate the webcam, (2) the webcam was covered or does not work properly, (3) there were several people and none of them was the correct user, (4) the correct user was accompanied one or several people, (5) the person from the picture is not the user who he/she says, (6) there were no people in front of the screen, and (7) the system has correctly identified the user.

Design and sample. The research was carried out with a non-probabilistic sample of 70 students for tests and 50 students for glossaries, in the first semester of the academic year 2013/2014 at the UDIMA. The students are enrolled in two courses of the Master of Education and New Technologies in the Department of Computer Science. The stu-

T_M05_2013	WebCam rejected		WebCam on but covered		+ one person: none the correct user		+ one person: one is the correct user		Another person		Nobody in front of the screen		Correct user	
Total	0	0%	0	0%	0	0%	0	0%	2	6.67%	8	26.67%	20	66.67%
1	0	0%	0	0%	0	0%	0	0%	2	6.9%	7	24.14%	20	68.97%
2	0	0%	0	0%	0	0%	0	0%	0	0%	1	100%	0	0%

Fig. 1. SMOWL control board of one student.

Table 1. Average ages in groups A and B

Moodle activity	Group A	Group B
Test	36.1	31.9
Glossary	34.4	32.8

dents are assigned to two groups: A and B. The group A is designed as the control group (students without experience with SMOWL), whilst the group B is used as the experimental group (students with experience with SMOWL). As the groups were not divided at random the design is quasi-experimental. Table 1 shows the averages of each group.

Data analysis. In order to carry through the analysis of the data obtained, we divided the analysis into three steps: descriptive analysis, normality test, and hypothesis testing. In the first step we analyzed the mean, median, mode, and standard deviation of each sample. Also, this descriptive information is enriched with a box-plot diagram. In the next step, a Kolmogorov-Smirnov test and histogram are performed in order to test the normality. The third step consists of designing the hypothesis. In this study, we used the following hypotheses: H0: there are not statistical differences between grades of the group A and B; and H1: the grades of group A are statistically different to the grades of the group B.

4. Results

The descriptive analysis of both groups is showed in the Table 2. This table exhibits the mean, median, mode, and standard deviation of student grades for test and glossary activities. For example, the average of grades for test in group A is 8.95, whilst for the group B is 9.31. It is important to note that grades are ranged from 0 to 10 according to the Spanish Education System (students pass the course if their grades are greater than or equal to 5). The most repeated grade for the group A is 9, while for the group B is 10. This fact could indicate that probably the group B obtained better grades than group A in both activities. Apparently, this table shows a slightly increase of student performance in group B. This could indicate that not just the use of facial recognition software could harm student performance, but it could help raising it.

In addition, box-plot diagrams were obtained with IBM-SPSS 20. The Fig. 2 shows four box-plot diagrams for grades of test and glossary activities. On the left side of this figure it is shown two box-plot diagrams for test grades of groups A and B. There is a possible outlier for the group A. The grade of this student was 0.0, which means that this student did not finish the test activity. As this observation could indicate a drop in student performance, we do not remove this observation from the data. The right side of Fig. 2 shows that all students of group B passed the course. This fact also could indicate that facial recognition software could favor the attention of students, so that they could increase their grades. In addition, it is observed that the means of academic scores increase more than a third of point for both tests and glossaries when using the facial authentication software.

Table 2. Descriptive statistical data of experimental (group B) and control group (group A)

	Group A				Group B			
Moodle activity	Mean	Median	Mode	Standard deviation	Mean	Median	Mode	Standard deviation
Test (n = 70)	8.95	9.17	9	1.773	9.31	9.59	10	0.863
Glossary (n = 50)	7.67	8.00	9	1.699	8.42	8.70	10	1.501

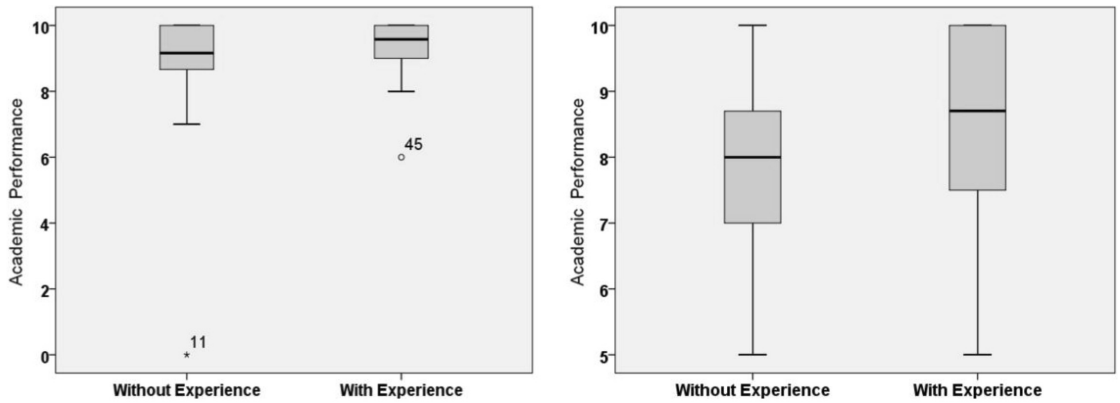

Fig. 2. Box-plot for groups A and B in test and glossary grades.

Table 3. Normality test for the group A and B in test and glossary grades

	Normality test (Kolmogorov-Smirnov)	
Moodle activity	**Control group**	**Experimental group**
Test	0.000	0.000
Glossary	0.070	0.181

The Kolmogorov-Smirnov test shows that the normality test fails in test grades (0.05 significance level), but glossary grades pass this test in both groups (Table 3). Thus, the distribution for glossary grades follows a Gaussian distribution.

Since only glossary grades passed the normality test, we divided the hypothesis testing in two parts: hypothesis testing for test grades, and hypothesis testing for glossary grades.

(a) Hypothesis testing for the test grades

Due to the sample size and the previous results, the Mann-Whitney non-parametric test is considered appropriate to test the hypothesis H0. The results of this test are shown in the Table 4. This table includes: (1) the column titled ''Difference among the means'' which refers to the difference between the experimental group and the control group; and (2) the results of the nonparametric Mann-Whitney U test including the levels of significance, Test statistics and their corresponding decisions.

It is observed that Mann-Whitney U test maintains the null hypothesis (H0). Thus, there are not significant differences between the two groups; the academic grades from both groups of students are similar. This result suggests that students who are monitored by the facial authentication software while they perform the test activities obtain similar grades as the students who are not monitored.

(b) Hypothesis testing for the glossary grades

Since normality assumption is accepted, a T-Student test is performed. Table 5 exhibits the results of T-Student test. It is observed that there is not any evidence to reject the H0. Thus, the recognition software does not have significant influence in student academic performance of the glossary activities.

Table 5 shows the value of statistical t = –1.641 and its p-value 0.107. Therefore, hypothesis of measure equality cannot be avoided. In addition, T-Student test provides the confidence interval which involves the mean difference in order to be able to accept the null hypothesis. This shows the difference that will be valued between –1.656 and 0.168, resulting a difference of –0.744 between them, and this value is within the bounds of the confidence interval. Hence, it is accepted that means of both samples do not present significant differences.

5. Discussions

The main conclusion of this study is that the academic achievement of students who used SMOWL has not significantly decreased, as the non-parametric test and the parametric test have shown. In this manner, this control mechanism of facial authentication allows instructors to identify the students without interfering negatively with their academic performance.

As it is observed in these statistical analyses and as Phipps et al. [25] mentioned when surveying some works in education, the results of learning obtained with the new information and communication technologies are similar to those got by traditional education. From the analysis of the current research, we have been able to check that the use of authentication software did not influence significantly the students' results of learning in the glossaries and tests activities.

Moreover, it is also observed that the two groups of students obtained better results in tests activities than glossaries activities. The reason might be that when students perform a test they can easier select an answer from a multiple choice, whilst in glos-

Table 4. Mann-Whitney test for the test grades

	Difference among the means			Mann - Whitney U Test	
Moodle activity	**Medians**	**Means**	**(sig.)**	**Test statistics**	**Decision**
Test	0.42	0.36	0.629	573.000	Retain the null hypothesis

Table 5. T-Student test for the glossary grades

T-test for Equality of Means						
					95% Confidence Interval of the Difference	
T	**df**	**p-value**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
–1.641	48	0.107	–0.744	0.453	–1.656	0.168

saries activities they need to develop their own descriptive answers.

A limitation of the current work is that cheating is only detected from the images captured by the webcam, but it cannot capture the whole environment. For example, a person could assist the student from behind the laptop, without being detected. It is planned to improve the current approach by including another camera besides the webcam, in order to cover the whole environment of student while doing his/her activities.

6. Conclusions and future work

This work has analyzed whether the use of the facial authentication has impact in the academic performance of the students at the UDIMA. In this sense, this work briefly explained the SMOWL authentication software. This work compares the grades of two groups of students, in which only one of them used SMOWL. The statistical analysis of the results shows that SMOWL does not significantly affect the academic performance of students.

This study has an impact on the way facial authentication technology is applied because distance education can be improved mainly for two reasons: (1) it helps to verify the identity of the students in order to avoid frauds, and (2) its use does not cause drops in academic achievement of students.

Hence, this type of facial recognition tools opens up a prospect of possibilities to contribute the virtual and learning environments, since they face one of its biggest difficulties: the authentication of the user that take part in them. There are several open challenges, such as the possibility that the student does their tasks in pairs or groups being one of them out of SMOWL vision. In these cases, the software may not detect some frauds.

Despite these open challenges, the use of biometrics methods during authentication and monitoring of the face provided some additional help to validate academic performance of the student during learning lessons. SMOWL assists instructors in identifying those who commit fraud when they do their tasks. Therefore, the quality and prestige of certificates of distance-education universities may increase when monitoring students with facial software, since the amount of frauds will be probably reduced.

This research is planned to be extended by analyzing and comparing the students' academic data by using other Moodle activity tools, such as forums, workshops, wikis or lessons. The goal of this future work would be to know whether the academic achievements of students are similar using these activity tools. Moreover, these experiments are planned to be enhanced with more courses and lecturers to corroborate the results of the current experience.

Furthermore, the current work can be extended towards other educational stages, for example, in secondary education or in on-site courses at the university. In this way, the data obtained would be compared and contrasted with the data from this investigation (i.e., students from online universities).

Generally, the investigation developed could have a satisfactory repercussion in other educational contexts, because it has been proved that the use of tools of facial authentication do not harm education, and may guarantee the real identity of students. Therefore, these procedures could be extrapolated to blended learning or for the realization of homework outside the classroom in face-to-face education.

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