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Evaluación de usabilidad a través del seguidor ocular, EUS y CSUQ en plataforma educativa

Evaluation of usability with eye tracking, SUS and CSUQ in educational platform

Avaliação de usabilidade através do rastreador de olho, EUS e CSUQ em plataforma educacional

María Isolde Hedlefs Aguilar
Facultad de Ingeniería Mecánica y Eléctrica, Universidad Autónoma de Nuevo León, México
lab.cognitive@gmail.com

Resumen

Se evaluó la usabilidad de una plataforma educativa (NEXUS, www.nexus.uanl.mx/) por medio de la Escala de Usabilidad del Sistema (EUS), el Cuestionario de Usabilidad de Sistemas informáticos (CSUQ) y el seguidor ocular. La muestra se conformó de 29 participantes con una media de edad de 22.5 años. Primero se aplicó el estudio con el seguidor ocular, este consistió en buscar la actividad en la plataforma NEXUS que se le indico al principio; cuando localizaba la tarea, el participante tenía que cargar el archivo a la plataforma NEXUS que previamente se le había informado donde estaba localizado el archivo en la computadora y, por último, tenía que cerrar su sesión de la plataforma NEXUS; terminando con el seguidor ocular se le aplicó el EUS y el CSUQ en línea por medio de la plataforma Google Forms. Se obtuvo en el CSUQ un puntaje de 5, donde los participantes se encontraron algo satisfechos con la plataforma NEXUS, mientras que en el EUS se obtuvo un puntaje de 65.51, lo cual significa que la plataforma NEXUS no cuenta con un nivel adecuado de usabilidad. Por último, en el seguidor ocular, a través de los mapas de zonas ciegas, se pudo observar detalladamente como los participantes van directo a lo que necesitan y no ven el resto de la interfaz a menos que no encuentren la manera de llevar a cabo la actividad, también por medio del seguidor ocular se pudo observar que 16 de los 29 participantes tuvieron problemas con localizar la actividad y 6 de los 29 participantes no localizaron el icono

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correcto para cerrar sesión de la plataforma NEXUS. Se concluye que es mejor utilizar el seguidor ocular en conjunto con los cuestionarios para evaluar la usabilidad de una interfaz, con la finalidad de obtener mayor información de cómo el usuario interactúa con la interfaz y, por lo tanto, poder realizar análisis más detallado y tratar de entender por qué el participante dio esos puntajes en los cuestionarios de usabilidad a la interfaz.

Palabras claves: CSUQ, EUS, plataforma educativa, seguidor ocular, usabilidad.

Abstract

The usability of an educational platform (NEXUS www.nexus.uanl.mx/) was evaluated through System Usability Scale (EUS), the Computer Systems Usability Questionnaire (CSUQ) and an eye tracking. The sample was conformed of 29 participants with an average of age of 22.5 years. First, the study moved along with the eye tracking, which was consisting of looking for the activity where they had to upload a file to his NEXUS's account; then, the eye tracking follower was applied SUS and CSUQ online through the Google Forms platform. A score of 5 was obtained in the CSUQ, where the participants found something satisfied with NEXUS platform, while in the EUS was obtained a score of 65.51, which means that the NEXUS platform does not have an adequate level of usability. Finally, in the eye tracker through maps of blind zones, is observed in detail how the participants will direct what they need and they do not see the rest of the interface unless they are not the way to carry out the activity; also, through of the eye tracker noted that 16 of the 29 participants had problems with locating activity, and 6 of the 29 participants not located the correct icon to log out of the NEXUS platform. It is concluded that it is better to use the eye tracking in conjunction with the questionnaires to evaluate the usability of an interface to obtain more information on how the user interacts with the interface and, therefore, be able to perform a more detailed analysis of the interface and to know why those scores in the usability questionnaires were obtained.

Keywords: CSUQ, SUS, educational platform, eye tracking, usability.

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Resumo

A usabilidade de uma plataforma educacional (NEXUS, www.nexus.uanl.mx/) foi avaliada através da Escala de Usabilidade do Sistema (EUS), do Questionário de Usabilidade de Sistemas de Computador (CSUQ) e do seguidor de olho. A amostra consistiu de 29 participantes com idade média de 22,5 anos. Primeiro, o estudo foi aplicado com o seguidor do olho, isto consistiu em procurar a atividade na plataforma NEXUS que foi indicada no início; Ao localizar a tarefa, o participante teve que carregar o arquivo para a plataforma NEXUS que já havia sido informado onde o arquivo estava localizado no computador e, finalmente, teve que fechar a sessão da plataforma NEXUS; terminando com o seguidor do olho, o EUS e o CSUQ foram aplicados on-line através da plataforma Google Forms. Uma pontuação de 5 foi obtida no CSUQ, onde os participantes ficaram um pouco satisfeitos com a plataforma NEXUS, enquanto que no EUS obteve uma pontuação de 65,51, o que significa que a plataforma NEXUS não possui um nível adequado de usabilidade. Finalmente, no rastreador de olho, através dos mapas de áreas cegas, foi possível observar em detalhes como os participantes vão diretamente ao que eles precisam e não vêem o resto da interface a menos que não consigam encontrar uma maneira de realizar o atividade, também através do rastreador de olho observou-se que 16 dos 29 participantes tiveram problemas para localizar a atividade e 6 dos 29 participantes não encontraram o ícone correto para fechar a sessão da plataforma NEXUS. Conclui-se que é melhor usar o seguidor do olho em conjunto com os questionários para avaliar a usabilidade de uma interface, a fim de obter mais informações sobre como o usuário interage com a interface e, portanto, ser capaz de realizar análises e tratamentos mais detalhados para entender por que o participante deu esses escores nos questionários de usabilidade da interface.

Palavras-chave: CSUQ, EUS, plataforma educacional, seguidor de olho, usabilidade.

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Introduction

Most of the designs of the interfaces are based on the user with the aim that they have a good usability, since this will be what helps or complicates achieving the objectives pursued by the interface; For example, find some information that needs to communicate with other people, learn some subject, etc. (Hassan, Martín and Iazza, 2004).

The International Organization for Standardization (ISO) defines usability as the "degree of effectiveness, efficiency and satisfaction with which specific users can achieve specific objectives, in specific contexts of use" (ISO, 1998). The usability in each interface can be measured depending on the objectives that need to be met with its use and with the user that makes use of the interface.

There are different methods to evaluate the usability, one of them are the questionnaires and scales. One of the first scales that were used to evaluate usability without the user performing laboratory tests was Brooke's in 1986 (Brooke, 1996), entitled System Usability Scale (SUS), System Usability Scale, EUS). Reliability data have been reported from this scale (Lucey, 1991, in Kirakowki, 1994, Bangor, Kortum and Miller, 2008, Lewis and Sauro, 2009), where Alpha coefficients range from .85 to .92. Data are available in the Latino population where an Alpha coefficient of .92 was found (Hedlefs and Garza, 2016). Another instrument that is useful for evaluating the usability of an interface without the user performing any task or activity with the interface and only requiring the user to use it is the Computer System Usability Questionnaire (CSUQ). In its original language an internal consistency of .95 was reported (Sauro y Lewis, 2012) y en población latina de .97 (Hedlefs, de la Garza, Sánchez y Garza, 2015).

Both the EUS and the CSUQ present different factorial structures. The EUS has two factors, which are usability and ease of learning (Lewis and Sauro, 2009); while in the CSUQ there are three factors: quality of the system, quality of the information and quality of the interface (Sauro and Lewis, 2012). These same factors of EUS and CSUQ were found in the Latino population (Hedlefs and Garza, 2016, Hedlefs, de la Garza, Sánchez and Garza, 2015).

Another method of evaluation of usability that is having a boom in the area of Human Computer Interaction is the eye follower, although this has been used for more than 100 years in different

areas, for example, in psychology (Shiessl, Duda, Thölke and Fisher, 2003; Poole and Ball, 2005), neuropsychology (Duchowski, 2007; Cipresso et al., 2012), marketing (Reutskaja, Nagel, Camerer and Rangel, 2011; Duchowski, 2007); and its use is relatively recent in the area of usability.

In 1949, Fitts, Jones and Milton used the eye tracker to study the movement of the eyes of the pilots on the control board of the plane, recording how long they watched each instrument during the maneuvers and how many times they watched the board. control. This was known as the first application case of eye tracking in usability engineering.

Currently, the use of the eye tracker in the area of Human Computer Interaction (IHC) is focused more on the study of usability in the interfaces and as an input device (Pernice and Nielsen, 2009), which is not very convenient, because if we use it as an input device, we could fix our gaze on some object or blink if we want to select it; however, some movements of the eyes are unconscious and involuntary, so it would be necessary to add a voice command device or some instrument that complements the eye follower to be able to work correctly (Jacob and Karn, 2003). So Pernice and Nielsen (2009) mention that the eye follower is used as another tool for the evaluation of usability and that it is used in conjunction with another method of evaluation. Therefore, in our research, we evaluated the usability of an educational platform (NEXUS, www.nexus.uanl.mx/) by means of the ocular tracker and usability questionnaires, which were the Computer Systems Usability Questionnaire (CSUQ).) and the System Usability Scale (EUS).

Method

Participants

The sample is of convenience; It consisted of 29 eighth-semester students of the Systems Administrator Engineering degree from the Faculty of Engineering of a public university. The average age was 22.5 years; There were 18 men and 11 women.

Originally, the sample consisted of 30 participants, however, the data of one of them had to be discarded, since during its application with the eye follower there were failures with the Internet service and it was not considered for the global analysis.

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Instruments

The Gaze Point GP3 eye tracker and the Gaze Point Analysis Pro analysis software were used. The analyzed interface was www.nexus.uanl.mx, which was presented to the participants through a 19.5-inch monitor that had its mouse and independent keyboard. The keyboard, mouse and monitor used by the participants were connected to a laptop, which helped us to control and record the data of the eye follower.

The standardized version of the System Usability Scale (EUS) was applied, which has a Cronbach's Alpha coefficient of .92 (Hedlefs and Garza, 2016), which used a Likert scale of 5 response levels, which ranged entirely from disagreement (1) to totally agree (5). Finally, we used the standardized version of the Computer Systems Usability Questionnaire (CSUQ) with a Cronbach Alpha coefficient of .97 (Hedlefs, de la Garza, Sánchez and Garza, 2015); a Likert scale of 7 response levels was used, where they went from totally disagree (1) to totally agree (7). These were done online on the Google Forms platform so users responded on a MacBook Air laptop with an 11-inch screen.

Process

Students were invited to participate voluntarily through a Facebook group and during computer interface classes. The first thing that was done was to give them an informed consent, in which they were explained what the test consisted of and that their personal data would be treated confidentially. After proceeding to the application of the study with the eye follower, first all participants were calibrated the eye follower with nine points and then proceeded to perform the assigned task. The task was that the participant had to access their NEXUS account (www.nexus.uanl.mx), search where the activity was so they could upload the file to NEXUS that had previously been mentioned where it was located on the computer and, Finally, I had to close the session. After completing the study with the eye follower, the questionnaires were answered, first the EUS and then the CSUQ, with which the use of the NEXUS platform was evaluated. These questionnaires were answered on another computer where the eye tracker was not installed.

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Results

In the CSUQ a coefficient of Cronbach's Alpha of .94 was obtained. The average resulting from the 29 users was 4.56, that if we round to 5 we will see that they are somewhat satisfied with the NEXUS interface. This questionnaire has a minimum level of 1 and a maximum level of 7, where 1 represents totally disagree and 7 totally agrees. Table 1 breaks down the response levels.

Table 1. Niveles de respuesta del CSUQ.

Niveles de respuesta	
1	Totalmente en desacuerdo
2	Muy en desacuerdo
3	Algo en desacuerdo
4	Ni desacuerdo ni en desacuerdo
5	Algo de acuerdo
6	Muy de acuerdo
7	Totalmente de acuerdo

Source: elaboración propia.

It can be seen that the participants to whom the questionnaire was applied were somewhat in agreement with the general satisfaction with the NEXUS platform. Then we proceeded to obtain the average for each factor. This has three factors, where factor one is Quality of the Interface, factor two is Information Quality and factor three is System Quality.

Figure 1 shows the averages for each factor, where it can be seen that the 29 participants were somewhat in agreement regarding the quality of the NEXUS interface system and showed neither agree nor disagree on the quality of the interface and the quality of information about it.

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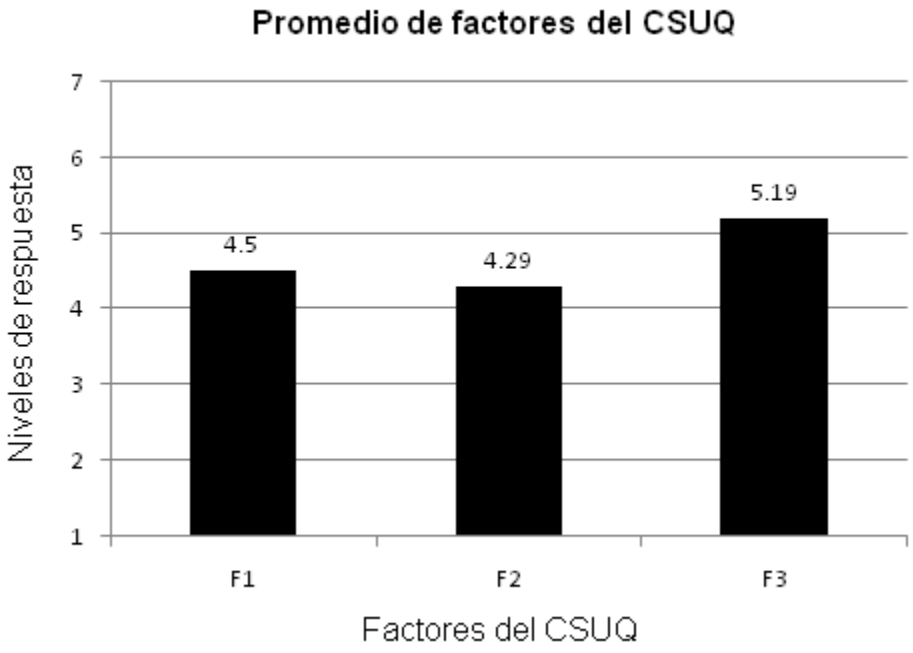
Figure 1. Promedio de cada factor del CSUQ.



Source: elaboración propia.

In the EUS an Alpha Coefficient of .86 was obtained, which is why it is very good. Then we proceeded to take the average score of the scale, which was 65.51 (the score range is from 0 to 100), which means that the NEXUS platform does not have an adequate level of usability. According to the perception of the EUS participants the factor one, they disagree with the fact that the interface presents usability. In factor two a score of 3.25 was obtained, which means that the participants do not agree that the interface is easy to learn, but neither do they disagree with this. This can be understood that for the participant it is not so difficult to use the NEXUS platform, but neither is the platform easy to interact (see Figure 2).

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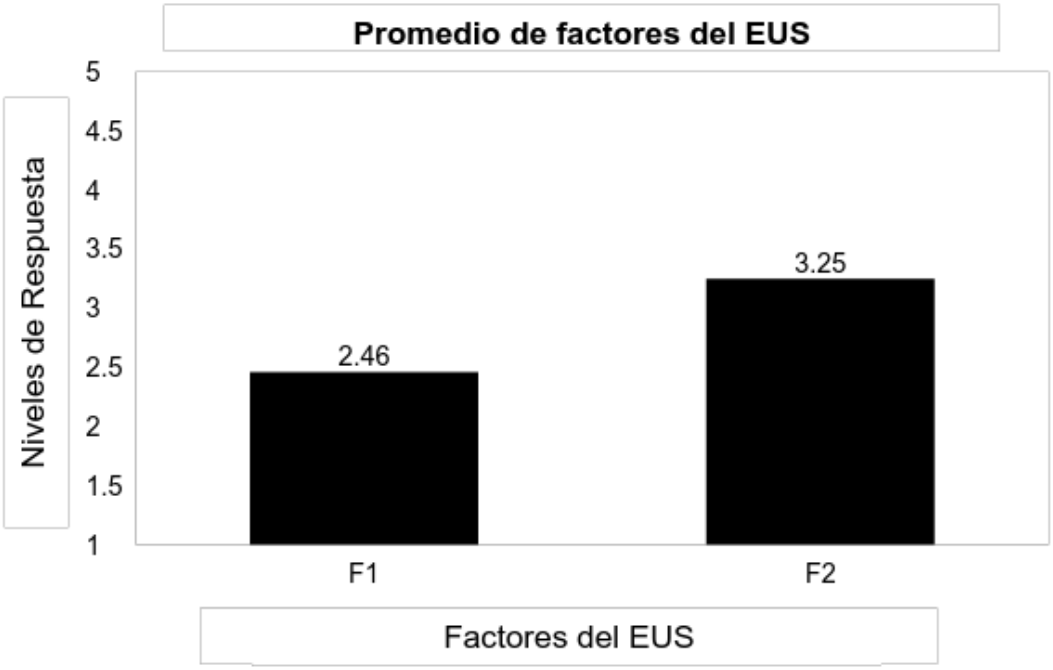
Figure 2. Promedio de cada factor del EUS.



Source: elaboración propia.

A Pearson correlation analysis of the two scales was performed, resulting in 0.816, which is strong and has a level of significance of 0.01, which tells us that the two scales (EUS and CSUQ) are related to each other. To say, the two scales are evaluating usability, for which they show a convergent validity between them.

Through the eye tracker we could observe what the participants were observing and in what parts of the interface (NEXUS) they did not fix their eyes. For example, most participants did not look at the ad that appears next to the user and password fields, which means they do not pay attention to that point. Another important point to note is that it could be observed that they also do not read the information that appears below the user and password fields (see Figure 3).

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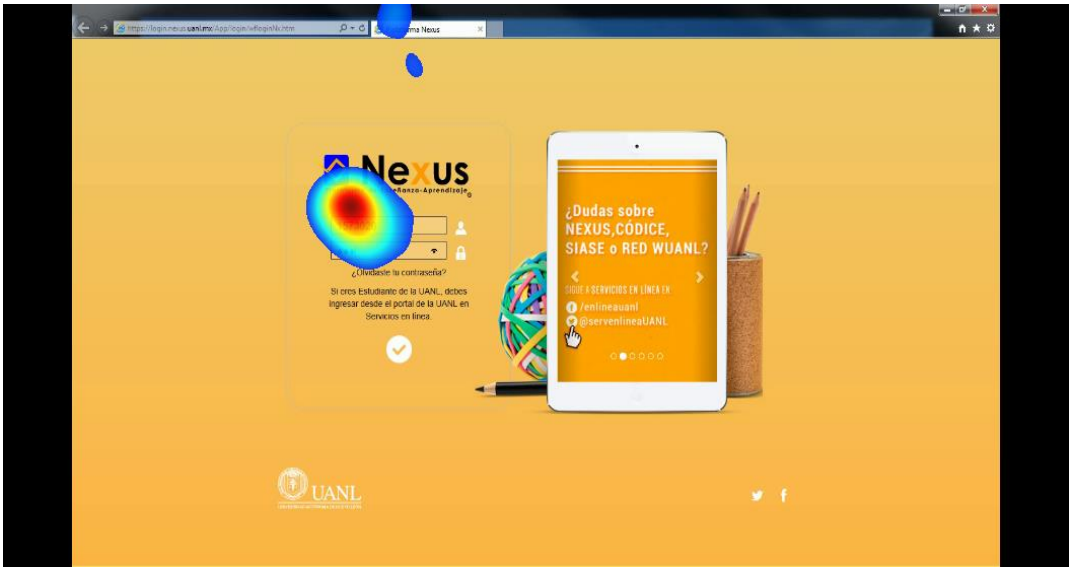
Figure 3. Mapa de calor de los 22 participantes que accedieron a NEXUS desde la plataforma.



Source: captura de pantalla realizada por el autor.

Thanks to the review of the map of blind areas (see Figure 4) made from the information of 22 participants (total of participants who could access through www.nexus.uanl.mx, which are from 1 to 22 of the Table 2), it was possible to observe in detail how the participants go directly to what they need, that is, they do not read extra information nor do they see the rest of the page unless they can not find a way to carry out the task.

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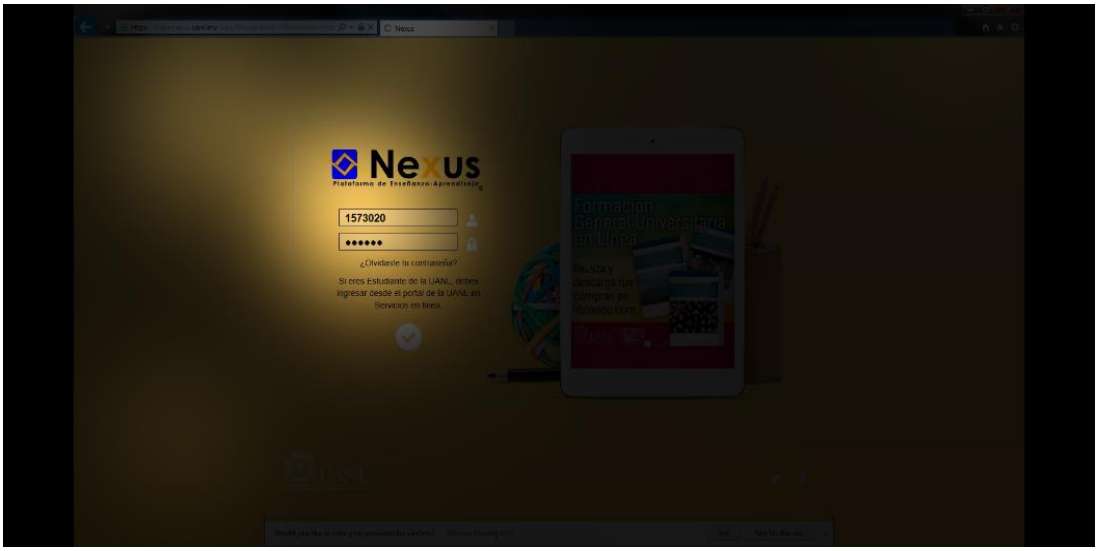
Figure 4. Mapa zonas ciegas realizado con los datos de los 22 participantes que accedieron a NEXUS desde la plataforma.



Source: captura de pantalla realizada por el autor.

When the 29 participants were in their NEXUS account, none of them had problems locating the course they should enter, since this page is very simple and only shows the information that is completely necessary, which in this case was to enter the matter of computational interfaces. After selecting the subject, there are two ways to access the task: one through the calendar and another through the chapters that appear on the main page of each course. However, most were confused when looking for the activity and did not know where it was (16 of the 29 participants had problems with this point). More than half of the participants hesitated when they had to enter the activity specified at the beginning, and some even clicked on places that were not; for example, on the right side of the interface where there is a small menu that shows some options such as forums, chat, email, etc.

When participants accessed the assigned task on the NEXUS platform, they quickly found the place they should click to upload the file to the platform. When this was loading, 21 of 29 participants stared at the small circle that says "loading". Finally, when it finished loading, 17 of them verified that the file of the task was uploaded correctly and then closed the session.

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At the time of closing the NEXUS platform session, six of the 29 participants clicked in the wrong place, because next to the exit icon there is a button with the student's name and an arrow pointing down, and with this a menu is displayed where the participants looked for the way to close session.

When comparing the questionnaires (EUS and CSUQ) versus the ocular tracking technique, it was observed that some of the participants reported that the interface has good usability; However, when examining their individual vision diagrams, it could be perceived that they had problems when searching for the task they had to perform, which caused time to be lost and browsing the interface in areas that were not necessary to give them click (participants 4, 9, 10, 15, 17, 19 and 26 see Table 2).

Eight of the 29 participants (7, 8, 12, 13, 17, 19, 21 and 23 see Table 2), reported in the questionnaires (CSUQ and EUS) that the interface did not have good usability; however, analyzing their individual vision diagrams, it could be observed that they were the same ones that took the shortest time to perform the task (EUS versus time with the eye follower). Therefore, for these eight participants who did the activity and did it in the shortest time possible, the interface did not have good usability, since they did not feel satisfied with the platform and this was what made these participants score in the questionnaires that the educational platform did not have good usability.

It was also observed in table 2 that participant number 23 (in bold), who accesses the platform through SIASE (http://www.uanl.mx/enlinea) was the one who rated the NEXUS platform in the worst way , not only in usability, but also in terms of satisfaction. However, the amount of total fixations and the time it took to complete the task and meet the objective is low; therefore, this shows that learning how to use the platform in order to get things done quickly does not mean that it has good usability.

Another aspect to note was that the participant number 29 (in bold), who did not access the platform directly (http://www.uanl.mx/enlinea), was the one who qualified with the best scores in both usability and satisfaction to the NEXUS interface. Reviewing the notes made to this participant during the application of the eye follower, it was noted that there were problems with

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the internet for a moment, but this did not affect the perception of the participant with regard to the NEXUS platform.

Table 2. Muestra la comparación de los resultados obtenidos mediante el tiempo usando NEXUS (años y meses), los cuestionarios CSUQ y EUS, el tiempo que le tomó a cada participante realizar la tarea con el seguidor ocular (segundos) y el número de fijaciones que dieron durante el estudio. Los participantes 1 al 22 accedieron por www.nexus.uanl.mx y los participantes 23 al 29 accedieron por www.uanl.mx/enlinea.

Participante	Tiempo usando NEXUS	Promedio CSUQ	Promedio EUS	Tiempo con el seguidor ocular (segundos)	Cantidad de fijaciones
1	4.11	4.6	77.5	72.1	178
2	3.6	5.46	80	53.5	109
3	5.6	5.76	82.5	48.5	98
4	3.6	5.23	72.5	54.6	128
5	3.6	5.61	82.5	50.7	95
6	4.3	5.30	80	85.3	178
7	3.2	3.30	55	71.5	125
8	4.2	4.15	50	72.6	162
9	3.6	5.23	57.5	102.8	219
10	4.6	5	70	97.6	213
11	4.1	5.61	70	68.9	148
12	3.6	5.23	67.5	67.4	163
13	2.4	4.38	67.5	53.5	93
14	4.6	5	72.5	72.5	154
15	3.0	5	82.5	84.0	206
16	4.4	3.46	52.5	96.6	162
17	4.2	5	62.5	57.0	136

18	5.5	2.69	47.5	86.3	164
19	3.6	5.07	67.5	65.2	127
20	4.5	5.69	75	51.1	106
21	4.0	3.69	52.5	56.2	127
22	7.7	5.15	77.5	69.7	172
23	**4.1**	**2.15**	**15**	**62.7**	**136**
24	3.1	3	35	107.5	242
25	3.6	4.84	75	83.6	169
26	6.8	4.07	57.5	85.0	201
27	2.6	3.61	67.5	109.4	232
28	3.4	2.76	65	99.0	245
29	**3.2**	**6.23**	**82.5**	**90.0**	**193**

Source: elaboración propia.

Discussion and Conclusions

The 29 participants that were part of the study and to whom the questionnaires were applied (CSUQ and EUS) reported that the NEXUS interface does not present usability and we could verify this with the ocular tracking technique. This is in the same sense as what Pernice and Nielsen (2009) mention, that any evaluation method that is used will help to detect the basic usability problems that the interface has.

The participants were confused when locating the task, when this should not happen, since the 29 participants have a minimum of two years with four months interacting with the platform. Some participants looked for the task on the right side of the page, since there are some options that are also on the main menu (see Figure 5). The fact that the participants do so many times can cause them to get confused and lose time, so that the NEXUS platform is saturated. Therefore, it was

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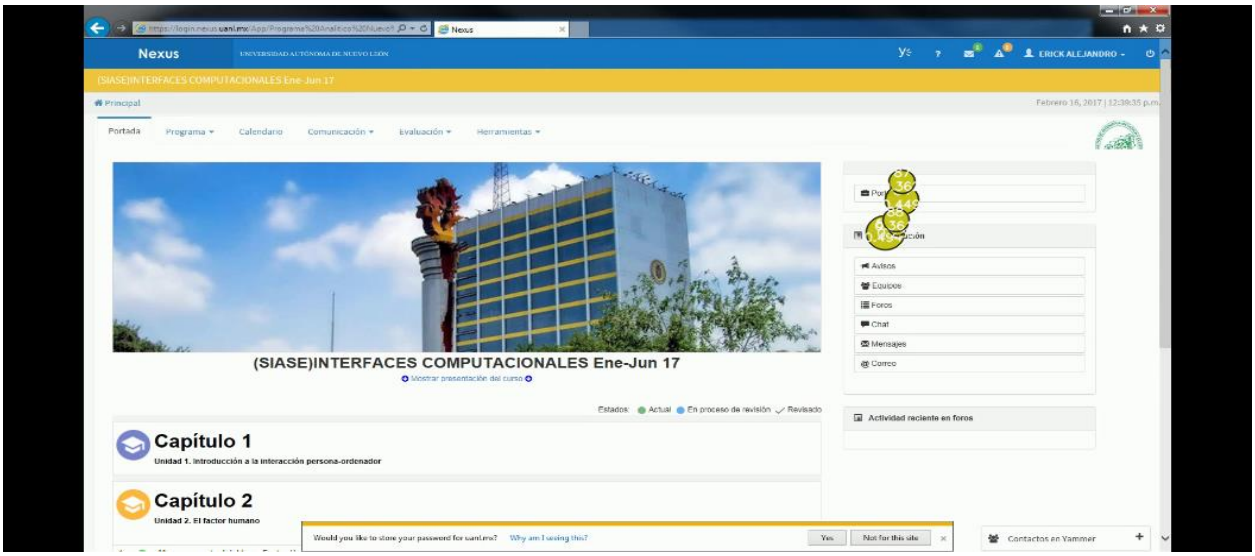
shown that this is a usability error, since the participants took a long time to complete the task and this should not have happened, since the participants had experience using the platform.

Figure 5. Ejemplo de un participante que busca la sección de tareas en la lateral derecha de la página.



Source: captura de pantalla realizada por el autor.

With the use of Z scores, the participants who gave the worst and best results in the questionnaires (EUS and CSUQ) were selected to the NEXUS platform and an individual analysis of the vision diagrams of these cases where the following information: some participants evaluated the NEXUS platform negatively in the usability questionnaires (CSUQ and EUS), although they did not take long to complete the task. The opposite happened with other participants: they reported that the NEXUS platform presented good usability and commented that they were satisfied with the platform, when in reality they took longer to complete the task, since they could not locate the task.

These contradictory results highlight the need to use both eye follower tests in conjunction with questionnaires, as these are complemented. This could be observed in the ocular tracker where aspects of the interface could be examined that the questionnaires did not report (see Table 2).

The questionnaires allowed us to detect which participants obtained the most relevant scores, allowing us to review and analyze the vision diagrams of those participants and detect the problems

they had during the completion of the task.

Another important point is that we can obtain more information about the usability of an interface if we apply both techniques simultaneously. For example, the study by González and Velásquez (2012) in which they used an eye tracker to analyze the content preferences of web users and found that with the eye tracker, the important objects of the web site can be better detected for the user and achieve thus a more accurate and detailed analysis of the preferences of the users.

One of the limitations that we encountered in the development of the research was that no test was used with which the user could express their thoughts and / or emotions during the study or at the end of it; perhaps this would have provided us with additional information to understand why the questionnaires answered and why their movements in the interface.

It is recommended to use a retrospective test in conjunction with the questionnaires and the eye follower, since with it you can question the user about certain movements he made and also know what he was thinking at that moment (Pernice and Nielsen, 2009). Even some neurotechnology could be used where this can tell us which part of the brain is activated when the user is interacting with the interface (González and Velásquez, 2012). Finally, psychophysiological measures could be used to indicate the degree of stress of the participant and their possible state of mind.

In conclusion, it can be mentioned that the NEXUS interface through the CSUQ was well evaluated, while for the EUS and the ocular follower it was evaluated with bad usability; therefore, mixed results were obtained. We can highlight from the present research that it is better to use the eye follower in conjunction with the questionnaires to evaluate the usability of an interface and thus obtain more information on how the participant interacts with the interface, perform more detailed analyzes and understand why the participant gave those scores in the usability questionnaires of the interface.

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Bibliography

Bangor, A., Kortum, P., & Miller, J. (2008). An Empirical Evaluation of the System Usability Scale. *International Journal of Human*-Computer Interaction, *24*, 574- 594. doi: 10.1080/10447310802205776.

Brooke, J. (1996). SUS: A Quick and Dirty Usability Scale. *Usability evaluation in industry*, *189*(194), 4-7.

Cipresso, P., Meriggi, P., Carelli, L., Solca, F., Poletti, B., Lulé, D., Riva, G. (2012). Brain computer interface and eye tracking for neuropsychological assessment of executive functions: a pilot study. En Proceedings of the 2nd International Workshop on Computing Paradigms for Mental Health, MindCare 2012, in Conjunction with BIOSTEC 2012 (pp. 79-88). Recuperado de https://s3.amazonaws.com/academia.edu.documents/30737038/MindCare_2012_-_152_4x228_6.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1505241962&Signature=OvGohWyGnjpn7XlpCQFUmIsUIuw%3D&response-content-disposition=inline%3B%20filename%3DManaging_Data_in_Help4Mood.pdf#page=87

Duchowski, A. (2007). *Eye tracking methodology: Theory and practice*. London: Springer. doi: 10.1007/978-3-319-57883-5

Fitts, P. M., Jones, R. E., & Milton, J. L. (1949*). Eye Fixations of Aircraft Pilots. III. Frequency, Duration, and Sequence Fixations When Flying Air Force Ground- Controlled Approach System (GCA).* AIR MATERIEL COMMAND WRIGHT- PATTERSON AFB OH. Recuperado de http://www.dtic.mil/get-tr-doc/pdf?AD=ADA329371

González, L., & Velásquez, J. D. (2012). Una aplicación de herramientas de eye-tracking para analizar las preferencias de contenido de los usuarios de sitios web. *Revista de ingeniería de sistemas*, *26*(1), 95-118. Recuperado de http://www.dii.uchile.cl/~ris/RISXXVI/gonzalez.pdf

Hassan, Y., Martín, F. F. J., & Iazza, G. (2004). Diseño web centrado en el usuario: usabilidad y arquitectura de la información. *Hipertext.net*, (2). Recuperado de http://eprints.rclis.org/8998/1/Diseño_Web_Centrado_en_el_Usuario_Usabilidad_y_Arquitectura_de_la_Información.pdf

Hedlefs, A. M. I., de la Garza, G. A., Sánchez, M. M. P., & Garza, V. A. A. (2015). Adaptación al español del Cuestionario de Usabilidad de Sistemas Informáticos CSUQ. *RECI Revista Iberoamericana de las Ciencias Computacionales e Informática*, *4*(8). Recuperado de https://www.reci.org.mx/index.php/reci/article/view/35/120

Hedlefs, A. M. I., & Garza, V. A. A. (2016) Análisis comparativo de la Escala de Usabilidad del Sistema (EUS) en dos versiones. *RECI Revista Iberoamericana de las Ciencias Computacionales e Informática*, *5*(10). Recuperado de https://www.reci.org.mx/index.php/reci/article/view/48/215

ISO 9241-11 (1998). Ergonomic requirements for office work with visual display terminals (VDTs)–Part 11: Guidance on usability. *International Organization for Standardization*. Recuperado de https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-1:v1:en

Jacob, R. J., & Karn, K. S. (2003). Eye tracking in human-computer interaction and usability research: Ready to deliver the promises. *Mind*, *2*(3), 573-605. Recuperado de https://pdfs.semanticscholar.org/5f1f/69d3f8807a5abc490955823ecfec55b15bb9.pdf

Kirakowski, J. (1994). The use of questionnaire methods for usability assessment. Unpublished manuscript. Recuperado el 12 de abril de 2016, de http://sumi.ucc.ie/sumipapp.html

Lewis, J., & Sauro, J. R. (2009). The Factor Structure of the System Usability Scale. En M. Kurosu (Ed.) *Human Centered Design*, (pp 94-103). doi: 10.1007/978-3-642-02806-9_12

Pernice, K., & Nielsen, J. (2009). How to conduct eyetracking studies. *Fremont, CA: Nielsen Norman Group*. Recuperado de https://media.nngroup.com/media/reports/free/How_to_Conduct_Eyetracking_Studies.pdf

Poole, A., & Ball, L. J. (2005). Eye tracking in human-computer interaction and usability research: Current status and future. En C. Ghaoui (Ed.): *Encyclopedia of Human-Computer Interaction* (pp. 211-219) Pennsylvania: Idea Group, Inc.

Reutskaja, E., Nagel, R., Camerer, C. F., & Rangel, A. (2011). Search dynamics in consumer choice under time pressure: An eye- tracking study. *The American Economic Review, 101(*2), 900-926. Recuperado de http://www.rnl.caltech.edu/publications/pdf/reutskaja2011.pdf

Sauro, J., & Lewis, J. R. (2012). *Quantifying the user experience: Practical statistics for user research.* Elsevier, USA. doi:10.1016/B978-0-12-384968-7.00001-1.

Schiessl, M., Duda, S., Thölke, A., & Fischer, R. (2003). Eye tracking and its application in usability and media research. *MMI-interaktiv Journal, 6,* 1-10. Recuperado de https://pdfs.semanticscholar.org/ecc2/e7752ca4ab5da2bd9078055cf0f02b355f14.pdf