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Pedagogical impact during the pandemic of a virtual classroom with lightboard

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Abstract

This paper analyzes the influence of a virtual classroom with a lightboard on the pedagogical impact generated in students of two synchronous engineering courses taught during the Covid 19 pandemic. A technology acceptance model analyzed the influence of the virtual classroom with lightboard, the central core of analysis being the students' learning satisfaction. The results show that the ease of receiving the lectures for students, the teacher's chosen methodology, and the support material positively influence the student's learning process. The lightboard supports all these influence factors, being a helpful tool for teachers. Also, in virtual lectures, it is relevant that the student has a good Internet connection, stable power supply, and other elements that allow him/her to participate in all synchronous lectures and develop asynchronous activities.

Keywords: Virtual classroom; Lightboard; Teaching process; Technology acceptance model.

Impacto pedagógico durante pandemia de un aula virtual con lightboard

Resumen:

El presente artículo analiza la influencia de un aula virtual con lightboard en el impacto pedagógico generado en estudiantes de dos cursos sincrónicos de ingeniería dictados durante la pandemia por Covid 19. Un modelo de aceptación tecnológica analizó la influencia del aula virtual con lightboard, el núcleo de análisis principal es la satisfacción de aprendizaje de los estudiantes. Los resultados muestran que la facilidad con la que los estudiantes reciban la clase, la metodología elegida por el docente y el material de apoyo influyen positivamente sobre el proceso de aprendizaje del estudiante. El lightboard brinda apoyo a todos estos factores de influencia siendo una herramienta útil para los docentes, igualmente en las clases virtuales es relevante que el estudiante tenga una buena conexión a Internet, suministro eléctrico estable y demás elementos que le permitan participar en todas las clases sincrónicas y desarrollar las actividades asincrónicas.

Palabras clave: Aula virtual, Lightboard, Proceso de enseñanza, Modelo de aceptación tecnológica.

1. Introduction

Teachers have employed various tools to educate students for as long as the teaching process has existed. Initially, the students' visualization and proper interpretation of the information has been facilitated by creating a conventional board (Muttappallymyalil et al., 2016). The evolution of the board has presented changes in construction material, different writing devices, and the inclusion of 21st-century technologies until reaching the smart boards (Raajini et al., 2018).

Around 2011, Matt Anderson and Michael Peskhin in the United States independently developed the lightboard, composed of transparent glass illuminated by white LED light and fluorescent markers for writing (Birdwell & Peshkin, 2011).

The lightboard allows recording or transmitting a master class with a clear visualization of the notes and the teacher (McCorkle & Whitener, 2020), integrating slides for the presentation of the subject matter. It has been used in conventional classrooms (Skibinski et al., 2015), significantly impacting virtual teaching (P. D. Rogers & Botnaru, 2019). Several teachers have used the lightboard to develop short videos (Schweiker et al., 2020), video tutorials (Ye, 2016), videos for inverted lectures (Matthews & Dostal, 2020), and live broadcast lectures. In each use, the lightboard brings added value to the lectures conducted (Rosasco, 2018). The lightboard gives the teachers more dynamism to express their ideas and present the course material (Sidlauskas et al., 2021). The teaching methodology is crucial in taking advantage of the lightboard's characteristics (Choe, 2017; S. Pal et al., 2020). Seeing the teacher's face and handwriting the information generates greater receptivity in the students (Swenson et al., 2022).

Virtual lectures have grown exponentially in recent years due to the mandatory confinement due to the Covid 19 pandemic. Synchronous courses have gained more relevance than asynchronous ones, being necessary tools for clearly explaining the topics with distance communication (Long, 2020). The lightboard has guided virtual lectures in various subjects such as language (Ye, 2016), medicine (Schweiker & Levonis, 2020), biology (Sidlauskas et al., 2021), and STEM (Science, Technology, Engineering, Mathematics) courses (Fung, 2017; P. Rogers, n.d.). Several authors have analyzed the learning, cognitive load, and socialization generated by the lightboard in virtual courses, varying the results in positive and negative aspects depending on the oriented course (Lubrick et al., 2019). On the other hand, teachers' abilities to express, relate, and highlight topics, together with the gestures used, influence the knowledge perceived by students (Acartürk et al., 2021).

This research analyzes the relevance of a virtual classroom with a lightboard (VCL) in two synchronous-oriented STEM courses, evaluating the pedagogical impact on students using a lightboard as a support tool in synchronous sessions, course methodology, and student-teacher interaction, among others. A structural model is proposed to evaluate the characteristics related to synchronous teaching based on the technology acceptance model (TAM) (Nagy, 2018). The proposed model interrelates the study cores through influence hypotheses, where the central core is the learning satisfaction perceived by students.

2. Materials and methods

The proposed TAM model evaluates the relationships of 11 study cores to analyze the factors that influence students' perceived learning in two synchronous VCL-oriented courses:

- Students' perceived usefulness of the lightboard (SU). The degree to which students consider that the lightboard enhances their teaching process.
- Ease of receiving the lecture (EL), degree of difficulty students has in receiving the lecture with lightboard.
- Students' attitude towards the lightboard (SA). Degree of the predisposition of the students to receive the lectures with lightboard.
- Student-perceived learning satisfaction (LS). Degree of liking perceived by students concerning course topics.
- The technological aptitude of the students to receive the lectures (TA). Degree of skill of the students with different technological tools (like a computer, cell phone, and internet) and availability of necessary resources that influence the moment of receiving a virtual lecture.
- Student-student interaction (SS). The degree of the relationship between the different course members and the level of camaraderie may exist.
- Student-teacher interaction (ST). Degree of clear and trusting communication between the student and the teacher when explaining topics, resolving doubts, and providing counseling.
- Use of VCL by students (AV), degree of utilization of the information provided by VCL (synchronous lectures, recorded lectures, and support material) by the student.
- Student learning performance (SP). Degree of student-perceived learning concerning course orientation.
- Methodology of the course (M). Degree of student acceptance of the method of guidance, evaluation, and course feedback by the teacher.
- The socio-cultural factor of the students (SC). Degree of stress and procrastination presented by the students in the development of the different activities of the course.

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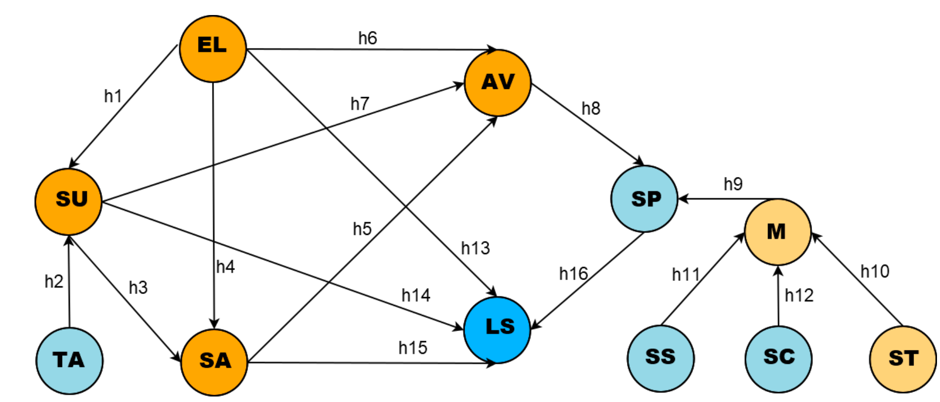
The central core of the analysis is student learning satisfaction (LS). Each study core has two or three Likert scale questions recorded in a survey conducted at semester end. Of the ten cores that generate influence on others, four are directly related to lightboard (U, F, AC, and AV) highlighted with orange color. The student-teacher interaction (ST) and the methodology (M) of the course are indirectly related to the lightboard (highlighted in yellow color) because, in the synchronous courses, the primary means of communication of the course and orientation of the lectures was a video conference platform, where the teacher always used lightboard. The cores unrelated to the lightboard are highlighted in light blue (AT, D, EE, and S), and the central analysis core is dark blue (LS) (Figure 1).

Figure 1. Proposed structural model.



The relationships between each core are hypotheses, represented by continuous line arrows. The 16 hypotheses proposed (h1-h16) to build the structural model to be analyzed are:

h1. Ease of receiving the lecture (EL) significantly affects students' perceived usefulness (SU).

h2. Students' technological aptitude (TA) has a significant positive effect on Students' perceived use-fulness (SU).

h3. Students' perceived usefulness (SU) has a significant positive effect on Students' attitude toward lightboard (SA).

h4. Ease of receiving the lecture (EL) has a significant positive effect on Students' attitude toward lightboard (SA).

h5. Attitude towards the lightboard (SA) has a significant positive effect on the use of the VCL (AV).

h6. Ease of receiving the lecture (EL) has a significant positive effect on using VCL (AV).

h7. Perceived usefulness (SU) has a significant positive effect on using VCL (AV).

h8. Course methodology (M) has a significant positive effect on Student learning performance (SP).

h9. Use of VCL (AV) has a significant positive effect on Students' learning performance (SP).

h10. Student-teacher interaction (ST) has a significant positive effect on course methodology (M).

h11. Student-student interaction (SS) has a significant positive effect on Course methodology (M).

h12. Socio-cultural factor (SC) has a significant positive effect on course methodology (M).

h13. Ease receiving the lecture (EL) has a significant positive effect on student learning satisfaction (LS).

h14. Perceived usefulness (SU) has a significant positive effect on student learning satisfaction (LS).

h15. Learning performance (SP) has a significant positive effect on student learning satisfaction (LS).

h16. Lightboard attitude (SA) has a significant positive effect on student learning satisfaction (LS).

The Special Mathematics and Digital Control Systems courses of mechatronic engineering of the Corporación Universitaria Comfacauca were synchronous for the second semester of 2021. The teacher realized the lectures of both courses through Google Meet, and a 32-inch lightboard was a support tool to guide the lectures, perform exercises, and resolve doubts (Figure 2).

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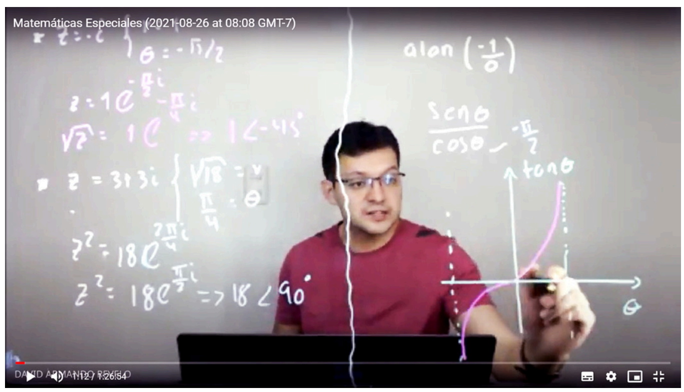
Figure 2. Use of Lightboard in a Virtual Classroom.

a) 32-inch lightboard (New Education Technology, 2021)

b) Lightboard used in a synchronous classroom.



Six open-ended questions were conducted in a survey of 28 seven-level Likert scale-type questions (strongly disagree, strongly disagree, disagree, neutral, agree, agree, strongly agree, strongly agree, and strongly agree). The questions were answered at the end of the second semester of 2021 by a sample of 30 online students using Google Forms. The sample is between the fifth and ninth semester of the degree program.

The R program performs the statistical processing of the data from the closed questions and graphic processing of the open questions. The statistical processing builds the structural model to corroborate the hypotheses. The word clouds provide a graphical summary of each set of responses to the open-ended questions.

3. Results

The survey obtained a Cronbach-Alpha coefficient of 0.802, indicating high reliability in the data provided by the students. Resampling the data by bootstrapping allows a statistical analysis of the data and verification of the hypotheses raised.

The arc weights obtained from the proposed structural model and the p-value achieved for each hypothesis (Table 1) with an alpha of 0.05 show that ten hypotheses are valid. The rejected hypotheses are h3, h5, h6, h7, h12, and h14. Of the accepted hypotheses (h1, h2, h4, h8, h9, h10, h11, h13, h15, and h16), most have arcs of positive influence (h1, h2, h4, h8, h9, h10, h11, h13, and h15) and one arc of negative influence (h6).

Table 1. Arc weights for the hypotheses of the proposed model

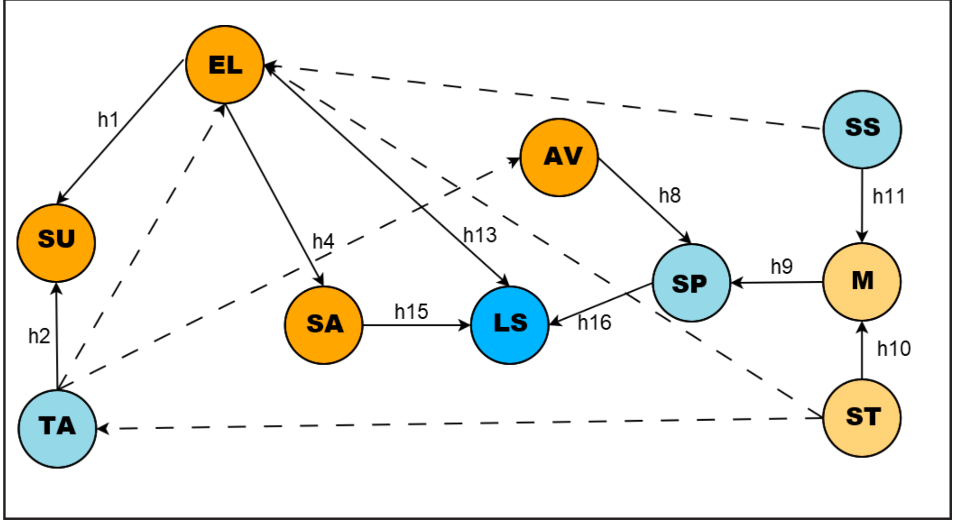
Arch	Weight	Standard error	t-stat	p-value	Confidence Interval Percentile 95%
SU ~ EL	1.4392	0.1225	11.7529	<0.00001	[0.3701; 0.5293]
SU ~ TA	0.9806	0.1829	5.3608	<0.0001	[-0.0501; 0.1045]
M ~ ST	0.5615	0.0347	16.1982	<0.0001	[0.4384; 0.4974]
M ~ SS	0.5300	0.0834	6.3571	<0.0001	[0.4811; 0.5683]
M ~ SC	0.0537	0.1451	0.3704	0.5882	[-0.2133; -0.0297]
SA ~ EL	0.9402	0.1188	7.9173	0.0039	[0.2847; 0.8232]
SA ~ SU	-0.0381	0.1490	-0.2556	0.8972	[-0.0716; 0.4738]
AV ~ EL	0.2648	0.3249	0.8150	0.3471	[-0.0439; 0.4716]
AV ~ SU	-0.1408	0.1072	-1.3132	0.5504	[-0.2710; 0.1765]

Arch	Weight	Standard error	t-stat	p-value	Confidence Interval Percentile 95%
AV ~ SA	0.4601	0.3769	1.2209	0.1179	[0.2861; 0.7994]
SP ~ M	0.3555	0.0675	5.2702	0.0006	[0.4209; 0.6133]
SP ~ AV	0.4150	0.0068	61.1312	0.0044	[0.2545; 0.5306]
LS ~ EL	0.5464	0.2788	1.9597	<0.0001	[-0.0323; 0.0195]
LS ~ SU	-0.1766	0.1473	-1.1992	0.2305	[0.0146; 0.1295]
LS ~ SA	0.8041	0.2507	3.2076	0.0013	[-0.3390; 0.1652]
LS ~ SP	1.1437	0.3003	3.8085	<0.0001	[0.6970; 1.0258]

The main analysis core (LS) is positively influenced by learning performance, the attitude of use, and ease of use, not influenced by perceived usefulness. Students' technological aptitude and ease of receiving the lecture positively influence students' perceived usefulness of the lightboard. The statistical results reject the stated hypotheses of the influence of VCL use. The course methodology is not affected by the socio-cultural factor of the students; the attitude of use is not affected by perceived usefulness.

The estimated construct correlations highlight that the ease of receiving lectures is positively influenced by students' technological aptitude, student-teacher, and student-student interaction. Regarding indirect interactions, student-teacher interaction positively influences technological aptitude; and technological aptitude positively influences VCL use. Any other factor has no significant effect on student-teacher and student-student interactions. These results generate modifications in the proposed structural model, representing the indirect relationships with dashed line arrows (Figure 3).

Figure 3. Resulting structural model.



Six open-ended questions allow a broader analysis of students' tastes and perceptions. In the three open-ended questions about the improvements of the VCL and the methodology according to the students: 1. What aspects can the teacher improve related to teaching with the VCL? 2. What aspects can the VCL improve? 3. What aspects can the methodology used in the course improve? the main answer was no improvement, being this a favorable aspect for both the teacher and the VCL. Students consider some elements to improve the lightboard lectures, such as modifying the markers' color and the size of the luminous board. The board size is 32", smaller than the dimensions of a classroom board.

Concerning the open-ended responses (Figure 4) regarding technology, the student's perception of better student-teacher interaction and the dynamic nature of the explanations are relevant aspects. Some aspects that do not favor interaction with technology are external factors such as Internet connectivity, computers with low performance, and deficiencies in the electrical grid.

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Figure. 4. Word clouds of open-ended responses.

a. If you perceive that there are advantages of VCL over other virtual classrooms, what are they?

b. If you have had any technical problems with the virtual classes, what have they been?

c. In general, according to your perception, what difficulties did you have during the semester in completing the course activities?

4. Discussion

The statistical processing results present the impact of the lightboard on students' learning satisfaction (LS) and performance (SP). The mentioned impact is supported by the positive influence of ease of receiving the lecture (EL), the attitude of use (SA), and use of the VCL (AV) on the learning cores, indicating that the lightboard provided support in the teaching process of synchronous courses oriented by the teacher. This characteristic is also evident in students' open-ended responses, who highlight several advantages of VCL over conventional virtual classrooms, such as handwriting on the board, similarity to face-to-face lectures, dynamic lectures, and proximity to the teacher.

The disadvantages or difficulties related to the VCL are related to the technological aptitude of the students (TA), which influences the lightboard's impact on the teaching process. Regarding technological aptitude, this is associated with the profile of the students surveyed, particularly with the type of housing (urban or rural) and socioeconomic strata 1, 2, or 3. In Colombia, it is expected that, for these socioeconomic strata, even more so in rural areas, internet connectivity and the electricity grid are not stable, being possible a negative effect on a technology-mediated by connectivity such as the VCL.

5. Conclusions

The present research analyzed the impact through an extended TAM model of a virtual classroom with lightboard on two synchronous STEM courses. The primary variable of analysis was the students' learning satisfaction which depends on the ease with which students receive the lectures, the student's attitude towards the lightboard, and the performance perceived by the students due to the influence of the methodology, the student-student and student-teacher interaction. This indicates that students' learning process in virtual lectures is affected by psychological, social, and pedagogical factors as in face-to-face lectures.

In addition, the technical and logistical factors necessary for online communication influence, i.e., virtual lectures, demand more

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significant commitment and resources from teachers to provide adequate teaching to students.

Lightboard use in the virtual classroom positively influences student satisfaction and learning performance by allowing students to access a dynamic synchronous lecture and interact more closely with the teacher, generating a positive predisposition of the students in the lectures oriented with lightboard.

A relevant factor of analysis is the technological aptitude of the students to receive the lectures since it indirectly influences in a positive way the ease with which the students receive the lectures and the use of the VCL. This confirms that the development of a virtual classroom depends on the student's skills, tools, and previous knowledge. Likewise, there is relevance in the student-teacher interaction to support the technological aptitude of the students.

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6. References

Acartürk, C., Coskun, M., & Emil, S. (2021). Multimodal communication in instructional settings: An investigation of the functional roles of gestures and arrows. Revista Signos, 54(107), 867–892. https://doi.org/10.4067/S0718-09342021000300867

Birdwell, J. A., & Peshkin, M. (2011.). Capturing Technical Lectures on Lightboard. http://lightboard.info.

Choe, E. (2017). A case study-based primer of informal, educational, digital video best practices Optimizing Video for Learning. https://ssrn.com/abstract=2909769

Fung, F. M. (2017). Adopting Lightboard for a Chemistry Flipped Classroom to Improve Technology-Enhanced Videos for Better Learner Engagement. Journal of Chemical Education, 94(7), 956–959. https://doi.org/10.1021/acs.jchemed.7b00004

Long, J. M. (2020). Anywhere-Anytime Engineering Education In a Complete Undergraduate Program. https://www.worldcampus.psu.edu/degrees-and-

Lubrick, M., Zhou, G., & Zhang, J. (2019). Is the future bright? The potential of lightboard videos for student achievement and engagement in learning. Eurasia Journal of Mathematics, Science and Technology Education, 15(8). https://doi.org/10.29333/ejmste/108437

Matthews, G. E., & Dostal, J. (2020). Flipped Classes: An Opportunity for Low-Stakes Group Problem Solving. The Physics Teacher, 58(9), 670–672. https://doi.org/10.1119/10.0002740

McCorkle, S., & Whitener, P. (2020). The Lightboard: Expectations and Experiences. International Journal of Designs for Learning, 11(1), 75–84. https://doi.org/10.14434/ijdl.v11i1.24642

Muttappallymyalil, J., Mendis, S., Jenny John, L., Shanthakumari, N., Sreedharan, J., & Shaikh, R. B. (2016). Evolution of technology in teaching: Blackboard and beyond in Medical Education. In Nepal J Epidemiol (Vol. 6, Issue 3). www.nepjol.info/index.php/NJE

Nagy, J. T. (2018). Evaluation of online video usage and learning satisfaction: An extension of the technology acceptance model. International Review of Research in Open and Distance Learning, 19(1), 160–185. https://doi.org/10.19173/irrodl.v19i1.2886

New Education Technology. (2021, June 26). Tu salón virtual de clase o estudio de grabación muy fácil con LightBoard [Video]. YouTube. https://www.youtube.com/watch?v=D9dRkqI6duE

Raajini, X. M., Rajesh, G., Pandian, V. P. A., & Vengadesh, N. (2018). Arduino Based Smart Blackboard Wiping System (Vol. 1, Issue 1).

Rogers, P. (n.d.). Using Lightboard Video Lectures to Improve Student Learning in a Flipped Classroom Environment.

Rogers, P. D., & Botnaru, D. (2019). Shedding Light on Student Learning Through the Use of Lightboard Videos. International Journal for the Scholarship of Teaching and Learning, 13(3). https://doi.org/10.20429/ijsotl.2019.130306

Rosasco, N. S. (2018). Using a Lightboard to Enhance and Retrofit an Existing Course. https://docs.lib.purdue.edu/aseeil-insectionconference/2018/innov/6

S. Pal, A. Ngampornchai, & P. Moskal. (2020). Teaching Dynamics Using a Flipped Classroom Blended Approach. Asee's Virtual Conference.

Schweiker, S. S., & Levonis, S. M. (2020). A quick guide to producing a virtual chemistry course for online education. In Future Medicinal Chemistry (Vol. 12, Issue 14, pp. 1289–1291). Future Medicine Ltd. https://doi.org/10.4155/fmc-2020-0103

Schweiker, S. S., Griggs, B. K., & Levonis, S. M. (2020). Engaging Health Student in Learning Organic Chemistry Reaction Mechanisms Using Short and Snappy Lightboard Videos. Journal of Chemical Education, 97(10), 3867–3871. https://doi.org/10.1021/acs.jchemed.0c00619

Sidlauskas, B. L., Burns, M. D., Buser, T. J., Harper, N., & Kindred, M. (2021). Teaching Ichthyology Online with a Virtual Specimen Collection. Ichthyology and Herpetology, 109(2), 407–423. https://doi.org/10.1643/t2020031

Skibinski, E. S., Debenedetti, W. J. I., Ortoll-Bloch, A. G., & Hines, M. A. (2015). A Blackboard for the 21st Century: An Inexpensive Light Board Projection System for Classroom Use. Journal of Chemical Education, 92(10), 1754–1756. https://doi.org/10.1021/acs.jchemed.5b00155

Swenson, M. J., Spence, T., & Smentkowski, B. (2022). Student-led development of a lightboard to enhance future student learning. International Journal of Mechanical Engineering Education, 50(2), 253–268. https://doi.org/10.1177/03064190211026229

Ye, W. (2016). Lightboard and Chinese Language Instruction（“光板”与对外汉语教学). In Journal of Technology and Chinese Language Teaching (Vol. 7, Issue 2). http://www.tclt.us/journal/2016v7n2/ye.pdfpp.97-112