

# Use of learning analytics in the flipped classroom: a systematic review

## Uso del análisis de aprendizajes en el aula invertida: una revisión sistemática

<http://dx.doi.org/10.32870/Ap.v11n2.1546>

Alexandro Escudero-Nahón\*  
Emma Patricia Mercado López\*\*

### ABSTRACT

#### Keywords

Learning analytics,  
flipped classroom,  
educational technology,  
systematic review

Learning analytics is a method of measuring, collecting, analyzing and reporting large volumes of data on apprentices in their learning contexts. The purpose is to predict the potential educational problems that could arise, anticipate effective solutions and, in this way, improve academic performance. Learning analytics opens new opportunities to adequately evaluate new didactic strategies that incorporate digital technology, such as the flipped classroom. A systematic review was performed to identify the state of knowledge about the Learning Analytics within the flipped classroom. The results suggest that: a) the use of Learning analytics within the flipped classroom in the last year has increased; b) its use has been addressed, indeed, to identify the learning behaviors of the students and to evaluate the academic achievement; c) in the cases in which the learning analytics was correctly applied, an improvement was obtained in academic achievement, self-regulated learning, motivation for study, collaboration and participation among students. However, the use of learning analytics has not yet been extended as much as other traditional methods that have also evaluated academic achievement within the flipped classroom.

### RESUMEN

#### Palabras clave

Análisis de los  
aprendizajes, aula  
invertida, tecnología  
educativa, revisión  
sistemática

*El análisis de aprendizajes consiste en la recolección, medición y análisis de grandes volúmenes de datos que generan los aprendices en sus contextos de aprendizaje, y cuyo propósito es predecir potenciales problemas educativos que podrían presentarse, anticipar soluciones efectivas y, así, mejorar el aprovechamiento académico. El análisis de aprendizajes presenta oportunidades inéditas para evaluar adecuadamente nuevas estrategias didácticas que incorporan la tecnología digital, como el aula invertida. Para identificar el estado del conocimiento sobre este análisis dentro del aula invertida, realizamos una revisión sistemática. Los resultados sugieren que a) ha aumentado el uso de este análisis dentro del aula invertida en el último año, ante todo b) para identificar las conductas de aprendizaje de los estudiantes y evaluar el aprovechamiento académico; c) en los casos que se aplicó de manera correcta, el análisis de aprendizajes sí obtuvo una mejoría del aprovechamiento académico, el aprendizaje autorregulado, la motivación para el estudio, la colaboración y la participación entre estudiantes. No obstante, el uso del análisis aún no se ha extendido tanto como otros métodos que también han abordado el aprovechamiento académico dentro del aula invertida.*

Received: December 11, 2018  
Accepted: May 10, 2019  
Online Published:  
September 30, 2019

\* EdD by Universidad de Barcelona [University of Barcelona]. Researcher of Universidad Autónoma de Querétaro (UAQ) [Autonomous University of Querétaro], Mexico.

\*\* Master on Education by Universidad Cuauhtémoc de Querétaro [University Cuauhtémoc of Querétaro]. Researcher of Universidad Autónoma de Querétaro (UAQ) [Autonomous University of Querétaro], Mexico.

The use of digital technology in formal education has fostered new educational models characterized by dissociating the space and time in which professors and students used to converge. The most outstanding examples are distance education, virtual education, hybrid education and mobile education. One of the most challenging didactic strategies of these educational models is the flipped classroom, since, in theory, it generates more responsibility from the students to study using digital technology (Escudero-Nahón and González, 2017; Madrid *et al.*, 2018).

The flipped classroom develops learning processes outside the classroom through digital technologies. One of its objectives is to optimize classroom time by having students study at home and using the classroom time to resolve doubts and putting into practice what they have learned. (Barral, Ardi-Pastores & Simmons, 2018; Blau & Shamir-Inbal, 2017). To do so, the flipped classroom integrates different digital applications allowing the students to access the information easily and to manage it in a simple way and process it collaboratively to obtain useful and meaningful knowledge (Chen & Chen, 2015; Fernández, Muñoz & Delgado, 2018).

These digital applications are usually articulated on a knowledge management platform such as Moodle, Blackboard, Webtc, Sakai or Canvas. These platforms and digital applications make it possible for every student to design his/her personal virtual learning environment (VLE). This environment can be formally defined as the personalized use made of the computer applications designed to facilitate educational communication between participants of an educational process, whether completely at distance or mixed. Such condition offers flexibility of learning and contributes to foster learning communities (Rojas, 2015).

The consolidation of virtual learning environments (VLE) lead to the analysis of learning currently defined as the process to obtain and interpret a wide range of data collected of the students' activities in order to assess their academic advancement, predict their achievement and identify potential educational problems (Rojas, 2017).

Some of the virtual learning environment characteristics are: studying qualitatively and quantitatively the learning processes arising from the interaction of users-students, containing basic components such as the time the students spend on online activities, place where the students have access to the virtual space and the characteristics of the group or population; it is based on tools of network analysis; its analysis method possess fundamental elements such as data collection, the analysis of students' data, the identification and resolution of students' needs and problems and the context analysis; and searches to improve the teaching-learning process (Rojas, 2017).

The learning objectives are, among others to:

- Predict and understand dropout and academic achievement behaviors.
- Model learning conducts (successful learning characteristics).
- Identify individual and group progress with the students' information.
- Acknowledge and assess the elements of the learning process.
- Analyze the dependent and independent variables of academic achievement and virtual environments.
- Map social interactions within the educational process.
- Examine the discourse and its relation to local language, dialogues and academic achievement.
- Assess the pedagogical model or learning strategies and results expected based on socio-constructivist theories (Ardura and Zamora, 2014; Rojas, 2017).

In recent years, systematic revisions of specialized bibliography on learning analysis have been carried out; however, attention was drawn on the analysis of the concept, its evolution, the application methods and the best developed objectives. Until now, there are no systematic revisions that identify which use has been more efficient and the results of this analysis method in a specific didactic strategy such as the flipped classroom (Rojas, 2017; Vieira, Parsons & Byrd, 2018). In this regard, the questions that guided this revision were: What has been the development of the learning analysis within the flipped classroom in the last four years? At what level and area is learning analysis used in the flipped classroom? What are the main objectives in using the learning analysis within the flipped classroom? What were the results in using the learning analysis within the flipped classroom in comparison with other methods?

## **OBJECTIVE AND RESEARCH METHOD**

The objective of this systematic revision was to identify the use of the learning analysis within the flipped classroom in recent years in order to obtain an update status of the question. We developed a sequential explicative design characterized in a first stage by collecting and examining quantitative data; subsequently, we collected and assessed qualitative data. The mixed method occurs when the initial quantitative results inform the collection of qualitative data. At the second stage, we constructed on the results obtained in the first stage (Plano, 2019). In order to comply with the foregoing, we conducted a systematic revision of scientific literature.

The purpose of this documentary research method is to integrate in an orderly manner the results of empirical studies on a specific research

problem. The systematic revision is widespread as documentary research in different areas of knowledge (Sánchez-Meca, 2010; Sánchez-Meca and Botella, 2010). This revision process was carried out between July and December 2018. In this process, we used two electronic databases: Scopus and Science Direct, and these were developed into four phases.

### ***Phase 1. Inclusion and Exclusion Criteria***

The inclusion criteria were research papers published in the Scopus and Science Direct databases between 2014 and 2018; papers which title, abstract or key words included the terms “learning analysis” and “flipped classroom”; papers on empirical research in the field of education, papers published in Spanish or English.

The exclusion criteria were academic texts that were not the result of an empirical research – i.e., scientific essays and academic text reviews -; and books, book chapters, congress memoirs and systematic revisions.

### ***Phase 2. Search Strategy***

The research strategy considered two main fields: Learning Analytics and Flipped Classroom. In both databases, the research was limited to the title, abstract and key words.

### ***Phase 3. Purifying Information***

We obtained a total of 251 papers in both databases, 70 were duplicates, hence, we carried out an initial revision of 181 articles in order to identify the relevance of every one of them for the objectives of this research. This initial revision dismissed 144 papers because they did not present any empirical data. Lastly, we reviewed 37 papers.

### ***Phase 4. Data Coding and Analysis***

The analysis process was carried out quantitatively and qualitatively based on the following categories:

- Number of papers in which the learning analysis in flipped classroom was applied.
- Educational level in which the learning analysis in the flipped classroom was applied.
- The area of knowledge in which the learning analysis in flipped classroom was applied.

- Objectives and purposes of the application of learning analysis in the flipped classroom.
- Results obtained after applying the learning analysis in the flipped classroom.

## RESULTS

In theory, the literature revised shows that besides the learning analysis, the flipped classroom has been approached with other methods. Table 1 contains the authors that have used it.

**Table 1.** Authors that have used the learning analysis in the flipped classroom

1.	Gewerc, Montero & Lama, 2014
2.	Díaz-Lázaro, Solano & Sánchez-Vera, 2017
3.	AlJarrah, Thomas & Shehab, 2018
4.	Gelan <i>et al.</i> , 2018
5.	Jovanović <i>et al.</i> , 2017
6.	Hsiao <i>et al.</i> , 2018
7.	Hui, Mai & Kwok, 2018
8.	Lau <i>et al.</i> , 2018
9.	Sedraz <i>et al.</i> , 2018

Source: Self development.

Table 2 shows the studies that did not use this analysis and the method they resorted to.

**Table 2.** Other methods used to analyze flipped classroom

No.	Analysis author	Method to assess inverted classroom
1.	Asarta & Schmidt, 2017	Quantitative method with statistical test to assess the academic achievement between a control group and a pilot group
2.	Blau & Shamir-Inbal, 2017	Qualitative method to analyze students' learning experiences and interpretations
3.	Kim <i>et al.</i> , 2014	Mixed method based on the framework of the <i>Research Community</i>
4.	Yunglung <i>et al.</i> , 2014	Mixed method under a holistic research paradigm
5.	MacDonald-Hill & Warren-Forward, 2015	Mixed method to identify the perception of students on the flipped classroom
6.	Nazarenko, 2015	Mixed method to identify the perception of students and teachers on the flipped classroom
7.	Rose <i>et al.</i> , 2016	Quantitative method to measure the efficiency and interactivity of classes on video
8.	Liebert <i>et al.</i> , 2016	Mixed method based on the quantitative analysis of a survey with Likert type responses and the qualitative analysis of narrative responses
9.	Desai <i>et al.</i> , 2016	Design method to demonstrate the viability of creating a web site integrated by medical students
10.	Bhuiyan <i>et al.</i> , 2018	Method of analysis of conglomerates and <i>post hoc</i> analysis to examine the consequences of the learning activities in a flipped classroom.

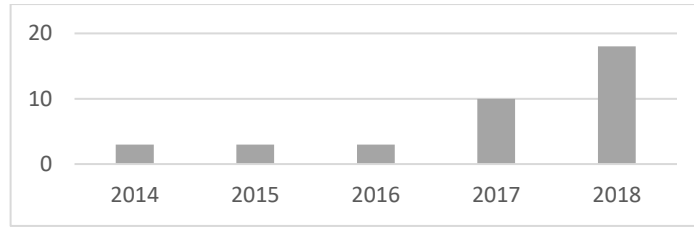
11.	Domínguez <i>et al.</i> , 2017	Quantitative method to measure the perceptions of pre and post intervention through the <i>flipped classroom perception instrument</i>
12.	Domínguez, Sanabria, y Sierra, 2018	Quantitative method to measure the theoretical model on relations between the learning atmosphere of the flipped classroom and the learning perceptions.
13.	Gadbury-Amyot, Redford & Bohaty, 2017	Quantitative method to examine the association between studying habits described by students and the active learning practices necessary for a meaningful learning in flipped/mixed classroom
14.	Melo y Sánchez, 2017	Mixed method to analyze the students' perceptions on the flipped classroom methodology
15.	Wang, 2017	Exploratory method to know how the online behavior affects achievement in the flipped classroom
16.	Yilmaz, 2017	Quantitative method to explore the impact of the electronic learning of the students on their satisfaction and motivation in flipped classroom
17.	Cochi, 2019	Informal <i>post hoc</i> experimental and statistical method carried out on a control group and an experimental group
18.	Barral <i>et al.</i> , 2018	Quantitative method with the chi-square test to assess the learning of students belonging to on an experimental group and a control group
19.	Bakla, 2018	Mixed method to carry out an explicative sequential study to identify if the material generated by the students fosters active learning
20.	Sergis, Sampson & Pelliccione, 2018	Qualitative method based on the theory of self-determination to explore the impact of mixed learning environments on the flipped classroom
21.	Foster & Stagl, 2018	Mixed method based on the survey, in-depth interviews and observation of students and teachers to design, implement and assess the flipped classroom

22.	Mejía <i>et al.</i> , 2018.	Quantitative, descriptive and transverse method. We used descriptive statistics to design an assessment model through the integration of immersive and at distance technology
23.	Mohamed & Lamia, 2018	Almost experimental method with a pilot group and a control group to implement the flipped classroom as an element of the Internet of Things. An intelligent tutoring system was used.
24.	Munir <i>et al.</i> , 2018	Mixed method with statistical analysis and focus groups on the self-perception of cooperative learning in the flipped classroom
25.	Smith, Rama & Helms, 2018	Mixed method to provide students with practical skills of critical thinking, including with instructors with limited experience in the teaching of critical thought
26.	Sun, Xie & Anderman, 2018	Quantitative method based on the self-regulated learning theory to examine the relations between the academic achievements and self-regulation key constructs. The structural equation was the method of analysis used
27.	Valero <i>et al.</i> , 2018	The pilot study method that evaluates through satisfaction questionnaires and in-depth interviews the perception of students on the quality of learning before and after the flipped classroom
28.	Webel, Sheffel & Conner, 2018	Case-study method to understand the experience of a professor who participated in a flipped classroom for the first time. Interviews, observation and content analysis were applied

Source: Self development.

The interest to assess the flipped classroom, whether with the analysis of learning or with other methods, grows every year. Graph 1 shows that during 2014, 2015 and 2016, there were only three articles per year; however, as of 2017, the interest in assessing the flipped classroom increased. Ten papers have already been published on this topic and, in 2018, this figure increased to 18.

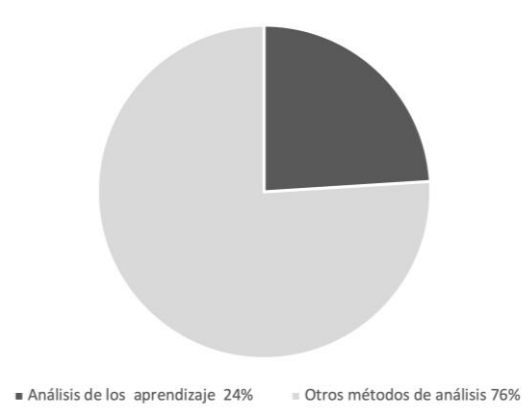




**Graph 1.** Number of papers informing on the assessment of flipped classroom.  
Source: Self development.

### Number of papers applying the learning analysis in the flipped classroom

We identified nine papers informing on the results of the research on the application of the learning analysis to assess the flipped classroom between 2014 and 2018. It was relevant that 28 papers cast research results with another method to assess the flipped classroom (See Graph 2) (said methods have been described in Table 2). Therefore, 24% of the research applied the learning analysis to assess the flipped classroom in comparison to 76% that did not.



**Graph 2.** Percentage of papers informing on the application of learning analysis to assess the flipped classroom.  
Source: Self development.

The results obtained when analyzing the same topic per year suggest that the interest in applying the learning analysis to assess the flipped classroom is growing. In 2014 a paper on this topic was published; however, there were none in 2015 and 2016. In 2017, two papers were published, and in 2018 the number of papers increased to six (See Table 3).

**Table 3.** Number of papers informing on the learning analysis to assess the flipped classroom per year

	2014	2015	2016	2017	2018
Learning analysis to assess the flipped classroom	1	0	0	2	6
Other methods to assess the flipped classroom	2	3	3	8	12

Source: Self development.

### *Educational level at which the learning analysis was applied in the flipped classroom*

In order to identify the level at which the educational level has been used in this analysis, we made a simple calculation which results are shown in Table 4. It is important to mention that no text give out information on the application of this analysis at the level of intermediate education. Higher education is the level most addressed at the educational level with seven papers published. Among these papers, only one mentions the application of the analysis at postgraduate level and one more on basic education. It is also relevant in this case that more than one method was used to assess the flipped classroom (these methods were described in Table 2). The flipped classroom has been assessed most at higher education with methods other than the learning analysis.

**Table 4.** Number of papers on the education level at which the learning analysis in flipped classroom was applied

	Postgraduate studies	Bachelor's degree	Basic education	Not mentioned
Using learning analysis to assess flipped classroom	1	7	1	0
Other methods to assess the flipped classroom	3	23	1	1

Source: Self development.

**AREA OF KNOWLEDGE AT WHICH THE LEARNING ANALYSIS IN THE FLIPPED CLASSROOM WAS APPLIED**

We have defined the areas of natural sciences, social sciences, engineering/mathematics/computing, economics/finances and other areas not mentioned as the areas of knowledge to which the analysis mentioned above was applied. (See Table 5).

**Table 5.** Number of papers on the area of knowledge to which the learning analysis in the flipped classroom was applied

	<b>Natural Sciences</b>	<b>Social Sciences</b>	<b>Engineering/ mathematics/ computing</b>	<b>Economics / finances</b>	<b>Not mentioned</b>
Use of learning analysis to assess the flipped classroom	1	1	4	1	2
Other methods to assess the flipped classroom	11	6	4	4	3

Engineering/mathematics/computing are the areas of knowledge to which the learning analysis in the flipped classroom were most applied; four papers mention this process of analysis. The other areas have scarcely been addressed. The use of methods other than the learning analysis to assess the flipped classroom is evident (See the detailed description in Table 2). The use of other methods is also highlighted in natural sciences and social sciences.

**OBJECTIVES AND PURPOSES OF THE APPLICATION OF THE LEARNING ANALYSIS IN THE FLIPPED CLASSROOM**

The objectives and purposes of applying the analysis aforementioned are the following: evaluate the academic achievement, identify/analyze the perception of the student regarding a course given in a flipped classroom, evaluate/identify the students' behavior in regard to learn, some research presented more than two objectives; however, the research studying the students' perceptions and the academic achievement (See Table 6) were most frequent.

**Table 6.** Number of papers presenting the objectives and purposes of the application of learning analysis in the flipped classroom

	Assess academic achievement	Identify/analyze the students' perception	Assess/identify the students' conduct	Objectives and mixed purposes
Use of learning analysis to assess the flipped classroom	4	0	5	0
Other methods to assess the flipped classroom	3	18	1	6

Source: Self development.

As we can notice, the main objectives and purposes of the application of the analysis were to evaluate and identify students' behaviors regarding learning with five papers. The second objective and purpose alluded to the assessment of the academic achievement with only four papers. The objective and purpose of other methods to evaluate the flipped classroom were stressed once again, more specifically by identify/analyzing the perception of the students regarding the course in the flipped classroom, with 18 papers (those methods are described in detail in Table 2).

### **RESULTS OF THE APPLICATION OF THE LEARNING ANALYSIS IN THE FLIPPED CLASSROOM**

According with the revised bibliography, the results obtained through the application of the learning analysis in the flipped classroom can be classified as follows: improves the academic achievement as well as self-regulated learning, increases the students' motivation/satisfaction in regard to the course of flipped classroom, increase the collaboration/social interaction in the flipped classroom, increases the participation of the students, reduction of the time of in-class classes or of the time in class with the teacher, and resistance to the change of traditional class to flipped classroom. It is worth mentioning that some papers present more than one of the results described above; thus, the total number of studies that used the learning analysis is higher than nine, and those using other methods exceeds 28 (See Table 7).

**Table 7.** Number of papers informing about the results obtained after applying the learning analysis in the flipped classroom

	Improvement of the academic achievement	Improvement of the self-regulated learning	Increase in motivation/satisfaction	Increase in collaboration/social interaction	Increase in participation	Reduction of in-class classes	Resistance to change
Use of learning analysis to assess the flipped classroom	3	4	2	2	1	0	0
Other methods to assess the flipped classroom	11	13	17	6	1	6	2

Source: Self development.

The tendency of using other methods for the learning analysis is maintained in this area; however, the specialized bibliography informs that the application of this analysis improves self-regulated learning mainly. Likewise, progress was obtained in the academic achievement, motivation and collaboration. All these areas are fundamental when considering that the flipped classroom is a didactic strategy that, when well developed, produces positive effects in the students.

Likewise, the specialized bibliography reveals that the results obtained when using other methods to assess the flipped classroom highlighted the students' motivation/satisfaction, even though academic achievement, motivation and satisfaction of the students were also addressed. The scarcest result in both methods of analysis is the improvement in the participation of the students. Nevertheless, we do not perceive an important resistance to transform the traditional class in the flipped classroom. In both cases, i.e., using the learning analysis and other methods to assess the flipped classroom; the second positive result was the improvement in self-regulated learning. This is significant since this type of learning is valuable for people to design their personal virtual learning environments.

## DISCUSSION AND CONCLUSION

Since the term “*learning analysis*” is recent, there is little specialized bibliography on the application of this method in the flipped classroom. Regardless that the development of the learning analysis in the flipped classroom has been scarce until now, there is empirical evidence that its use is drawing the attention of the academy.

Between 2017 and 2018, there was a considerable percentual increase of research that applied this analysis. Higher education is the educational level at which this analysis has been applied; the same applied to other methods used to assess the flipped classroom. Even though the bibliography does not mention the reason for which this educational level has received more attention, the results are consistent with other studies of information and communication technologies that indicate the reason to conduct more research at the higher level. Researchers find it more convenient to conduct empirical research in their work centers than move to the facilities where basic or intermediate education is provided.

Engineering, mathematics and computing are the areas of knowledge in which the learning analysis in the flipped classroom has been applied, contrary to natural sciences and social sciences in which said analysis has not been used. Even though the research reports do not explain the reason for this situation, it is possible that it occurs because the plans and programs of engineering, mathematics and computing are similar to the learning analysis method.

The systematic revision has identified that other methods of flipped classroom assessment have been used above all in natural sciences. This makes sense since the *flipped classroom* arose in this area of knowledge, more specifically in chemistry. The main objectives and purposes for applying the learning analysis in the flipped classroom were to assess and identify learning conducts and to improve academic achievement.

The objectives and purposes of measuring, collecting, analyzing and reporting data of the apprentices and their context, are closely linked to the learning analysis method, and they help in understanding and optimizing learning. On the contrary, other methods of flipped classroom assessment emphasized the identification/analysis of the perception the students have regarding the class of flipped classroom. This makes sense since these methods are qualitative, while the learning analysis is similar to the quantitative data treatment.

The most outstanding results in applying this analysis in the flipped classroom were the improvement in self-regulated learning and, by extension, a greater students’ academic achievement. In contrast, when we apply the traditional methods to assess the flipped classroom, we obtained an increase in the students motivation/satisfaction. Once more, these differentiated results, according to the method to assess the flipped classroom, are understandable since the learning analysis method is



- Ardura, Diego y Zamora, Ángela. (2014). ¿Son útiles los entornos virtuales de aprendizaje? Evaluación de una experiencia en la enseñanza y el aprendizaje de la relatividad. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, 11 (1), 83-93. Recuperado de <https://revistas.uca.es/index.php/eureka/article/view/2864>
- Asarta, Carlos & Schmidt, James. (2017). Comparing student performance in blended and traditional courses: Does prior academic achievement matter? *The Internet and Higher Education*, 32, 29-38. <https://doi.org/10.1016/j.iheduc.2016.08.002>
- Bakla, Arif. (2018). Learner-generated materials in a flipped pronunciation class: A sequential explanatory mixed-methods study. *Computers & Education*, 125, 14-38. <https://doi.org/10.1016/j.compedu.2018.05.017>
- Barral, Ana; Ardi-Pastores, Verónica & Simmons, Rachel. (2018). Student learning in an accelerated introductory biology course is significantly enhanced by a flipped-learning environment. *CBE –Life Sciences Education*, 17 (3), 1-9. <https://doi.org/10.1187/cbe.17-07-0129>
- Bhuiyan, Saifur; Goodarzi, Shoeli; Large, Jennifer; Serrano, Christina & Bristow, Susan. (2018). Understanding ERP learning success in flipped classrooms, en *Americas Conference on Information Systems 2018: Digital Disruption*. AMCIS.
- Blau, Ina & Shamir-Inbal, Tamar. (2017). Re-designed flipped learning model in an academic course: The role of co-creation and co-regulation. *Computers & Education*, 115, 69-81. <https://doi.org/10.1016/j.compedu.2017.07.014>
- Chen, Yang-Hsueh & Chen, Pin-Ju. (2015). MOOC study group: Facilitation strategies, influential factors, and student perceived gains. *Computers & Education*, 86, 55-70. <https://doi.org/10.1016/j.compedu.2015.03.008>
- Cochi, Carlana. (2019). Identifying differential benefits from a flipped-group pedagogy in introductory microeconomics. *International Review of Economics Education*, 30, 100143. <https://doi.org/10.1016/j.iree.2018.07.002>
- Desai, Naman; Bunch, Paul; DiSalvo, Donald; O'Brien, Reiko; Andriole, Katherine; Smith, Terri & Durfee, Sara. (2016). The use of an integrated website to enhance the educational experience in a medical school radiology clerkship course. *Current Problems in Diagnostic Radiology*, 45 (1), 17-22. <https://doi.org/10.1067/j.cpradiol.2015.03.002>
- Díaz-Lázaro, José; Solano, Isabel & Sánchez-Vera, Mar. (2017). Social



- learning analytics in higher education. An experience at the primary education stage. *Journal of New Approaches in Educational Research*, 6 (2), 119-126. <https://doi.org/10.7821/naer.2017.7.232>
- Domínguez, Luis; Sanabria, Álvaro y Sierra, Diego. (2018). El clima productivo en cirugía: ¿una condición para el aprendizaje en el aula invertida? *Educación Médica*, 19, 263-269. <https://doi.org/10.1016/j.edumed.2017.08.001>
- Domínguez, Luis; Sierra, Diego; Pepín, Juan; Moros, Gonzalo y Villarraga, Angélica. (2017). Efecto del aula invertida extendida a simulación clínica para la resucitación del paciente traumatizado: estudio piloto de las percepciones estudiantiles sobre el aprendizaje. *Revista Colombiana de Anestesiología*, 45 (S2), 4-11. <https://doi.org/10.1016/j.rca.2017.07.011>
- Escudero-Nahón, Alexandro y González, Diana. (2017). Propuesta para identificar la investigación de frontera en la investigación basada en diseño sobre nuevos modelos educativos, en L. Gómez, L. Romero, M. Mejía y R. Victoria (eds.), *Posibles retos del diseño ante grandes cambios* (pp. 932-944). Estado de México: Universidad Autónoma del Estado de México.
- Fernández, Aaron; Muñoz, Pedro & Delgado, Carlos. (2018). Scenarios for the application of learning analytics and the flipped classroom, en *2018 IEEE Global Engineering Education Conference (EDUCON)*, pp. 1619-1628. <https://doi.org/10.1109/EDUCON.2018.8363429>
- Foster, Gillan & Stagl, Sigrid. (2018). Design, implementation, and evaluation of an inverted (flipped) classroom model economics for sustainable education course. *Journal of Cleaner Production*, 183, 1323-1336. <https://doi.org/10.1016/j.jclepro.2018.02.177>
- Gadbury-Amyot, Cynthia; Redford, Gloria & Bohaty, Brenda. (2017). Dental Students' study habits in flipped/ blended classrooms and their association with active learning practices. *Journal of Dental Education*, 81 (12), 1430-1435. <https://doi.org/10.21815/JDE.017.103>
- Gelan, Anouk; Fastré, Greet; Verjans, Martine; Martin, Niels; Janssenswillen, Gert; Creemers, Mathijs & Thomas, Michael. (2018). Affordances and limitations of learning analytics for computer-assisted language learning: A case study of the VITAL project. *Computer Assisted Language Learning*, 31 (3), 294-319. <https://doi.org/10.1080/09588221.2017.1418382>
- Gewerc, Adriana; Montero, Lourdes & Lama, Manuel. (2014). Colaboration and social network in higher education. *Media Education Research Journal*, XXI, 55-62.

<https://doi.org/103916/C42-2014-05>

- Hsiao, Chen; Huang, Jeff; Huang, Anna; Lu, Owen; Yin, C. J. & Yang, Stephen. (2018). Exploring the effects of online learning behaviors on short-term and long-term learning outcomes in flipped classrooms. *Interactive Learning Environments*, 1-18. <https://doi.org/10.1080/10494820.2018.1522651>
- Hui, Yan; Mai, Bo & Kwok, Lam. (2018). Cultivating better learning attitudes: A preliminary longitudinal study. *Open Learning: The Journal of Open, Distance and e-Learning*, 33 (2), 155-170. <https://doi.org/10.1080/02680513.2018.1454830>
- Jarrah, A.; Thomas, M. & Shehab, M. (2018). Investigating temporal access in a flipped classroom: Procrastination persists. *International Journal of Educational Technology in Higher Education*, 15 (1), 2-18. <https://doi.org/10.1186/s41239-017-0083-9>
- Jovanović, Jelena; Gašević, Dragan; Dawson, Shane; Pardo, Abelardo & Mirriahi, Negin. (2017). Learning analytics to unveil learning strategies in a flipped classroom. *The Internet and Higher Education*, 33, 74-85. <https://doi.org/10.1016/j.iheduc.2017.02.001>
- Kim, Min; Kim, So; Khera, Otto & Getman, Joan. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. *The Internet and Higher Education*, 22, 37-50. <https://doi.org/10.1016/j.iheduc.2014.04.003>
- Lau, Vicent; Farooque, Pue; Leydon, Gary; Schwartz, Michel; Sadler, Mark & Moeller, Jeremy. (2018). Using learning analytics to evaluate a video-based lecture series. *Medical Teacher*, 40 (1), 91-98. <https://doi.org/10.1080/0142159X.2017.1395001>
- Liebert, Cara; Mazer, Laura; Bereknyei, Sylvia; Lin, Dana & Lau, James. (2016). Student perceptions of a simulation-based flipped classroom for the surgery clerkship: A mixed-methods study. *Surgery*, 160 (3), 591-598. <https://doi.org/10.1016/j.surg.2016.03.034>
- MacDonald-Hill, John & Warren-Forward, Helen. (2015). Feasibility study into the use of online instrumentation courses for medical radiation scientists. *Radiography*, 21 (3), 282-287. <https://doi.org/10.1016/j.radi.2015.02.004>
- Madrid, Margarita; Angulo, Joel; Prieto, Manuel; Fernández, María y Olivares, Karen. (2018). Implementación de aula invertida en un curso propedéutico de habilidad matemática en bachillerato. *Apertura*, 10, 24-39. <https://doi.org/10.18381/Ap.v10n1.1149>
- Mejía, Gilbran; López, Mildred; Hernandez-Rangel, Eduardo y Cerano,

- José. (2018). Diseño de un modelo de evaluación mediante la integración de tecnología inmersiva y a distancia. *Educación Médica*. <https://doi.org/10.1016/j.edumed.2018.02.009>
- Melo, Lina y Sánchez, Ramiro. (2017). Análisis de las percepciones de los alumnos sobre la metodología aula invertida para la enseñanza de técnicas avanzadas en laboratorios de análisis de residuos de medicamentos veterinarios y contaminantes. *Educación Química*, 28 (1), 30-37. <https://doi.org/10.1016/j.eq.2016.09.010>
- Mohamed, Hafidi; & Lamia, Mahnane. (2018). Implementing flipped classroom that used an intelligent tutoring system into learning process. *Computers & Education*, 124, 62-76. <https://doi.org/10.1016/j.compedu.2018.05.011>
- Munir, Tajammal; Baroutian, Saeid; Young, Brent & Carter, Susan. (2018). Flipped classroom with cooperative learning as a cornerstone. *Education for Chemical Engineers*, 23, 25-33. <https://doi.org/10.1016/j.ece.2018.05.001>
- Nazarenko, Alla. (2015). Blended learning vs traditional learning: What works? (a case study research). *Procedia-Social and Behavioral Sciences*, 200, 77-82. <https://doi.org/10.1016/j.sbspro.2015.08.018>
- Plano, Vicki. (2019). Meaningful integration within mixed methods studies: Identifying why, what, when, and how. *Contemporary Educational Psychology*, 57, 106-111. <https://doi.org/10.1016/J.CEDPSYCH.2019.01.007>
- Rojas, Pablo. (2015). Paradigmas analíticos en entornos virtuales y de aprendizaje: una revisión de sus principales puntos de encuentros y diferenciaciones teóricas y de enfoque. *Revista educación y tecnología*, núm. 7, pp. 91-106.
- Rojas, Pablo. (2017). Learning analytics. Una revisión de la literatura. *Educación y Educadores*, 20 (1), 106-128. <https://doi.org/10.5294/edu.2017.20.1.6>
- Rose, Emily; Claudius, Ilene; Tabatabai, Ramin; Kearl, Liza; Behar, Solomon & Jhun, Paul. (2016). The flipped classroom in emergency medicine using online videos with interpolated questions. *The Journal of Emergency Medicine*, 51 (3), 284-291. <https://doi.org/10.1016/j.jemermed.2016.05.033>
- Sánchez-Meca, Julio. (2010). Cómo realizar una revisión sistemática y un meta-análisis. *Aula Abierta*, 38 (2), 53-64. Recuperado de <https://www.um.es/metaanalysis/pdf/5030.pdf>
- Sánchez-Meca, Julio y Botella, Juan. (2010). Revisiones sistemáticas y

meta-análisis: herramientas para la práctica profesional. *Papeles del Psicólogo*, 3 (1), 7-17.

- Sedraz, Carlos; Zambom, Erik; Rodrigues, Rodrigo; Ramos, Jorge & De Souza, Fernando. (2018). Effects of learning analytics on students' self-regulated learning in flipped classroom. *International Journal of Information and Communication Technology Education*, 14 (3), 91-107. <https://doi.org/10.4018/IJICTE.2018070108>
- Sergis, Stylanos; Sampson, Demetrios & Pelliccione, Lina. (2018). Investigating the impact of flipped classroom on students learning experiences: A self-determination theory approach. *Computers in Human Behavior*, 78, 368-378. <https://doi.org/10.1016/j.chb.2017.08.011>
- Smith, Troy; Rama, Paul & Helms, Joel. (2018). Teaching critical thinking in a GE class: A flipped model. *Thinking Skills and Creativity*, 28, 73-83. <https://doi.org/10.1016/j.tsc.2018.02.010>
- Sun, Zhiru; Xie, Kui & Anderman, Lynley. (2018). The role of self-regulated learning in students' success in flipped undergraduate math courses. *The Internet and Higher Education*, 36, 41-53. <https://doi.org/10.1016/j.iheduc.2017.09.003>
- Valero, Mario; Martínez, María; Pozo, Francesc & Planas, Eulàlia. (2019). A successful experience with the flipped classroom in the Transport Phenomena course. *Education for Chemical Engineers*, 26, 67-79. <https://doi.org/10.1016/j.ece.2018.08.003>
- Vieira, Camilo; Parsons, Paul & Byrd, Vetricia. (2018). Visual learning analytics of educational data: A systematic literature review and research agenda. *Computers & Education*, 122, pp. 119-135. <https://doi.org/10.1016/j.compedu.2018.03.018>
- Wang, Feng. (2017). An exploration of online behaviour engagement and achievement in flipped classroom supported by learning management system. *Computers & Education*, 114, 79-91. <https://doi.org/10.1016/j.compedu.2017.06.012>
- Webel, Corey; Sheffel, Christina; & Conner, Kimberly. (2018). Flipping instruction in a fifth grade class: A case of an elementary mathematics specialis. *Teaching and Teacher Education*, 71, 271-282. <https://doi.org/10.1016/j.tate.2018.01.007>
- Yilmaz, Ramazan. (2017). Exploring the role of e-learning readiness on student satisfaction and motivation in flipped classroom. *Computers in Human Behavior*, 70, 251-260. <https://doi.org/10.1016/j.chb.2016.12.085>

Yunglung, Chen; Yuping, Wang; Kinshuk & Nian-Shing, Chen. (2014). Is FLIP enough? Or should we use the flipped model instead? *Computers & Education*, 79, 16-27. <https://doi.org/10.1016/j.compedu.2014.07.004>

