eISSN 2255-0569

ORIGINAL

# Synchronous versus asynchronous methodology in nursing students: a comparative study

*Metodología sincrónica versus asincrónica en estudiantes de enfermería: un estudio comparativo*

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**Received:** 5 - I - 2024
**Accepted:** 31 - I - 2024

**doi:** 10.3306/AJHS.2024.39.02.114

## Abstract

***Objectives:*** This study aimed to assess the influence of self-regulation and self-efficacy on two different e-learning models, asynchronous vs synchronous.
***Methods:*** 201 nursing students were randomly assigned (1:1) to a synchronous working group (SG) versus an asynchronous working group (AG). Sociodemographic variables, self-efficacy and self-regulation were collected. Comprehension was assessed with a multiple-choice test. Linear regression was used to identify influential covariates, and test scores were compared using propensity scoring and inverse probability weighted regression.
***Results:*** There were no differences between synchronous and asynchronous interventions. Age (β = -0.04), employment status (β = 1.16) and level of performance self-regulation strategies (β = 0.31) predicted the level of knowledge acquired. After adjusting for the scores of both groups, no differences were found in the knowledge test scores.
***Conclusions:*** There are no differences between the two e-learning models. Regardless of the type of model, level of self-regulation, employment status and age have an impact on e-learning.

*Key words:* e-learning, synchronous learning, asynchronous learning, self-efficacy, self-regulation.

## *Resumen*

***Objetivos:*** Este estudio tuvo como objetivo evaluar la influencia de la autorregulación y la autoeficacia en dos modelos diferentes de aprendizaje electrónico, asíncrono y sincrónico.
***Métodos:*** 201 estudiantes de enfermería fueron asignados aleatoriamente (1:1) a un grupo de trabajo sincrónico (SG) versus un grupo de trabajo asincrónico (AG). Se recogieron variables sociodemográficas, autoeficacia y autorregulación. La comprensión se evaluó con una prueba de opción múltiple. Se utilizó la regresión lineal para identificar covariables influyentes y las puntuaciones de las pruebas se compararon mediante puntuación de propensión y regresión ponderada de probabilidad inversa.
***Resultados:*** No hubo diferencias entre las intervenciones sincrónicas y asincrónicas. La edad (β = -0,04), la situación laboral (β = 1,16) y el nivel de estrategias de autorregulación del desempeño (β = 0,31) predijeron el nivel de conocimientos adquiridos. Después de ajustar por las puntuaciones de ambos grupos, no se encontraron diferencias en las puntuaciones de las pruebas de conocimientos.
***Conclusiones:*** No existen diferencias entre los dos modelos de e-learning. Independientemente del tipo de modelo, el nivel de autorregulación, la situación laboral y la edad tienen un impacto en el e-learning.

*Palabras clave:* aprendizaje online, aprendizaje síncrono, aprendizaje asíncrono, autoeficacia; autorregulación.

**Cite as:** Moreno G, García-González FJ, Meneses-Monroy A, Valdespina-Aguilar C, Mayor-Silva LI. Synchronous versus asynchronous methodology in nursing students: a comparative study. *Academic Journal of Health Sciences 2024*; 39 (3):114-120 doi: 10.3306/AJHS.2024.39.03.114

## Introduction

During the COVID-19 pandemic, many universities were affected and had to suspend face-to-face classes from the beginning[1]. According to statistics provided by UNESCO in 2020, the COVID-19 pandemic affected more than 190 countries and almost 1.5 billion students[2]. On March 9, 2020, in an effort to protect public health in the midst of the COVID-19 pandemic, the Autonomous Community of Madrid became the first region in Spain to suspend face-to-face classroom activities as of March 11. Then, five days later, on March 14, the Spanish government declared a state of emergency, resulting in the suspension of face-to-face education nationwide[3]. During this time, online learning emerged as a solution to minimise the impact on students' academic progress[4]. While online education has been recognized as a promising and effective method for teaching nursing students[5,6], the transition to fully online courses during the COVID-19 crisis presented a unique challenge. The functioning of online courses and the mental states of individuals can differ significantly from those in normal times[7]. Of particular note is the situation of international students currently engaged in distance learning from resource-limited home countries, where institutional readiness in terms of technological and infrastructural support may not always be available[8]. This circumstance adds an additional layer of complexity to cross-national online education. The mandated shift to distance learning during the lockdown required a rethinking of both teaching-learning methods and processes. In addition, the reopening of schools, accompanied by the necessary sanitary measures, brought about a profound change in the perception of learning and teaching[9]. This process has been generalized to many other countries (10–12). In a survey of 700 universities and institutions in 8 countries, 95% of institutions had offered online learning during the COVID-19 pandemic, and 80% intended to increase investment in technology over the next 5 years[13].

E-learning is a concept that emerged in the 1990s as a form of distance learning using the Internet and technology, where the main aim is to ensure independent learning without the need for constant teacher intervention[14]. This concept has undergone a long evolution, from the design and publication of multimedia resources, the use of Learning Management Systems (LMS) with content on platforms (defined as virtual classrooms), the use of Web 2.0 (which enhances social interaction) and cloud computing, more focused on open content, which has generated new methodologies for Massive Online Open Courses (MOOCs)[15].

There are two types of e-learning: asynchronous and synchronous. Synchronous learning refers to online or distance learning that takes place in real time, with students attending scheduled classes. Asynchronous learning uses technology to facilitate the exchange of information and online learning resources by promoting communication and peer interaction in a timeless manner, thus removing the spatial and temporal limitations of synchronous methodology and allowing students to learn anytime, anywhere[16,17]. However, no differences have been found between the two types of e-learning in the academic performance of medical students[18,19]. The success of e-learning depends to a large extent on the learner's ability to direct and manage his or her own learning process. This requires the student to set appropriate goals and strategies to achieve them. This methodology encourages autonomy, independent learning and self-regulated thinking rather than traditional modes[20]. As a result, the most efficient and effective students in this learning model achieve better results[21]. There are few studies that assess self-efficacy in online learning environments in a multidimensional way[22,23]. Most studies have focused on the development of technology for learning[24-26] or on students' competence in using the Internet[27,28], but none of these studies has focused on evaluating the influence of general self-efficacy and self-regulatory processes on the e-learning process, either synchronous or asynchronous.

For these reasons, the aim of this study was to evaluate, in the context of teaching during the COVID-19 pandemic, in our environment, the degree of assimilation of content taught through synchronous e-learning compared to asynchronous e-learning taught simultaneously to two groups of students, as well as to know the influence of self-regulation and self-efficacy on the results obtained.

## Methods

### Design and setting

A comparative study was carried out in October 2021, in a single University centre in Madrid, Spain.

### Population

The study population consisted of all first-year nursing students at a public university in Madrid, Spain (N=201). Students who did not want to participate or did not sign the informed consent form were excluded from the study. Students were randomly assigned (1:1) to a synchronous working group (SG) before an asynchronous working group (AG). For randomization, a list of random numbers was generated using the statistical-epidemiological program Epidat v. 4.2.

The reasons for exclusion were not completing the previous questionnaires or not completing the asynchronous course.

### Variables

At baseline, the following socio-demographic variables were collected: gender (male or female), age (years), living arrangement (with parents, friends, partner, only)

and employment status (full-time, part-time, none and including volunteer work to explore its influence on academic performance). In addition, two validated self-report questionnaires were administered to all participants to measure self-efficacy and self-regulation:

- The Inventory of Self-Regulation Learning Processes (IPAA) (Rosario et al., 2007): an instrument to assess the use of self-regulation strategies by subjects in the three phases of this process (planning, execution and evaluation). It consists of 12 items in Likert format with five alternatives: 1 (never), 2 (few times), 3 (sometimes), 4 (many times) and 5 (always). The score in each variable (planning, execution and evaluation) is obtained from the mean of the subject's responses to the set of items assessing each of these dimensions. Therefore, the maximum score in each variable is five and the minimum is one. The internal consistency of the scale is adequate ($\alpha = 0.87$)[29].

- General self-efficacy scale (Schwarzer & Jerusalem, 1995). The scale consists of 10 items that are scored on a Likert scale with four alternatives: 1 (never), 2 (rarely), 3 (often), 4 (always). The maximum score is 40 and the minimum score is 10. The scale has adequate internal consistency indices ($\alpha = 0.90$) and a unidimensional structure[30].

## Procedure

Prior to the experience, students completed the informed consent and self-efficacy and self-regulation questionnaires. Both groups were then exposed to an academic lesson, each in their respective modality. For the AG, the lesson was delivered in an asynchronous e-learning format by watching a 40-minute video on health content creation and dissemination, based on the principles of mobile learning[31]. The video was created by an expert in audiovisual communications and digital content distribution. In this group, the students had the opportunity to send e-mails to the professors with questions about the content of the video. Students watched the video on their own devices, allowing them to pause and rewind as many times as they needed to if they did not understand certain parts. The video was watched in class to ensure that students completed the task and to assess their knowledge acquisition.

The SG received the same content synchronously via a webinar where they could ask questions to the presenter in a traditional classroom setting. The webinar consisted of an online class through the Microsoft Teams platform, where the instructor interacted directly with the students and explained the content directly online. Students could ask the instructor questions through an online chat facility. In addition to chat questions, students were able to ask final questions directly to the presenter via the online platform at the end of the webinar. The study was conducted with both groups on the same day, in different classrooms and at the same time. At the time of both lessons, all students in both groups were physically present in the classrooms. During the course of the study, there were no COVID-19-related restrictions, such as limitations on the number of students and social distance in our center. In both groups, the students were accompanied by a professor to solve any technical problems that might arise during the lesson. At the end of the lesson, the students completed a 10-question test with 3 possible answers and a single correct answer on the assimilation of the content covered in the lesson. This knowledge test was administered on the virtual campus but was conducted in person within the classroom, under the supervision of a professor. This arrangement ensured that students were unable to share information or answers during the test.

## Statistical analysis

The results of the categorical variables were presented as absolute frequencies (n) and percentages (%). Quantitative variables were presented as means and typical deviations. The characteristics of the participants were compared using the chi-squared test for categorical variables and univariate T-Student and ANOVA tests for continuous quantitative variables. Linear regression was used to identify covariates (socio-demographic factors, self-efficacy and self-regulation) that might influence the results. In order to adjust the test scores for the type of educational intervention and the covariates that were significant in the linear regression models, the propensity score matching technique (logistic regression model) was used, which selects the individuals in a paired form based on the values obtained in each covariate, and inverse probability weighted regression (simple linear regression model), which weighted each observation by the values obtained in the covariates, with different weights (the model gives high weight to subjects who obtain low values in the covariates and low weight to those who obtain high values). The results were considered statistically significant with a significance level of $p< 0.05$. All data analyses were performed using SPSS version 24 for Windows.

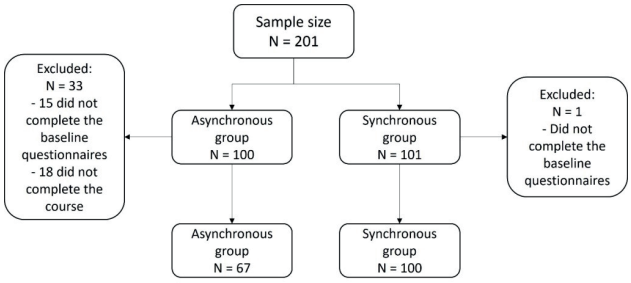
## Ethical and legal aspects

The tenets of the Declaration of Helsinki on biomedical research involving human subjects have been always followed. All students were informed of the aims and conditions of the research and signed an informed consent form stating that participation was completely voluntary and anonymous, that they were free to withdraw from the study at any time without giving any reason, and that participation did not entail any advantage or disadvantage for the students. In accordance with current legislation on the protection of personal data, the confidentiality and privacy of the data have always been respected. Data were entered into secure databases and access to data was restricted to researchers. Data analysis was restricted to the purposes of this study. The research protocol was approved by the University Research Committee.

## Results

Of the total number of students (201), 167 completed the study, 100 in the SG and 67 in the AG (**Figure 1**). 85.6% (n = 143) were women.

**Figure 1:** Distribution of students by groups.




Note: AG: Asynchronous group. SG: Synchronous group.

The mean age was 20.72 (6.86) years. Most students lived with their parents (73.05%), and half (56.3%) did not work or volunteer (**Table I**).

No differences were found between the groups in self-efficacy scores and in all subscales of self-regulation (planning, execution and evaluation) (**Table II**).

No differences were found in the age of the participants between the groups (IG: 19.62 vs. GC: 21.46; t = -1.89; p = 0.06) or by gender ($X^2$ = 0.08; p= 0.78), type of cohabitation ($X^2$ = 2.88; p = 0.41) or employment status ($X^2$ = 0.83; p = 0.84). There were no differences in the scores between the groups on the test following the synchronous and asynchronous interventions (AG: 8.00 vs. SG: 7.95; t = 0.24; p = 0.81).

In the simple linear regression model to predict the effect of covariates on test scores, the regression equation for age was statistically significant, indicating that 39% of the variability in test scores was due to age differences, which were inversely related to test scores (β = -0.04). A statistically significant association was also found for the work variable (F3, 146 = 8.19; p = 0.002), those who did not work in a remunerated and continuous way had a higher score than those who did work in a remunerated and continuous way (β = 1.16), explaining a variability in scores of 14.4%. No statistically significant associations were found between the level of self-efficacy and the processes of self-regulation of learning (planning and evaluation) with the test scores. However, the regression equation was statistically significant for the execution processes (F1, 148 = 4.06; p = 0.046), the higher the score on the execution subscale, the higher the score on the test (β = 0.31), explaining 26.7% of the variability in the test scores.

Finally, the scores obtained by each group on the test were adjusted using the propensity and scoring technique, considering the scores obtained on the IPAA execution subscale, age and employment status. After adjusting for the covariates in the model, the difference between the groups' test scores did not reach statistical significance (t = -0.60, 95% CI: -0.61, 0.37; p = 0.55). In the inverse probability weighted linear regression model adjusting for IPAA performance scores, age and employment status, no statistically significant differences were observed between the groups in the test scores ($F_{1, 148}$ = 0.88; p = 0.35).

**Table I:** Sociodemographic data between groups.

| | Synchronous Group | Asynchronous Group | Total | p-value |
|---|---|---|---|---|
| | N=100<br>M (SD) / n (%) | N=67<br>M (SD) / n (%) | N=167<br>M (SD) / n (%) | |
| **Age** | 21.46 (8.02) | 19.62 (4.45) | 20.72 (6.86) | 0.95 |
| **Employment situation** | | | | 0.86 |
| *Part-time paid job* | 12 (12.00%) | 9 (13.43%) | 21 (12.57%) | |
| *Does not work* | 55 (55.00%) | 38 (56.72%) | 93 (55.69%) | |
| *Full-time paid job* | 15 (15.00%) | 7 (10.45%) | 22 (13.17%) | |
| *Volunteer* | 18 (18.00%) | 13 (19.40%) | 31 (18.56%) | |
| **Type of cohabitation** | | | | 0.56 |
| *With friends* | 15 (15.00%) | 8 (11.94%) | 23 (13.77%) | |
| *With parents* | 71 (71.00%) | 51 (76.12%) | 122 (73.05%) | |
| *In couple* | 10 (10.00%) | 3 (4.48%) | 13 (7.78%) | |
| *None* | 2 (2.00%) | 2 (2.99%) | 4 (2.40%) | |
| *Alone* | 2 (2.00%) | 3 (4.48%) | 5 (2.99%) | |
| **Gender** | | | | 0.78 |
| *Woman* | 85 (85.00%) | 58 (86.57%) | 143 (85.63%) | |
| *Men* | 15 (15.00%) | 9 (13.43%) | 24 (14.37%) | |

**Table II:** Differences in the self-efficacy and self-regulation scales by groups.

| | Asynchronous Group | Synchronous Group | 95% CI | p-value |
|---|---|---|---|---|
| | M (SD) | M (SD) | | |
| **General Self-efficacy Scale** | 29.39 (4,04) | 29.62 (4,06) | (-1.71, 0.84) | 0.50 |
| **Planning (IPAA)** | 3.80 (0,70) | 3.71 (0,69) | (-0.15, 0.23) | 0.66 |
| **Execution (IPAA)** | 4.00 (0,62) | 3.96 (0,60) | (-0.15, 0.24) | 0.66 |
| **Assessment (IPAA)** | 3.72 (0,76) | 3.80 (0,79) | (-0.33, 0.17) | 0.54 |

Note: IPAA: The Inventory of Self-Regulation Learning Processes.

## Discussion

According to our results, we did not observe any differences in the scores of a knowledge test between the two e-learning based teaching strategies (synchronous vs. asynchronous). Regardless of the e-learning technique used, age, employment situation and level of self-regulation strategies affect test scores in such a way that the older the student, the lower the score; students who do not work continuously obtain better grades than those who work; and students who use more self-regulation strategies in the execution dimension obtain higher scores on multiple-choice knowledge tests.

The students who achieve better results are those who use more self-regulation strategies, which seems to confirm the idea that learning through active online strategies depends to a large extent on the student's ability to manage their own learning process through the use of executive strategies[20,21]. Therefore, self-regulation of learning mediates between context, student characteristics and performance[32] to better explain differences in performance between students and as a means of improving academic success[33].

We found no differences between groups in levels of self-efficacy, and no associations were found between grades and scores on the self-efficacy scale. However, other studies have found direct relationships between levels of self-efficacy and academic performance in terms of students' tendency to choose more difficult and challenging academic tasks[24,34]. In addition, in a survey of 200 nursing students, Kim et al found that self-directed learning in online learning was a predictor of academic success[35]. Razzak et al. found that students receiving online instruction in physiology preferred the asynchronous method to the synchronous method in which they adequately achieved the learning objectives[36]. In a survey of 4 Korean universities, Park et al. found that the variables that predicted online learning success were learning flow, learning engagement, and self-directed learning[37]. These findings reinforce the line of our results, that academic success depends on self-regulation through learning strategies. Vodovar et al, evaluating medical students, observed that students preferred the combination of online modality with face-to-face learning modality. In this combined modality, students attended more and had better academic success[38].

In a design very similar to ours, Mao et al. found no differences in outcomes between one online learning modality and the other, but did find that the level of active participation (participation in online discussions) was associated with better academic outcomes[18]. Similar to our study, Farros et al. found no differences between synchronous and asynchronous modalities in a test-based knowledge test[19].

Based on the results obtained and the publications in this field, it is necessary to emphasise that, in order to improve the academic learning process, a series of elements must be included: the use of open social networks that facilitate the process of self-direction of learning by students; the creation of activities with interactive and attractive content; the establishment of flexible deadlines for the submission of work in order to organise time; the use of technology and training in its use; and the support of self-regulation processes[39].

### Study limitations and Future lines

This study was conducted with a sample of students from a single centre and a single degree, so the results cannot be generalized to other student populations. Studies with larger samples of students and other disciplines should be carried out to confirm the results of our study. In addition, it is important to contrast the data obtained from our two e-learning modalities with face-to-face learning to compare the influence of self-efficacy and self-regulatory processes on academic performance. The results obtained are from a single training session, which is characterized by its limited time frame. Ideally, these findings should be incorporated into more comprehensive training programs that provide a thorough understanding of content assimilation across different instructional models.

### Educational Practice Implications

The study shows that there are no significant differences in knowledge acquisition between the two e-learning methods. Although asynchronous methods are less expensive and offer greater flexibility, making them a viable alternative for moderately complex topics, synchronous methods involve live instruction with the ability to resolve doubts immediately. Surprisingly, delivering content through recorded video that allows students to review at their own pace produces similar levels of comprehension and content acquisition. Disadvantages of synchronous methods include potential disruptions caused by student questions; a challenge not present in asynchronous settings. Efficiency is enhanced in asynchronous methods when alternative communication channels are allowed to resolve questions. To enhance the asynchronous approach, it is suggested that instructional videos be straightforward and that communication channels be provided for students to interact with instructors, thus promoting a more supportive learning environment.

## Conclusions

In conclusion, there are no differences in academic performance in nursing students between both e-learning models. There is no evidence to confirm that nursing students who complete their education through a synchronous course score higher on a test of subject knowledge than those who complete their education asynchronously. Irrespective of the type of model, levels of self-regulation, employment status and age have an impact on e-learning.

## Acknowledgements
We would like to thank the reviewers for their comments and suggestions.

## Conflict of interest
The authors declare that they have no competing interests.

## Author contributions
LIMS: Conceptualisation, Methodology, Writing-Original draft preparation. FJGG: Conceptualisation, Methodology, Writing-Original and Editing. PRGD: Data curation, Visualisation, Software, Validation. CVA: Translation, Validation, Writing-Reviewing and Editing. GM: Writing-Reviewing and Editing; AMM: Writing-Reviewing and Editing. All authors have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted. All authors read and approved the final manuscript.

## Ethics approval and consent to participate
The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by the Ethics and Research Committee of the Faculty (approval number: FEFP 20/21, on 4 November 2020). All participants included in the study were informed, verbally and in writing, of the study objectives and conditions. Written informed consent was obtained from all participants.

## Availability of data and materials
The datasets generated and/or analysed during the current study are not publicly available due to data protection policy but are available from the corresponding author on reasonable request.

## Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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