wjpmr, 2023,9(10), 21-29

SJIF Impact Factor: 5.922

WORLD JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.wjpmr.com

Research Article

ISSN 2455-3301

WJPMR

EVALUATION OF THE DIDACTIC STRATEGIES IMPLEMENTED IN THE PHARMACEUTICAL PHYSICAL CHEMISTRY II SUBJECT OF THE UNIVERSIDAD DE COSTA RICA AFTER BEING TAUGHT AS A SUMMER COURSE

José-Manuel Fallas-Ramírez[1,2], Juan José Mora-Román[1,2], Rolando Vargas-Zúñiga[1,2*]

[1]Industrial Pharmacy Department, Faculty of Pharmacy, Universidad de Costa Rica, San José, Costa Rica.
[2]Instituto de Investigaciones Farmacéuticas (INIFAR), Universidad de Costa Rica, San José, Costa Rica.

***Corresponding Author: Rolando Vargas-Zúñiga**

Industrial Pharmacy Department, Faculty of Pharmacy, Universidad de Costa Rica, San José, Costa Rica.

Article Received on 31/07/2023 **Article Revised on 21/08/2023** **Article Accepted on 11/09/2023**

ABSTRACT

After coming back to face-to-face classes in 2022, due to the virtuality generated by the COVID-19 pandemic, Pharmaceutical Physical Chemistry II (FA-0336) approval rate was meager, which is why it was taught in a modality known as a summer course aimed at repeaters and through a series of strategies, different from those employed in the regular subject. Therefore, it was decided to explore the opinion of the enrolled persons to determine their appreciation of the procedures contemplated. Forty-three pharmacy students were surveyed, revealing that more than 95% had a favorable perception regarding these methods, more than 88% considered them very good or good, and more than 93% rated them with a grade equal to or greater than 8 (on a scale from 1 to 10). The data collected helps to conclude that the didactic strategies for developing the FA-0336 course in this mode generated a positive perception in the people registered.

KEYWORDS: physical chemistry, didactic strategies, COVID-19 pandemic, students.

INTRODUCTION

The pharmacy career of the Universidad de Costa Rica (UCR, for its Spanish acronym) has more than 125 years of training quality pharmacists to meet the demands of the national market regarding these health professionals. Its curriculum contains courses that train these professionals to work in many areas, from hospital and community pharmacy to industrial pharmacy.[1] Specifically in the industrial area, physical chemistry is an essential discipline for aspects related to the formulation, preparation, distribution, storage, and stability of medicines.[2, 3]

The UCR Pharmacy Degree includes two courses in Pharmaceutical Physical Chemistry (I and II), where fundamental concepts applied to pharmaceutical work are studied. Due to the logical-mathematical nature and the in-depth understanding of chemistry, these subjects have historically represented great complexity for students. Therefore, their failure level is high within the entire curriculum.[4]

During the years 2020 and 2021, because of the pandemic caused by COVID-19, the Faculty of Pharmacy of the UCR taught the Pharmaceutical Physical Chemistry II subject (FA-0336) in a 100% virtual modality, which represented a significant barrier in the teaching and learning processes, both for professors and students. Since this is an educational program in which mathematical skills for problem-solving must be strengthened, personal interaction between students and professors becomes a mandatory necessity. This approach is based on the social-cognitive theory, according to which learning occurs through dynamic and multidirectional interactions between personal factors of the individual (knowledge, motivation, among others), the environment (home, classroom, among others), and behaviors (teaching strategies). Three environmental levels are considered: imposed, selected, and built. Professors significantly impact the imposed and the built environments, given that the person needs to learn, replicate, and demonstrate their values and behaviors, for which the professor must be an active agent.[5, 6]

After the decrease in infection cases and deaths, in 2022, the FA-0336 course was once again taught in person (under a series of measures adopted by the UCR). The comeback to face-to-face interaction represented a variation in students' learning paradigms. This change can be associated with difficult-to-predict results, which may or may not be favorable.[5, 7]

In the specific case of the FA-0336 educational program taught by the Faculty of Pharmacy of the UCR, the return to face-to-face lessons was unfavorable for content

comprehension and subject approval, showing one of the lowest approval percentages in the last ten years (less than 40%). For this reason, the professorship of Physical Chemistry decided to teach it in the modality known at the UCR as a summer course, which corresponds to an intensive program during the vacation period (between January and February 2023) aimed at those who did not approve it in 2022. This version implied a new didactic approach. As a result of the course's nature and the target population, it is impossible to teach it regularly, with students receiving the topics for the first time. This inability is related to needing at least a superficial knowledge of these contents. For this reason, this investigation aimed to evaluate the implemented strategies in the teaching and learning processes of pharmacy students who had previously failed this course.

MATERIALS AND METHODS

Population

Forty-three students who took the FA-0336 summer course after failing it in 2022 were surveyed to determine their perception of the strategies implemented and to evaluate them.

Data collection instrument

A survey was prepared through Google Forms to know the students' perceptions and qualifications of the FA-0336 course. The document was answered anonymously. It had distinct sections, including a socio-demographic exploration of the population description, direct questions about the procedures contemplated using Likert scales, a direct rating of them, and the self-assessment experience of each student. In addition, the survey contained open questions to explore some reasons that could explain the results achieved.

Analysis of the results

The data acquired were tabulated with the help of Excel® and analyzed by descriptive statistics. The socio-demographic information summarizes the main characteristics of the FA-0336 educational program population in the modality taught. The perceptions and the general evaluation of the approaches were treated through a frequency analysis to know the percentages and, thus, generate the respective graphs showing the people's opinions.

The answers to the open questions were treated through a content analysis, which allowed them to be grouped into categories, facilitating their evaluation and subsequent utilization to triangulate the relevant results achieved from the descriptive analysis.

Description of the strategies employed during the course

Various approaches were implemented to present and review the program topics. Each of them depended on its theoretical or theoretical-practical nature. **Table 1** describes the approaches according to the contents taught.

Table 1. Summary of the didactic strategies designed during the lessons in the FA-0336 summer course.

Contents	Activities description
Colligative properties	- Utilization of own videos as didactic support for the student's self-study. - Class construction of comparative tables between equations to look for similarities among the properties and arrive at new equations that relate them. - Development of timed exercises in class (simulating the time of an exam) in subgroups for later resolution on the whiteboard with the professor. - Tasks assignments about the particular topic's aspects and exercises for personal resolution.
Solutions tonicity	- Utilization of own videos as didactic support for the student's self-study. - Discussion in subgroups about the solutions and their mixtures tonicity for their subsequent analysis with the whole group and the professor. - Class construction of comparative tables between methods to elaborate isotonic solutions, establishing each method's characteristics. - Development of timed exercises in class (simulating the time of an exam) in subgroups for later resolution on the whiteboard with the professor. - Task assignments about the particular topic's aspects and exercises for personal resolution.
Solubility phenomena	- Class discussion on the most relevant concepts of acid-base balance and pH. - In-class individual exercises resolution, followed by a plenary in subgroups of no more than three people and concluding with a group review. It started with simple problems and ended with integrative ones. - Task assignments with exercises for personal resolution.
Interfacial phenomena	- Utilization of videos and presentations containing the general topic's explanations for individual study before the face-to-face lessons. - Development of guides as a questionnaire to synthesize the theoretical topic's contents. - Elaboration of conceptual schemes to relate the relevant topic's aspects. - Resolution of individually timed practical exercises and their subsequent joint

	resolution with the professor on the whiteboard. - Discussion about the topic's practical applications in professional life.
Pharmaceutical colloidal systems	- Class discussion of the primary topic's concepts and evaluation of these through interactive platforms such as Kahoot and Genially. - Preparation of a group glossary fed by the students through the course virtual classroom and supervised by the professor. - Elaboration of guides as a questionnaire in class for the study and understanding of the relevant topic's aspects. - Task assignments with practical problems for individual study.
Reology	- Class review of the most relevant rheological concepts and models for the pharmaceutical industry. - Resolution of practical exercises in subgroups, followed by group review on the whiteboard.
Applied chemical kinetics	- Class discussion of the most relevant concepts on drug stability. - In-class exercises resolution, individually and in groups, followed by a plenary in subgroups of no more than three people and concluding with a group review. It started with simple problems and ended with integrative ones. - Task assignments with exercises for personal resolution.

RESULTS

After teaching the FA-0336 summer course, which was exclusively for repeaters, the 43 people enrolled were surveyed to identify their perception compared to the modality usually developed in the ordinary semester. First, the survey explored sociodemographic information to characterize the population examined. All registered students were of legal age (18 years in Costa Rica), and none exceeded 25 years. **Table 2** summarizes the primary data appreciated according to sex and place of origin.

Table 2. Sociodemographic characteristics of the population surveyed according to sex (male or female) and place of origin (within the Greater Metropolitan Area or GAM, for its Spanish acronym, or outside this area). N = 43.

Characteristic	Condition	Percentage %
Sex	Man	18.6
	Woman	81.4
Place of origin	Inside GAM	55.8
	Outside GAM	44.2

Next, the instrument explored their perception of the strategies established for teaching the lessons in the summer course modality concerning performance in laboratory activities, putting into practice the knowledge acquired, understanding of the subject theoretical contents, and order in which the professors explained the topics. **Figure 1** shows that almost 100% had a favorable perception.

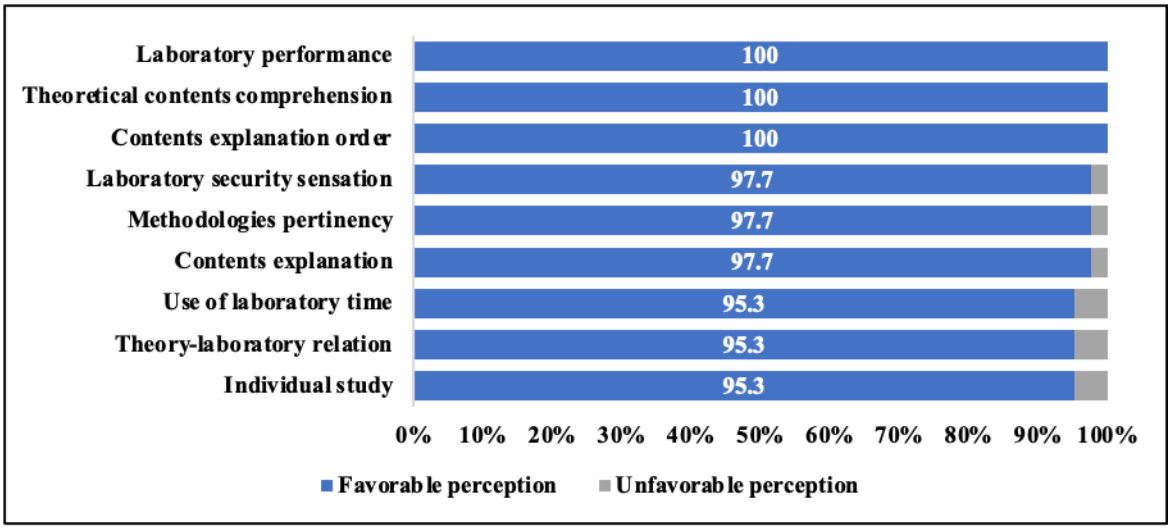

Figure 1. Perceptions from students of the strategies contemplated in the FA-0336 summer course. N = 43.

From the previous figure, it can be highlighted that more than 97% of the students had a positive perception since the subject strategies gave them greater security in their laboratory performance, they were adequate to teach the topics based on the population characteristics and favored the explanation of the educational program contents. Likewise, more than 95% of the respondents considered that they optimized the time of the laboratory sessions, allowed a balance between theory and practice in theoretical lessons, and helped them study outside the classroom.

As a complement, they accessed aspects that compared the summer course to the regular one, which they had failed. **Figure 2** shows the main results observed.

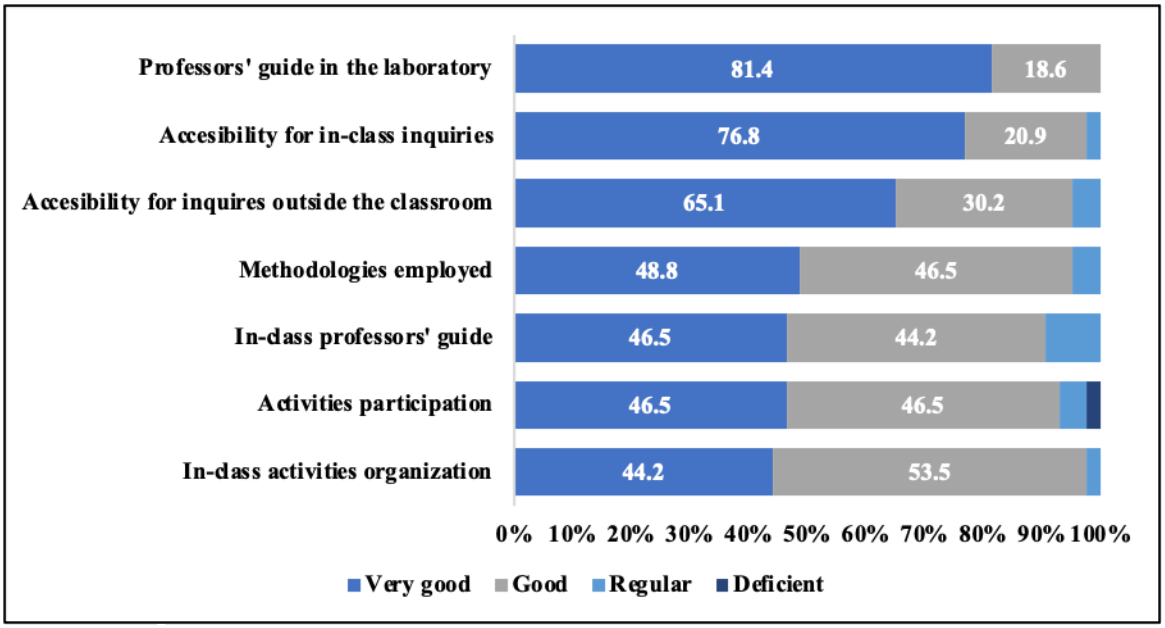

Figure 2. Students' appreciation concerning the FA-0336 summer course compared to the regular course previously taught. N = 43.

The students' opinions were very good or good regarding the strategies settled in the summer course for the professors' guide (100%, summing the percentages of students who indicated that it was very good or good), the accessibility for in-class inquiries (97.7%) and outside it (95.3%), the professors' methodologies utilized for the lessons (95.3%), the professors' in- class guidance provided in the teaching and learning processes (90.7%), each student participation attitude during the activities proposed (93.0%), and their organization (97.7%).

Also, the registered people were asked to give a numerical assessment of the summer modality compared to the regular one. For this, a scale of 1 to 10 was proposed, with 1 being the worst rating and 10 being the highest. As shown in **Figure 3**, 14.0% gave a 10 to the strategies, 51.2% a 9, and 27.9% an 8. A grade lower than 6 was not achieved.

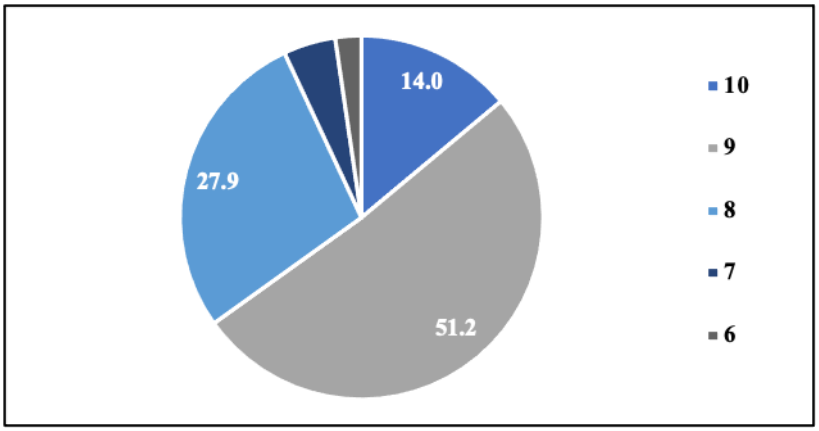

Figure 3. Grades given by the students to the FA-0336 summer course concerning the regular one. N = 43.

Additionally, they were consulted about their personal experiences regarding the knowledge level acquired and course interest during this modality and their previous experience with the subject. The main results achieved are summarized in **Figure 4**.

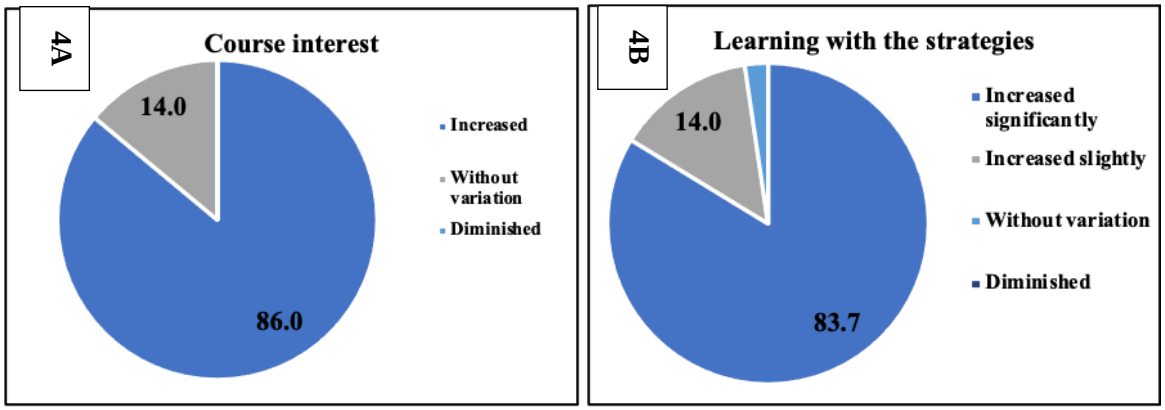

Figure 4. Assessment of the students' experiences with the FA-0336 summer course compared with the course previously taught in regular modality. N = 43.

Figure 4A shows that 86.0% established their interest augmented when taking it in this modality. Furthermore, **Figure 4B** demonstrates that the students thought their learning in the summer course increased significantly (83.7%) or slightly (14.0%).

Finally, the positive aspects and improvement opportunities that the respondents could highlight after their experience with the approaches contemplated for the FA-0336 educational program were explored through two open questions. Through a content analysis of all the positive aspects emphasized, they were categorized and summarized in **Table 3**, which shows the main categories, a category description, the number of people who gave their opinion about each one, and some examples (*Verbatims*) of the comments provided.

Table 3. Categorization of the most frequent positive aspects indicated by the FA-0336 summer course students.

Category	Description	Number of opinions	Examples through *Verbatims*
In-class practice execution	It includes opinions highlighting that it was possible to do more in-class exercises and solve them with the professor, as well as focus on the most relevant aspects of each topic and apply them to the future professional.	29 (67.4%)	V1. "Devoting more time to practice allowed me to have a greater ability to analyze problems." V2. "There were more practice exercises, and the most important thing is that we had the opportunity to do them together with the professors."
Better contents explanation	It includes opinions on the professors' strategies to explain the course topics.	16 (37.2%)	V3. "The topics were made much clearer thanks to the professors taking the time to explain the general things we need to understand in addition to getting to the point." V4. "The way in which the professors explained allowed us to understand the theory deeper and to be able to put it into practice."
Greater contents understanding	It includes opinions on how the strategies gave students a clearer understanding of the course topics.	10 (23.3%)	V5. "It allowed me to understand better how to apply and relate what I had already seen in theory to practical exercises and to understand what the exercise asked of me."
Easy to clarify doubts	It includes opinions based on the fact that the strategies generated a more favorable environment for students to	8 (18.6%)	V6. "Greater confidence when asking questions in class since it is a small group." V7. "...more closeness and

	make inquiries inside and outside the classroom.		interaction with professors during classes."
Time usage	It includes opinions on the strategies that allow better use of time in classes and their personal study time.	5 (11.6%)	V8. "Time is used in a better way." V9. "…there is more time to study the information."

Many answers were achieved, which varied since they were very personal and obeyed each student's needs. The strategies corrected these requirements. However, due to their diverse nature, it was impossible to categorize them, so these results are not shown, except for those aspects repeated most frequently and judged the most relevant.

On the other hand, the improvement opportunities differed a lot and were focused on specific individual needs. These responses did not allow for a content analysis similar to the one created for the positive aspects and thus categorized the opinions provided. Nonetheless, the most recurrent comments were that more theoretical classes needed to be given to review each topic concepts and that the procedures were adequate for the educational program's nature during the summer modality. Therefore, they had yet to detect improvement opportunities. Below are two examples in the form of *Verbatims* regarding these frequent observations:
V10. "Always give a general review of the subject before entering the resolution of exercises."
V11. "It seems to me that the course they gave in summer is perfect."

DISCUSSION

Physical chemistry is one of the fundamental disciplines in the training of pharmacy professionals since many of its theories and principles are applied in the formulation, preparation, storage, and stability of medicines. An example is the determination of a medication shelf life or raw materials' physicochemical characterization.[8, 9]

The UCR Pharmacy Degree includes two physical chemistry courses applied to the pharmacy major within its curriculum. Due to their complex nature, they have historically been two of the most difficult, with lower approval rates than the rest of the subjects. The FA-0336 educational program is in the fifth cycle (third year of the degree), and it is taught regularly once a year between March and July (known at the UCR as the first semester).

Because of the pandemic provoked by COVID-19 in 2020 and 2021, it was imparted virtually, causing problems in the student's teaching and learning processes. Its logical-mathematical and chemical structure demands a close accompaniment between the professor and the student to explain the theoretical bases and resolve exercises.

In the first semester of 2022, it was possible to return to face-to-face classes, implying that the students returned to the classroom and that the evaluations were performed in person, supervising the strict care this entails. In that year, a considerable decrease was observed (only about 20% of the population registered approved the course) compared to that appreciated during the pandemic (60 to 70%). The high failure rate concerned the Pharmaceutical Physical Chemistry professorship, so it was decided to teach it differently during the summer course.

This new methodology was offered in January and February of 2023 for students who still needed to approve it. This situation made it possible to design a strategy based on the assumption that the entire enrolled population already had some approach to its contents, which would allow for building and reinforcing prior knowledge. Once finished, a survey was conducted on the people enrolled to determine their perception regarding the methodologies used in this modality and evaluate the initiative.

Forty-three students enrolled were over 18 but not over 25 years old. This information is vital since age is fundamental to cognitive abilities and learning.[10] Therefore, having a relatively homogeneous population with similar cognitive skills was essential to validate the survey results.

Also, more than 80% of the registered students were female (**Table 2**). Pharmacy in Costa Rica has historically been a profession studied predominantly by women. This situation is similar to that observed worldwide. According to data from the International Pharmaceutical Federation (FIP), 59% of those who practice the profession are women.[11]

Likewise, it was possible to identify that about 55% of the people came from the country's central urban area known as the GAM. Moreover, a significant sector surveyed (close to 4%) had to move their residence near the university during January and February to participate in the FA-0336 subject. This scenario was established because this factor could be decisive in the attitude and success of taking advantage of the educational program. When people have to move their residence to study, the distance from their families is a factor that influences their academic success, in most cases negatively. Furthermore, this displacement requires more effort.[12] If differences were found in the strategies' perception, a factor that could influence this variance could have been the distance from the family environment. Nevertheless, the persons' opinions were homogeneous, ruling out that the place of origin correlates with the findings.

The perception of the approaches in the summer modality was explored to identify if there had been adequate to favor the learning process of the enrolled population in contrast to the regular course. As seen in **Figure 1**, the vast majority affirmed that the strategies facilitated understanding the theoretical contents since they were taught in an orderly, and the professors' explanations were adequate and pertinent.

Teaching a course intensively (18 hours a week) to repeaters, who were not wholly unaware of the contents, facilitates the development of resources that allow them to focus on specific and relevant aspects and make practices and discussions in class (as listed in **Table 1**), becoming the instructional scaffolding, according to Vygotsky's ideas. It is a controlled process of the tasks' elements that exceed the students' capacities so that they concentrate and dominate the aspects they can quickly grasp.[13]

Another relevant consideration is that, compared to the regular class (close to 100 students registered), a group of 43 people allows better interaction between the professor and the student. Large groups (over 50 people) require outstanding leadership and facilitation to avoid falling into procedures centered on the professor or passive learning environments.[14]

Besides, **Figure 1** illustrates that more than 95% of those surveyed stated that the strategies employed in the educational program favored the individual learning of the contents. This outcome may result from weekly theoretical and laboratory hours, which demand a personal effort to study daily, and the scenario in which they were only enrolled in this course in the months mentioned. Additionally, having good study habits and a weekly activities schedule, attending classes regularly, and taking advantage of the professors' office hours are crucial to a student's academic success. As other authors point out, study conditions, adaptation to the institution, and learning techniques are decisive in academic success.[15]

Another effort was coordinating with the Student Advising Center (CASE, for its Spanish acronym) of the UCR to give two talks of 30 minutes each during class time. The idea was to advise on good study habits that should be implemented in the summer course and throughout academic life.

Many students claimed better performance during the laboratory sessions and better time utilization. The learning gained was complemented by the knowledge provided in the theoretical classes, as described in **Figure 1**. This assertion may be because students think the strategies favored their understanding of the contents from several aspects. It is necessary to emphasize that the laboratory sessions in the theoretical-practical courses seek to complement the knowledge. Though, an optimal understanding of the theory that supports the practice must be comprehended. This idea is reinforced in an investigation referring to laboratory sessions during a general biology course. Reading, dictation, and study were encouraged to promote the integration between theory and practice.[4]

Another detail to highlight is that since the 43 enrolled students were retaking the subject, requesting a comparative assessment between the procedures settled under the summer course modality concerning those used during the regular one was relevant. As shown in **Figure 2**, between 90 and 100% of the people considered a very good or good teaching guide in theoretical classes and laboratory sessions, accessibility to academic staff to consult during and after school hours, particular methodologies addressed, activities organization for their fulfillment, and each student attitude to participate. Because of the student's previous experience, changing the methodology to teach an already-known educational program could generate resistance to change. Still, the positive appreciation showed that the approaches and methodological proposal were well-received and pertinent for a subject of this nature, with groups exclusively for those registered previously in the course.

A relevant fact was to increase student-professor interaction and avoid repeating academic failures, along with innovative didactic techniques. This interaction implied a change in the traditional educational paradigm.[16] The previous could be validated with the results seen in **Figure 3**. More than 93% of the persons rated the strategies with a grade higher than 8 out of 10, with a 9 being the most frequent response among those surveyed. These data are consistent with the success percentage observed in the summer course (approval superior to 76%), higher than in the first semester of 2022.

Self-efficacy beliefs (people's expectations about the possibility of dealing adequately with diverse stressors) represent a cognitive mechanism between action and knowledge, influencing, along with other variables, one's success. Therefore, an individual's attitude towards a course is essential for a good result. A high approval percentage reflects a positive perception and an excellent personal qualification.[17]

Added to the above, **Figure 4** complements the results since more than 97% of the students indicated that their knowledge level increased, and more than 86% said their interest augmented. In this way, a good attitude towards courses with high difficulty levels (as in the FA-0336 educational program) is vital to favor the person's learning process.[17] Besides, the desired academic success could be achieved if strategies that motivate their interest are executed.[16]

The Pharmaceutical Physical Chemistry professorship found academic success in the approval percentage and because most of the individuals experienced an interest

rise. Such a scenario is satisfactory since failing a subject at the university level is associated with a traumatic event, generating a negative attitude in the students when faced again, internally perceiving themselves as unable to face the learning process successfully.[18]

Another element was the intention to know the anonymous opinion regarding the positive aspects and the opportunities for improvement detected. For this, two open questions were asked. A large amount of qualitative information was acquired, dictating a content analysis to classify the opinions and categorize and tabulate them for a better examination.

Table 3 shows the categorization contemplated, briefly describing the criteria selected to create it and some *Verbatims*. Doing more practice in class compared to the regular course was the most common comment among the respondents (more than 67%), highlighting the importance of solving practical exercises to accompany the theory (V1 and V2). Plus, the courses involving logical-mathematical thinking are more complex than those essentially theoretical. From this scenario, techniques in which space is generated during the class to do exercises that allow students to improve their skills, together with the professor's guidance, are necessary. Instead of only providing information, teaching mathematics requires processing and interpretation.[19]

In the FA-0336 course, these spaces are a reality in the traditional modality. However, the need to adequately develop the theoretical explanations makes them shorter than those offered in the summer course. By having a population with a prior approach to the theoretical contents, it was possible to optimize the time and generate more exercises. Because of this time availability, a recurring opinion was that doing more in-class practice represented a valuable element.

Other recurring positive opinions were the improved professors' explanations (V3 and V4), leading to a better content understanding (V5). Precisely, due to the nature of the target population, it was easier for the staff to explain the topics' theoretical bases since they were not unknown and helped the students to delve into the transcendental content details, which during a regular course influence the individual work and study that each person must do.

In addition, numerous individuals highlighted that being in a small group, compared to the large ones who enrolled during the regular semester, facilitated asking questions in class (V6 and V7), and they distributed their time in a better way (V8 and V9). Once again, the dedication of a smaller temporary space to the theoretical explanation and a greater topic understanding promotes that people can clarify specific doubts in class, with the consequent opportunity to consult the professor at that moment. As a complement, it is clear that when the groups are minor, there is better interaction between the students and the professors, contrary to large ones.[14]

Finally, regarding the improvement opportunities, it was impossible to generate an in-depth analysis like the one built for the positive aspects, mainly since few people commented. Also, these commentaries focused on personal aspects and individual requirements that did not allow for establishing common categories. The previous is acceptable since the persons have particular needs according to their reality, making it almost impossible to find convergence points unless there is a generalized deficiency.

Nonetheless, two frequent comments indicated the need to review the theoretical contents before solving exercises (V10). These opinions may be because the professors requested the students to review the videos or read the information in advance. This petition implied an effort to attend the lessons with the revised information, making the person responsible for covering the topic study individually and thoroughly. The preceding was crucial for the strategies proposed in the summer modality to be successful.

Several individuals indicated that they had no observations regarding upgrading points or that it seemed to them that the approaches were good and relevant or sufficient for the summer subject (V11). This result validates the observations in **Figures 1** and **2**, which reflected their relevance and were qualified as very good or good.

CONCLUSIONS

The perceptions from the students of the strategies promoted in the FA-0336 summer course were favorable, increasing the topics' understanding, the individual study, and the general performance in the laboratory sessions. Likewise, compared to the course taught regularly in the first semester of 2022, the students' appreciation regarding their progress was very good or good due to the professors' guidance, their accessibility to make questions, the organization and the relevance of the activities, and the attitude of each person to participate. In this way, the activities in the summer modality augmented the content learning in the enrolled population and their interest in the course.

Finally, the time spent in theoretical classes to make exercises was the most highlighted positive aspect of the instrument given to each individual. All the information gathered shows that how the FA-0336 educational program was taught may be a valid option for future opportunities.

ACKNOWLEDGEMENT

The authors thank Dr. Lorena Berrocal, Dr. Gustavo Carazo, Dr. Melissa Brokke, and Dr. Marta Porras for the information about their lessons in the summer course modality during 2023.

REFERENCES

1. Facultad de Farmacia. Plan de Estudios de la Facultad de Farmacia. San José; Universidad de Costa Rica: 2020.
2. Florence AT, Attwood D. Physicochemical Principles of Pharmacy. 6th ed., London; Pharmaceutical Press: 2007.
3. Sinko PJ. Martin's Physical Pharmacy and Pharmaceutical Sciences. 6th ed., London; Lippincott, Williams & Wilkins: 2011.
4. Lemus M, Guevara M. Prácticas de laboratorio como estrategia didáctica para la construcción y comprensión de los temas de biología en estudiantes del recinto Emilio Prud'homme. Revista Cubana de Educación Superior, 2021; 40(2): e11.
5. Alqurshi A. Investigating the impact of COVID-19 lockdown on Pharmaceutical education in Saudi Arabia - A call for a remote teaching contingency strategy. Saudi Pharm J, 2020; 28(9): 1075-83.
6. An J, Meaney KS. Inclusion Practices in Elementary Physical Education: A Social-cognitive Perspective. Int J Disabil Dev Educ, 2015; 62(2): 143-57.
7. Almetwazi M, Alzoman N, Al-Massarani S, Alshamsan A. COVID-19 impact on pharmacy education in Saudi Arabia: Challenges and opportunities. Saudi Pharm J, 2020; 28(11): 1431-4.
8. Desta KH, Tadese E, Molla F. Physicochemical Characterization and Evaluation of the Binding Effect of *Acacia etbaica* Schweinf Gum in Granule and Tablet Formulations. Biomed Res Int, 2021; 2021: 5571507.
9. Vargas-Rodriguez YM, Obaya Valdivia AE, Montano-Osorio C, Lima-Vargas AE, Pacheco-Ortin SM, Vargas-Rodriguez GI. Online Applied Problem-Based Learning to Determine the Shelf Life of an on-Site Solution of Refrigerated Drug. International Journal of Educational Technology and Learning, 2020; 9(1): 10-8.
10. Mora-Gallegosa A, Salas S, Fornaguera-Tríasa J. Efectos del enriquecimiento ambiental dependiente de la edad en el comportamiento, funciones cognitivas y neuroquímica. Rev Mex Neuroci, 2017; 18(3): 66-78.
11. International Pharmaceutical Federation. Pharmacy at a glance: 2015-2017. The Hague; International Pharmaceutical Federation: 2017.
12. Simón H, Casado Díaz JM, Castejón Costa JL, Driha O. Efecto del tipo de alojamiento y el tiempo de desplazamiento sobre el rendimiento académico del alumnado universitario. In: Roig-Vila R (ed.). El compromiso académico y social a través de la investigación e innovación educativas en la Enseñanza Superior, Barcelona; Ediciones Octaedro: 2018.
13. Schunk DH. Teorías del aprendizaje: Una perspectiva educativa. 6th ed., México; Pearson: 2012.
14. Domínguez LC, Carreño O, Sierra D. Divide y vencerás: Efectos de dos intervenciones para el aprendizaje interactivo en grupos grandes de estudiantes sobre la percepción de la calidad del ambiente de aprendizaje. Educ Med, 2021; 22(Suppl 5): S390-S395.
15. Gatica-Lara F, Méndez-Ramírez I, Sánchez-Mendiola M, Martínez-González A. Variables asociadas al éxito académico en estudiantes de la Licenciatura en Medicina de la UNAM. Rev Fac Med UNAM, 2010; 53(5): 9-18.
16. Macho-González A, Bastida S, Sarriá Ruiz B, Sánchez Muniz FJ. Aprendizaje basado en errores. Una propuesta como nueva estrategia didáctica. J Negat No Posit Results, 2021; 6(8): 1049-63.
17. Abarza Morales LE, Gajardo Martínez P, Araya Retamal JM, Alarcón Luna C, Acuña González P, González Rojas S. Percepción de autoeficacia académica de estudiantes de medicina como predictor de éxito académico. Ciencia Latina Revista Científica Multidisciplinar, 2022; 6(1): 4360-74.
18. Acevedo D, Torres JD, Jiménez MJ. Factores Asociados a la Repetición de Cursos y Retraso en la Graduación en Programas de Ingeniería de la Universidad de Cartagena, en Colombia. Form Univ, 2015; 8(2): 35-42.
19. Concha Yero L, Cutiño Reinaldo A, Rodríguez Rodríguez A, Gutiérrez García JL, Marcillo Merino J. Falacias que Atentan contra el Desarrollo del Pensamiento Lógico Matemático. Didasc@lia Didact Educ, 2018; 9(4): 227-38.