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INVERTED CLASSROOM

TO TEACH AND LEARN THE LIST CONCEPT IN PROLOG

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TO TEACH AND LEARN THE LIST CONCEPT IN PROLOG

AULA INVERTIDA PARA ENSEÑAR Y APRENDER EL CONCEPTO DE LISTA EN PROLOG

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ABSTRACT

Inverted classroom or flipped classroom is a pedagogical model that applies Information and Communication Technologies and inverts the activities that are traditionally carried out in classes, with the activities that students carry out outside the classroom. The objective of this work was to implement and evaluate this model by teaching complex contents of the declarative programming language PROLOG, a theme of the Artificial Intelligence subject of careers related to Computer Science. The list concept in PROLOG was selected to teach, so that students in their study time would analyze new content and then in the classroom, with their teacher and the rest of the students, they would face the solution of exercises. Two experiments were carried out for this study. The first was carried out with 27 students of the subject Introduction to Artificial Intelligence of the 2nd Year of Computer Engineering at the "Marta Abreu" Central University of Las Villas, Cuba, in the 2020-2021 academic year. The second was held in June 2019 with 9 students enrolled in Artificial Intelligence from the 47th academic period of Systems Engineering, at the Metropolitan University of Ecuador. In both cases, a satisfaction survey was carried out on the students regarding the methodology used and its impact on the learning results of the students was evaluated, verifying that they accept the methodology and that the majority improve their academic performance.

Keywords:

Flipped classroom, teaching list, PROLOG.

RESUMEN

Aula invertida es un modelo pedagógico que aplica las Tecnologías de la Información y Comunicación e invierte las actividades que tradicionalmente se realizan en clases, con las actividades que los estudiantes realizan fuera del aula. El objetivo de este trabajo fue implementar y evaluar este modelo al impartir contenidos complejos del lenguaje de programación declarativa PROLOG, temática de la materia Inteligencia Artificial de carreras afines a la Informática. El concepto de lista en PROLOG fue seleccionado para enseñar, de manera que los estudiantes en su tiempo de estudio analizarán un contenido nuevo y luego en el aula, con su profesor y el resto de los estudiantes, se enfrentarán a la solución de ejercicios. Para este estudio se realizaron dos experiencias. La primera se llevó a cabo con 27 estudiantes de la asignatura Introducción a la Inteligencia Artificial del 2do Año de Ingeniería Informática en la Universidad Central "Marta Abreu" de Las Villas, Cuba, en el curso 2020-2021. La segunda se realizó en junio del 2019 con 9 estudiantes matriculados en Inteligencia Artificial del período académico 47 de Ingeniería en Sistemas, en la Universidad Metropolitana, Ecuador. En ambos casos se realizó una encuesta de satisfacción a los estudiantes con respecto a la metodología empleada y se evaluó el impacto de la misma en los resultados de aprendizaje de los estudiantes, comprobándose que la metodología es aceptada por ellos y que la mayoría mejora su rendimiento académico.

Palabras clave:

Aula invertida, enseñanza de listas, PROLOG.

INTRODUCCIÓN

In the current society of knowledge and information, it is necessary to take into account the characteristics of the students who arrive at university classrooms, since most of them are those born in the period 1994-2001 who belong to the so-called digital natives, which are characterized by being dependent on technology and by being tied to a digital culture. There are studies that show that traditional master classes do not facilitate the acquisition of skills or competencies by the future graduate of higher education in the 21st century, which is why a change of model is imposed to innovate in the teaching-learning process and incorporate ways to diversify the process and focus on student learning. One of the innovative models, which is currently being used worldwide, is the inverted classroom, which comes from the English flipped classroom (Marqués, 2016; Opazo Faundez et al., 2016; García Hulauda & Tello Ardemagni, 2016; Santiago Campión et al., 2019). In Sola et al. (2019), the effect of the flipped classroom model on the academic performance of university students is analyzed from studies indexed in the Web of Science (WoS) and Scopus databases.

In Domínguez Torres et al. (2021), the effects of the conventional flipped classroom and the remote flipped classroom are compared for the interactive discussion of clinical cases of surgery, as a teaching/learning strategy in the face of the COVID-19 pandemic. The study was carried out by comparing the levels of self-directed learning, as an indicator of the result of the change in methodological strategy, in a group of undergraduate students who participated in a conventional flipped classroom in 2017 with those of a group of students who participated in a remote flipped classroom in 2020. In relation to the pandemic stage, the work of Campillo Ferrer & Miralles Martínez (2021); and Collado Valero et al. (2021), in which a study is carried out that investigates the effects of the flipped classroom on the perceptions of Education students about their learning and motivation during the current pandemic and their use in Higher Education in Spain is investigated.

The inverted classroom, also called the reverse class, emphasizes learning that originates from what the student does and not what the teacher explains and does to teach in the classroom. In this model, face-to-face classes are dedicated to students working on tasks with a high cognitive level (solving exercises and practical application problems, analyzing solutions, etc.) while tasks with a lower cognitive level (reading or studying, hear, observe) takes place outside the classroom. Reversing the classroom is considered a radical transformation for teachers and students, who have to get out of their routine to achieve a change in the way they teach and learn. Teachers who are encouraged to use this pedagogical model may be afraid at first, but it is worth trying changes, which require a different job from the teacher who needs to incorporate new strategies and tools that can be used as resources, since educational informatics and action-based learning are the key components of this model (Contreras et al., 2017).

It was in 2007, from a teaching experience of two American professors (Jonathan Bergman and Aaron Sams), that this pedagogical model was born, they recorded and posted their classes online for those students who could not attend the classroom. These materials spread and other teachers began to record their classes so that the students could use the videos outside the classroom and use the class time in the classroom to carry out more complex tasks, which required collaborative work and the guidance of the teacher (Tourón Figueroa & Campión, 2015). In Sandobal Verón et al. (2021), is carried out a review of the use of the flipped classroom in higher education for engineering careers.

In Cuba, works are reported where this pedagogical model has been used, to name a few, there are investigations carried out at the University of Informatics Sciences (UCI) in the Bioinformatics career (Polanco Garay & Moré Soto, 2020) and for the teaching-learning of the Operating Systems subject of the Computer Science Engineering degree (Molina Correo et al., 2021). At the José Antonio Echeverría Technological University of Havana, Cujae, the implementation of the inverted class in the pedagogical training of engineers in Telecommunications and Electronics is disclosed (López Collazo, 2020). The University of Sancti-Spíritus José Martí Pérez, reports the experience of using this model in the Infotechnology subject that is taught in the 5th year of the Computer Engineering career and is part of its optional curriculum (Ríos Rodríguez, 2018). For its part, at the Central University Marta Abreu de Las Villas (UCLV), the use of this approach is reported in a distance course for the pedagogical preparation of Assistant Students of the Automatic Engineering Career (Torres Alfonso, 2020). In the area of health, a methodological proposal is made for the subject Introduction to Genetics (Sánchez Delgado, 2019) and the importance of the inverted classroom in the National School of Health is disclosed (Vidal Ledo et al., 2016). In Cantuña Ávila & Cañar (2021), the state of the art of the flipped classroom didactic strategy in Ecuador is presented in the databases: Scielo, Redalyc and the Google Scholar search engine for the period 2017 to August 2020.

Taking into account the characteristics of the flipped classroom and how it influences the improvement of learning, it is decided by the authors of this paper to introduce this pedagogical model for the teaching and learning of certain contents of programming with the declarative language PROLOG in careers related to the Computing. The objective of this work is to evaluate the effectiveness of the flipped classroom model based on the observation of its advantages compared to a traditional classroom model.

MATERIALS AND METHODS

In the development of this work, the type of qualitative research is used, where the teacher of the subject introduces changes in the traditional way of teaching content, to observe the behavior of the participating students and collect data on the results achieved.

The selected content was Lists in PROLOG, because it is a difficult concept for students to understand. The methodological planning of the activities was carried out to apply the flipped classroom approach for two weeks. The activities carried out are described below.

Preparation prior to the practical class: it was considered that it could be useful for the students to have a short didactic video (11 minutes), where the fundamental aspects of lists, list patterns and recursion in the procedures that use them were explained. The elaborated video constituted a complement to the instructional material, where the addressed content and examples of solved problems are summarized. So, that the students outside the classroom could see the video, this content is not taught as a conference and instead the time is dedicated to carry out a practical class, for which the group is guided to study the content using some of the means available in the subject (textbook in digital format, conference in a word document and video created by the teacher that addresses lists in PROLOG). The study of the content is oriented a week in advance so that the student can plan correctly, since it is necessary to take into account that he is taking other subjects.

In the class: two practical classes are held, in the first the content presented by the video and digital documents is discussed; the teacher asks about possible doubts that may arise in this regard. Once the doubts have been clarified in the classroom, consolidation activities of the studied content are carried out, the teacher asks general questions and the students answer, if there are errors, it encourages discussion in the group, then simple exercises are carried out on list patterns, unification of these list patterns with others and then problems involving lists are solved. In a second practical class, it is passed to the resolution of problems where it is useful to use this type of compound term of the programming language.

The flipped classroom pedagogical model is applied to groups of students on a selected topic and then the students' perception of the use of this approach as well as learning outcomes are evaluated.

Experience 1: For the introduction of this pedagogical model, in a first experience, a sample was taken consisting of the 27 students of the second year of Computer Engineering of the Faculty of Mathematics, Physics and Computing of the Central University of Las Villas, Cuba, of the regular daytime course, in the subject Introduction to Artificial Intelligence of the 2020 academic year.

Experience 2: Convinced that this model is feasible, it is also decided to innovate in the Artificial Intelligence subject of the Systems Engineering career of the Metropolitan University (UMET), Quito, Ecuador, for the teaching-learning of Lists in PROLOG that is taught in his Theme III. In this second experience, the sample is made up of the 9 students of the group in period 47 of the year 2019.

Satisfaction survey: the level of satisfaction of the flipped learning approach was evaluated through a satisfaction survey, which consists of an anonymous response instrument composed of 6 statements, in which the response options were Totally disagree, Neutral and Totally. in agreement.

Evaluations of knowledge on the selected topic: the answers to the questions made in the two practical classes and the answer to a question in the partial test that evaluates the acquired knowledge are considered. The responses to the satisfaction survey were tabulated and analyzed and an analysis of the learning outcomes was made.

RESULTS AND DISCUSSION

The first experience of introducing this pedagogical model occurred in the 2020-2021 academic year in the subject Introduction to Artificial Intelligence of the 2nd Year of Computer Engineering at the Central University Marta Abreu de Las Villas (UCLV), Cuba.

The Figure 1 shows the behavior of the students in their previous preparation study using only the video, the lecture or both ways of studying the contents.

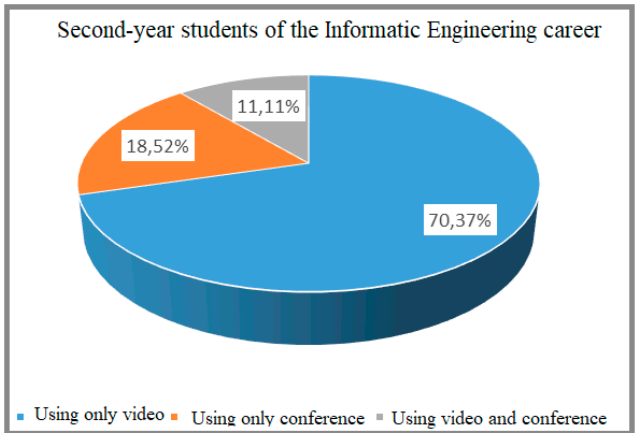

Figure 1. Behavior of the study carried out by second-year students of the Computer Engineering career.

The Figure 2 shows that 77.78% prepare for practical class, that is, 21 of the 27 students prepare according to the guidelines indicated in the study guides made.

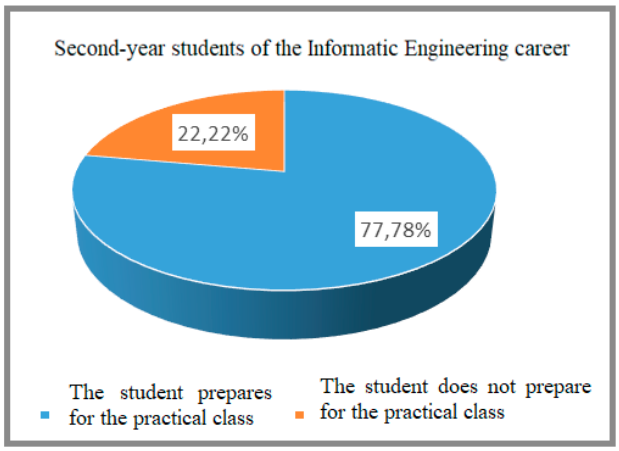

Figure 2. Preparation for practical class of the second-year students of the Computer Engineering career.

The practical class is attended by 26 students, of which 9 students are evaluated, 7 of them with a good grade and two with excellent, the remaining 17 students, although they did not receive a grade, had an active participation in the class, interested in solving problems. Problems, ask their doubts, and most of them solved some exercise. The 19 students, of the 26 who take the partial test, correctly answer the question related to the subject of lists in PROLOG, which represents 70.37% of the students in the sample and 73.07% of the students attending the assessment.

When applying the survey (see Figure 3) the results were satisfactory, since in 4 statements out of 6 the students surveyed were in total agreement, which represents 67%, they are statements 2, 3, 4 and 6 that correspond respectively to prefer to watch a video, comprehension when reading the summarized material, understand the study material through the video and that they liked the flipped classroom method. 66% disagreed with opting for the traditional class, 46% were neutral with the statement about understanding the content when reading a summary of the content addressed.

It is possible to establish a close relationship between the response of the students to the review of the video, the conference or the video and conference with respect to the statement "I liked the flipped classroom method compared to the traditional method", which is justified.

Statistically, since when applying the Chi square test, the significance is 0.012 less than 0.05. The same happens with the results of the students in the test, specifically in the answer to the question about lists in PROLOG in which the significance of the Chi square test is 0.00 less than 0.05.

Dear student, your opinion on the application of the Flipped classroom methodology for the teaching-learning of lists in PROLOG is valuable, we ask you to answer the survey with the utmost sincerity.
Please circle only one option for each statement.

Affirmation	Totally disagree	Neutral	Totally agree
1. I choose traditional class of the teacher instead of studding alone theory contents according to Flipped Classroom Methodology.	1 2 3	4	5 6 7
2. I prefer watching a short didactic video instead of having a traditional lesson with lists content in PROLOG.	1 2 3	4	5 6 7
3. I could understand while reading a summarized material of the content taught.	1 2 3	4	5 6 7
4. I understood the study material better through the video than by reading about the content.	1 2 3	4	5 6 7
5. I felt prepared to solve the problems discussed in class.	1 2 3	4	5 6 7
6. I liked flipped classroom method more than the traditional method.	1 2 3	4	5 6 7

Respondent data age: sex:

Figure 3. Survey applied to students.

Cronbach's α coefficient is known to be a widely used internal consistency statistic. The alpha value ranges from 0 to 1. When calculating the Cronbach coefficient for these two variables, 0.6 and 0.707 are obtained, which are considered acceptable. This result means that the inverted classroom model is accepted by the group of students and its application should continue to be tried in other courses and other topics of the subject should be incorporated.

Based on the good results obtained and that this model has been used in subjects from other universities related to the teaching of computer programming (Griffiths et al., 2016), it was chosen because that experience in the 2nd year of Computer Engineering of the UCLV is also carried out to teach Lists in PROLOG in the Systems Engineering career of the Metropolitan University (UMET), Quito campus, for the teaching and learning of Lists in PROLOG that is taught in its Theme III. To apply the inverted classroom model in the group, the same elaborated video was used, used in the first experience, which summarizes the key concepts about the list in PROLOG. The students had to review, through the virtual classroom that uses Moodle of the UMET, this material and the video before the practical activity to be carried out in the classroom.

For the practical class in the classroom, a collaborative learning activity was designed that allowed for a formative evaluation. In the first part of this practical activity, the teacher presents a summary of the concepts reviewed by the student and allows them to ask about any doubts they have. Subsequently, they are presented with a set of problems to solve, related to operations on lists. In total, three simple exercises and two with some complexity were solved, leaving one proposed to apply lists in a cryptography method to transmit information. It was observed that the students had understood the content studied and that they were able to solve the problems presented in the classroom, with the help of the teacher and other classmates. In addition, the students felt motivated by the type of activity developed. The teacher was also able to identify widespread misconceptions and clarify them for whole group. The students also asked the teacher for an explanation of the solutions given to the problems posed, which allowed them to provide an individualized formative evaluation. In this activity, 7 students out of 9 were present in the classroom for 78% attendance, of which two were evaluated as excellent and the rest as good.

With respect to the applied survey (see Fig. 3) the results were satisfactory, since in 4 statements out of 6 the students surveyed were in total agreement, which represents 67%, they are statements 2, 3, 4 and 6 that are they correspond respectively to preferring to watch a video, understanding when reading the summarized material, understanding the study material through the video and that they liked the flipped classroom method. 100% were neutral with opting for the traditional class and 57% disagreed or were neutral with statement 5 related to feeling prepared to solve problems.

When reviewing the results of the survey, it was striking that two of the youngest students in the group, one 20 years old and the other 21, were the ones who showed the most resistance to change since in all the statements they marked neutral or totally disagree, while that the three students from 26 to 28 years of age only marked statement 1 as neutral and all the others totally agreed. It is known that the two youngest students in the group are the ones with the best results in the race, which justifies their opposition to the change. This shows that the inverted classroom model is accepted by the group of students and it will be necessary to continue investigating its application in other periods.

CONCLUSIONS

The flipped classroom model can be considered simple, but it requires preparation to be truly effective in achieving the proposed objectives. The design and recording of videos, as well as the elaboration of instructional materials, needs effort and time the first time it is developed, however, for later academic periods it is not necessary to repeat all the work done.

The instructional material prepared must be didactic, summarized, where the concepts are clearly exposed. In addition, the design of the practical activity in the classroom must be carefully prepared; activities that develop critical thinking of students, interest and motivate them are demanded. The teacher must have experience in teaching the content, with skills to successfully develop practical work in the classroom. The teacher must be a facilitator of learning, encourage collaborative work, and conduct tutorials that allow the student to clarify their doubts.

In the first application experience of the model (at UCLV), the results show that the model can improve student grades and content learning. The experience at the UMET showed that the students were better prepared to face more complex exercises. In both groups, the students had a positive opinion regarding the acceptance of the model.

Using the inverted classroom pedagogical model in the context of distance education constitutes a valuable opportunity to facilitate the teaching-learning process in the midst of social isolation, mandatory due to the COVID-19 pandemic, therefore it is intended to continue with the experience including all the contents of the Artificial Intelligence a subject that is taught to the second year of Computer Engineering at UCLV in the course of the current year 2021, collecting data and processing information to continue evaluating this way of teaching.

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