



ISSN: 2230-9926

Available online at <http://www.journalijdr.com>

# IJDR

*International Journal of Development Research*

Vol. 11, Issue, 11, pp. 51924-51929, November, 2021

<https://doi.org/10.37118/ijdr.23321.11.2021>



RESEARCH ARTICLE

OPEN ACCESS

## THE APPLICATION OF THE FEDATHI SEQUENCE IN TEACHING HUMAN ANATOMY: A SUCCESSFUL CHANGE OF ATTITUDE

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### ARTICLE INFO

#### Article History:

Received 15<sup>th</sup> August, 2021

Received in revised form

16<sup>th</sup> September, 2021

Accepted 10<sup>th</sup> October, 2021

Published online 28<sup>th</sup> November, 2021

#### Key Words:

Anatomy, Students, Nursing, Professor, University, Teaching, Fedathi Sequence.

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### ABSTRACT

The study aimed to analyze the performance of the students and lecturers of the Nursing Course in Human and Clinical Anatomy before and after the implementation of the Fedathi Sequence. This descriptive and exploratory research with a qualitative approach, carried out with the Nursing Course students at Fametro University (Unifametro), Brazil, from April 2019 to October 2020. After consenting, the Sequence was adopted for students of the years 2018 and 2019. The performance of the students in the Human Anatomy of the Nursing Course in 2016 and 2017, not submitted to Sequence, and the academic indicators of the professors were researched in the data bank of Unifametro. The data was tabulated and analyzed. A significant rise in the academic performance was observed in the morning classes in Human Anatomy from 2018 on, independent of the semester compared to 2016.2, 2017.1 and 2017.2. There was an overall increase of about 10% in the academic indicators of the professors in Anatomy after the application of the Sequence. It is concluded that the application of the Fedathi Sequence in the Anatomy course promoted a better academic performance, reducing the failure indicator, as well as providing a better evaluation of the professor that applied it.

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Citation: Francisco Herculano Campos Neto, Hermínio Borges Neto, Antônia Lis de Maria Martins Torres et al. "The application of the fedathi sequence in teaching human anatomy: a successful change of attitude", *International Journal of Development Research*, 11, (11), 51924-51929.

## INTRODUCTION

It is of supreme importance for the learning and teaching process to create a satisfactory environment where the student is able to construct his own knowledge. It is necessary to reevaluate the methodological and didactic strategies to meet all needs of students, enabling them to be continuously interested and to offer them new forms of learning. The professor's attitude in the classroom, together with his planning, his strategy, his educational skill, and technological tools are essential to the learning and teaching process. Therefore, the Fedathi Sequence appears to be a methodological suggestion that focuses on the teaching and attitude of the professor as well as taking the students' participation in the process into account (Santos; Neto; Pinheiro, 2019).

The Fedathi Sequence was developed in the 1970s by Hermínio Borges Neto, a lecturer at the Federal University of Ceará (UFC) and introduced as a research methodology in 2018, aiming to improve the involvement of students in the classroom into their knowledge acquirement process. Despite coming from the Science of Mathematics, the Sequence can be applied to many areas such as Nature and Human Science (Felício; Teodósio; Borges Neto, 2018). Its structure is based on three levels, named Preparation, Experience and Analysis (Santos; Borges Neto; Pinheiro, 2019). The Preparation involves the teacher's didactical organization, including the analysis of the existing space and theory and the elaboration of the lesson plan. During the Experience, the development/execution of the lesson plan/didactical classroom situation, consisting in four stages (Position taking - comprehension of the statement and problem; Maturing - looking for different solving strategies; Solution - application of the strategies; Test - revision and confirmation of the chosen process) happens. In the Analysis the professor evaluates the lesson.

In the context of a consolidation of the Fedathi Sequence as a teaching method that is adaptable to a vast number of areas (Santos; Borges Neto; Pinheiro, 2019), its application in Human Anatomy is strategically important for the learning process of this science because of its relevance and interest assumed in the formation of health professionals (Barbosa et al., 2021). Furthermore, this science often generates dread among the students due to its specification related to its contents, consisting in a new set of vocabulary and the attribution of significance to these new words (Silva et al., 2018). In fact, the application of the Sequence during the study of Anatomy can boost consolidation of the knowledge of the different structures in the human body, from their localization, forms and sizes to their functioning and relations (Barbosa et al., 2021). Through this strategy it will be possible to construct a well founded base to understand other sciences, like Histology, Physiology, Biochemistry and Genetics (Barbosa et al., 2021). In addition, because of its focus on interactivity during the theoretical and practical classes of the course, the application of the Sequence can be of great help in the teaching and learning process of a vast curricular matrix (Barbosa et al., 2021). In face of the above exposed, the aim of this study was to analyze the performance of the students and lecturers of the Nursing Course in Human and Clinical Anatomy before and after the implementation of the Fedathi Sequence.

## MATERIALS AND METHODS

This exploratory and descriptive research with a qualitative approach was made with Nursing course students at Fametro University (Unifametro) in Fortaleza, state of Ceará, Brazil, and carried out between January 2018 and January 2020. The students of the years 2018 and 2019, from the morning and evening classes, attending the lectures of Human and Clinical Anatomy of the Nursing Course at Unifametro, were included in this study. No exclusion criteria were established. In terms of quantity of participants, all students of all semesters and shifts with interest in the research took part. In Human Anatomy, the following numbers were attained: 2018.1: 1 morning class (n = 47) and 1 evening class (n = 39); 2018.2: 1 morning class (n = 52) and 1 evening class (n = 36); 2019.1: 1 morning class (n = 69) and 1 evening class (n = 24); 2019.2: 1 morning class (n = 52) and 1 evening class (n = 37). In the Clinical Anatomy the following numbers were attained: 2019.1: 1 morning class (n = 23) and 1 evening class (n = 27); 2019.2: 1 morning class (n = 16) and 1 evening class (n = 18). First, the project was explained to the students of the years 2018 and 2019, enrolled in Human Anatomy, present in the classroom, and after accepting to participate, an Informed Consent Term (ICT) was signed. There was no need for a Term of Assent application, as all participants were 18 or older.

After that, the Fedathi Sequence was adopted by the professor of the above mentioned courses in his didactical planning. The application of the Sequence consisted in a phase of Position Taking, in which the professor analyzed the level and previous knowledge of his students, enabling them to accompany the subject to be addressed and stimulating their creativity and construction of new knowledge (Felício; Teodósio; Borges Neto, 2018). The subsequent phase consisted in the Maturing, during which the professor questioned the subject featured in the Position Taking, asking, orienting, and not answering all doubts. So that the students had to reflect on the problem in order to solve it. The Solving phase was characterized by the exposition of the devised answers to the problem by the students, as an opportunity for the professor to assess possible mistakes and to create consciousness about the chosen path for the learning process. However, the students' answers were appreciated independently of their correctness or not (Felício; Teodósio; Borges Neto, 2018). The last phase of the Sequence application, called Testing, was characterized by the conclusion of the answer to the problem, having the student as the major player in the process of learning. The professor was of supporting importance in the process (Felício; Teodósio; Borges Neto, 2018). During these phases, some classroom activities/dynamics were executed, such as model producing with the help of biscuit (cold porcelain clay) and games, electronic

questionnaires like *google form* and *kahoot* with immediate feedback, production of videoclases by the students discussing topics of the course; creation of conceptual and mental maps as tools to fix the learning content; application of the principles of storytelling. An analysis of the most adequate classroom dynamics was made depending on the addressed subject, the class profile, and the aim of the learning. It is important to mention that the implementation of the Fedathi Sequence was stricter in the first part of the semester of each teaching term, because the average scores of the theoretical tests of these periods were more essential for the final results. In addition, it must be acknowledged that the students of the Clinical Anatomy of the semesters 2019.1 and 2019.2 had already had contact with the Fedathi Sequence during their Human Anatomy course in 2018.1 and 2018.2. Regarding the contents in which the Fedathi Sequence was applied, it was the locomotor system, represented by the skeletal, osteo-articular and muscular systems and the integumentary system. Regarding the Clinical Anatomy the Sequence was used in the part that refers to head and neck. Subsequently, as a form to evaluate the results of the application of the Fedathi Sequence, the performance of the students in the Human Anatomy of the Nursing Course in the semesters of 2016.1, 2016.2, 2017.1 and 2017.2 were researched in the data bank of Unifametro. Only students who had not had a prior contact with the Sequence were selected from these periods, besides the fact that it was only in 2016.1 when the awareness of the necessity arised to plan and use specific strategies in the subject of Human Anatomy to improve the outcomes.

The academic indicators related to the form of approach and format of applied tests of the data bank of the institutional assessment concerning the analysis of the professors of Unifametro, including the Human Anatomy course, were used. In these data banks, the average score of each Human Anatomy student, based on the theoretical tests during the whole semester, morning and evening classes in the period from 2016 to 2017, was analyzed. The average given by each of the students to the Human Anatomy professor, in the period from 2016 to 2019, morning and evening classes, was based on the following parameters: realization of the evaluation process compatible with the contents of the course, dynamic classroom conduct and promotion of activities that stimulate the active participation of the students, the application of the necessary didactical resources to improve the assimilation of content and establishing a relation between the theory and professional practice. Human Anatomy professors of other courses of the same university were also rated concerning the same parameters. The amount of students included in this phase of the study was: 2016.1: 2 morning classes (n = 114) and 2 evening classes (n = 73); 2016.2: 1 morning class (n = 62) and 1 evening class (n = 42); 2017.1: 2 morning classes (n = 77) and 1 evening class (n = 45); 2017.2: 1 morning class (n = 56). The collected data was organized in Excel for Windows, 2013 version, and analyzed with *GraphPad Prism* program, 5.00 version. A descriptive analysis was executed obtaining the measures of central tendency (arithmetic mean) and dispersion (standard error of the mean). To evaluate the quantitative variables, the paired Student's t test was applied to compare two groups of dependent samples and the Variance Analysis (ANOVA), followed by the Tukey test to compare the three groups of independent samples. The level of significance of  $P < 0,05$  was adopted. The study observed the ethical research principles involving human beings and was approved by the Ethics Committee for Research of Unifametro, in accordance with CAAE 88926218.2.0000.5618 under the protocol number 2.635.729.

## RESULTS

Figure 1 shows the scores of the students in the Human Anatomy Course, with and without the application of the Fedathi Sequence, organized according to the shift, semester, and year. A significant decrease in the obtained score by the students of semester 2016.1 evening classes ( $4,49 \pm 0,20$ ) can be noted, compared with the same semester morning classes ( $2,92 \pm 0,23$ ) ( $P < 0,0001$ ). Figure 2 shows the scores of the students of the morning classes in the Human Anatomy Course, with and without the application of the Fedathi

Sequence, organized according to semester and year. From 2018 on, there is a significant increase in the obtained scores by the students, independent of the semester, compared with 2016.2 ( $P < 0,0001$ ), 2017.1 ( $P < 0,0001$ ) e 2017.2 ( $P < 0,0004$ ). This increase occurred earlier among the students of the semesters 2018.2 ( $6,22 \pm 0,25$ ), 2019.1 ( $6,02 \pm 0,28$ ) e 2019.2 ( $6,63 \pm 0,20$ ) compared with the students of the 2016.1 semester ( $4,49 \pm 0,21$ ) ( $P < 0,0001$ ). Figure 3 shows the scores of the students of the evening classes in the Human Anatomy Course, with and without the application of the Fedathi Sequence, organized according to the semester and year. From 2018 on there is a significant increase in the obtained scores by the students, independent of the semester, compared to 2016.1 ( $P < 0,0001$ ), 2016.2 ( $P < 0,0005$ ) and 2017.1 ( $P < 0,0002$ ). Figure 4 shows the scores of the students who had been submitted to the Fedathi Sequence in their Human Anatomy course and, one year later, in their Clinical Anatomy course, organized by shift, semester and year. The students obtained a significant raise in their academic scores in Clinical Anatomy compared to Human Anatomy ( $P < 0,0005$ ) independent of shift or semester. When the academic indicators of the lecturer of the Human Anatomy course were compared with those of other professors of the university, not only his average score was higher even before the application of the Fedathi Sequence but also increased about 10% during the application of the Fedathi Sequence, independent of the analyzed aspect in all measured parameters. This score was much higher than the ones of the other professors during the analyzed period (Table 1).

## DISCUSSION

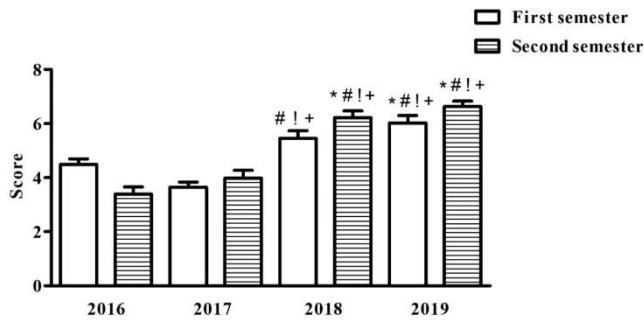
To our knowledge, this research was one of the first to describe the application of the Fedathi Sequence, a scientific method initially developed for the teaching of Mathematics (Felicio; Teodosio; Borges Neto, 2018), in the health sector, specifically in Anatomy courses. The significant increase of academic students' performance in the Nursing Course, independently of shift, semester, and year, due to the application of the Fedathi Sequence, as shown in this study, achieves the aim to reduce the high rate of reproval as well as to apply a learning method strategy that is more significant and directed to the context of nursing. When the performance of the students of the Human Anatomy Course is assessed with and without the application of the Fedathi Sequence, taking into account the shift, semester and year, the better performance of the morning class students 2016.1 when compared with those of the evening classes, can perhaps be explained by the profile of these students, demonstrating a greater commitment and a better base in terms of knowledge. Confirming this supposition, a study by Martins and Ribeiro (2019) shows a positive correlation among the different aspects of academic life, like commitment, success, conclusion within the foreseen time and better learning results. On the other hand, according to Pavão and Castro (2017), students that work have less time to spare for learning compared to students who only study, and this may cause more difficulties to pursue the course and, as a consequence, may also affect the academic performance.

Moreover, the evening student, spending a part of his day working, may have more difficulties carrying out activities like research, participating in extension projects, going to the library, and attending scientific events. Furthermore, university life may add to the development of stress and therefore contribute to the failure in the university life of these students (Peleias et al., 2017). This difference of performance may also derive from the bad sleep quality of the evening class students, known as a factor that interferes in a good academic performance (Araújo et al., 2021). Actually, in general, as working students work during the day, this fact may result in more time needed to relax and start sleeping. In addition, they arrive home from university at a really late hour and go to sleep later (Andreoli; Martino, 2012), which may not only jeopardize the start but also the maintenance and duration of sleep. The above mentioned result raises concern in view that presencial evening classes are more sought after as shown in the enrollment register of private universities/institutions (Inep, 2018). This behavior strengthens the student's interest or

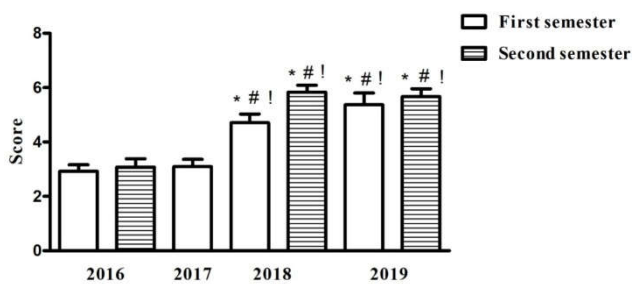
necessity to develop other activities during the day. The efficiency of the Sequence in the academic performance may be deduced from the significant rise of the students' scores, beginning with the application of the Fedathi Sequence, independently from year and semester, and therefore, in the learning of the contents of the Human Anatomy course. This hypothesis supports Oliveira and Pereira (2019), who showed the Fedathi Sequence as being satisfactory as a methodological tool in the search of cognitive development of the students. Possibly this finding is due to the change of attitude of the lecturer, thanks to the Fedathi Sequence application, reevaluating class planning and facilitating the development of activities and attitudes that stimulate the learning process of the students. However, the educational planning should not consist only of the form of how a subject is approached but also the interaction among the actors of this process (students, professor and environment). Another possible justification for the found data is the efficiency of the lecturer's application of the strategy. This presumption is based on the students' perception of the Human Anatomy professor, before and after the application of the Sequence. In fact, the professor scored higher in all academic indicators after the use of this teaching methodology.

The results showed an absence of progression in the obtained scores by the students during the experience of the Fedathi Sequence's application by the lecturer during the semesters. Although individual variability was considered in each semester the Fedathi Sequence was adopted, the non evolution of the performance in the subject with time may be the result of the lecturer repeating the same teaching strategy to a variety of students, that would confirm the practice mentioned in the study of Felício et al. (2021). According to the authors, the teacher, even being one of the foci of the study and having studied the Fedathi Sequence for almost one year, when confronted with the necessity of reorganizing the "Position taking" phase, had to improve his own knowledge about the methodology to reach the Test phase, showing the existing flexibility between the phases of the Sequence. Nevertheless, it must be highlighted that the Sequence is a scientific method applied to teaching in which the responsibility of learning is shared between the professor and the student. The first one should orient and induce the second to a commitment to achieve his learning goals (Felicio; Menezes; Borges Neto, 2021). In this research the competence of the Fedathi Sequence application by the professor was verified by the students by giving him higher scores for different teaching parameters, when compared with the other professors of the university where the study was carried out, even before the use of the Sequence. In this sense, it is important to mention that the professor's role is to act as a mediator, facilitator, "encourager", challenger, and investigator of knowledge, of his own teaching as well as of the individual and group learning. He must be a partner for the students, respecting the different ways to obtain their education (Soares Neto, 2020).

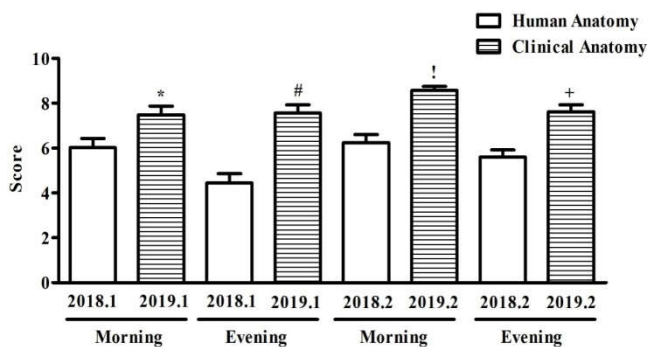
Despite the improved scores with the application of the Sequence, a similarity between the performance of the students of the morning classes in semesters 2018.1 and 2016.1 could still be observed. The little familiarity with the application of the Sequence in 2018.1 could explain this finding. There really is time needed to adapt to this methodology between the professor and the students (Felicio; Menezes; Borges Neto, 2020). In regard to the evening classes, the fact of the application of the Sequence increasing significantly the scores of the students of the years 2018 and 2019, even compared to 2016.1, which showed different results from the students of the morning classes, may suggest a higher efficiency of the methodology among the students of this shift. Particularly, for the inexistence of any difference in the students' performance of the semester 2016.1 and the semesters 2018.1 – 2019.2, morning classes, these results may be associated with a better performance of the lecturers of the 2016.1 term, the hereby detected phenomenon could have impaired the improvement of this score when the Fedathi Sequence was implanted in the evening classes. Through the major efficiency of the Sequence among the students of the different evening semesters, this strategy could be considered, by turning the student into an active agent in the teaching-learning process, to be able to encourage a greater involvement in the knowledge achievement of the evening students



**Figure 1.** Performance of the students of the Human Anatomy Course of a university, according to shift, semester, and year. The students were submitted to theoretical tests during the whole semester, obtaining an individual mean. The data represent the arithmetic mean of the individual mean  $\pm$  standard error of mean. \* $P < 0,0001$  when compared to 2016.1 morning class (ANOVA followed by the Tukey test)

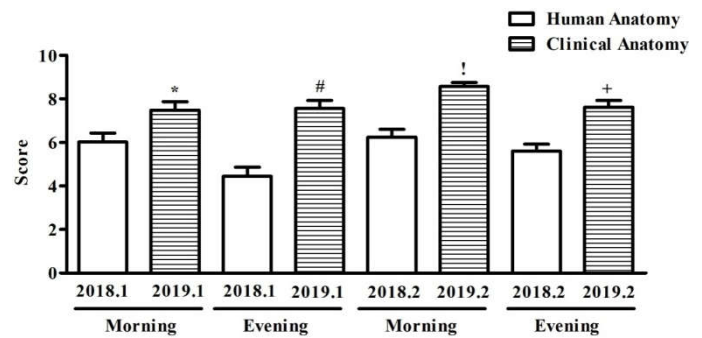


**Figure 2.** Performance of the students of the morning classes of the Human Anatomy Course of a university, according to semester and year. The students were submitted to theoretical tests during the whole semester, obtaining an individual mean. The data represent the arithmetic mean of the individual mean  $\pm$  standard error of mean. \* $P < 0,0001$  when compared to 2016.1; # $P < 0,0001$  when compared to 2016.2. ! $P < 0,0001$  when compared to 2017.1; + $P < 0,0004$  when compared to 2017.2 (ANOVA followed by the Tukey test)



**Figure 3.** Performance of the students of the evening classes of the Human Anatomy Course of a university, according to semester and year. The students were submitted to theoretical tests during the whole semester, obtaining an individual mean. The data represent the arithmetic mean of the individual mean  $\pm$  standard error of mean. \* $P < 0,0001$  when compared to 2016.1; # $P < 0,0005$  when compared to 2016.2. ! $P < 0,0002$  when compared to 2017.1 (ANOVA followed by the Tukey test)

and also help them to overcome the difficulties to accommodate study and work, including the mental and physical tiredness and being late for classes (Pereira; Coutrim, 2020). In this sense, the literature mentions that active methods have major impacts on education when motivating students, offering interaction among them, developing creativity and raising the commitment in the learning process (Parra-González et al., 2021).



**Figure 4.** Performance of the students who had been submitted to the Fedathi Sequence in their Human Anatomy course and, one year later, in their Clinical Anatomy course in a university, organized by shift, semester and year. The students were submitted to theoretical tests in each of the courses during the whole semester, obtaining an individual mean. The data represent the arithmetic mean of the individual mean  $\pm$  standard error of mean. \* $P = 0,0005$  when compared to 2018.1 - morning classes; # $P < 0,0001$  when compared to 2018.1 - evening classes. ! $P < 0,0001$  when compared to 2018.2 - morning classes. + $P = 0,0002$  when compared to 2018.2 - evening classes (paired Student's t Test)

The meta-analysis executed by Freeman et al. (2014), including different active methodologies with different subjects, confirmed that due to this method the learning process was improved and the failure reduced when compared to the method of basic classroom teaching. The better performance obtained by the evening classes could also be justified by an awakening of students' conscience to seize the opportunity in the classroom as the time available for studying is scarce (Pereira; Coutrim, 2020). It can be deduced that a higher degree of maturing and responsibility of these students, associated with the experience of the professor acquired through the application of the Sequence in the morning classes, favoured this performance. In relation to the better performance of the students exposed to the Fedathi Sequence in the Courses of Human and Clinical Anatomy, that phenomenon may have occurred because of the base built by the Human Anatomy as well as the prior experience with the Sequence and a higher degree of maturity and responsibility attained by the students during their course. Particularly the prior experience of students and teacher with the Fedathi Sequence, its contribution to the raise in performance is evidently shown as the method includes the phenomenon before, during and after the application, providing an improvement of the latter (Felício; Menezes; Borges Neto, 2020). Concerning the feedback for the professor in relation with the application of the Fedathi Sequence, although the lecturer already had attained higher academic indicators than his colleagues, the strategy of the Sequence improved all these indicators, especially the parameters related to the meaningful testing of the subject and dynamism and participation in the classroom. This result suggests that the phases of the Sequence were well executed, keeping in mind that in each of them dynamism and the active involvement of the students is worked on, for instance bringing a problem based game or other resources, stimulating the investigative and critical side of the students or promoting a knowledge not learnt by heart (Felício; Menezes; Borges Neto, 2020). Though the improvement of assessment criteria could be attributed to the experience of the lecturer in prior classes and to possible improvements made by the university, it is believed that this contribution wasn't significant, since the other teachers' scores in the years 2016 - 2017 and 2018 - 2019 only showed a slight difference between these periods, significantly inferior to the one obtained with the application of the Sequence. So it can be presumed that this difference is related to the new posture adopted by the professor of the Human and Clinical Anatomy, from planning to the execution of the class, based on the assumption of the Fedathi Sequence. In this context, it is necessary to emphasize the fundamental role of the teacher in the learning process because he is able to plan, reflect, decide and choose challenging situations for students' groups or for each one of them.

**Table 1. Academic indicators regarding the form of approach and test style of the Human Anatomy lecturer and other professors at the university, according to the Commission of Assessment before and after the application of the Fedathi Sequence. Fortaleza - CE, 2020**

Academic Indicators	Average score of the lecturer of the study before the Fedathi Sequence (2016-2017)	Average score of the lecturer of the study after the application of the Fedathi Sequence (2018-2019)	Overall mean of the professors of the university (2016-2017)	Overall mean of the professors of the university (2018-2019)
The lecturer applies assessment consistent with the course content	4,22	4,80	4,09	4,13
The lecturer teaches the classes dynamically and promotes activities that stimulate the participation of the students	4,33	4,81	3,98	4,04
The lecturer uses didactical resources to improve the learning process	4,36	4,77	3,87	4,17
The lecturer establishes a connection between theory and professional practice	4,39	4,84	4,02	4,16

During his own apprenticeship in each of these situations, the teacher should be able to anticipate or to imagine solutions that could be developed, trying to create other possibilities of conflict and solution (Borges Neto, 2016). Being a teacher means pursuing formal education by emphasizing educational practice which gives meaning to the learning process and starts to be the difference in the learning environment, as well as defending human development and defragmenting traditional learning processes.

## CONCLUSION

It may be concluded that the application of the Fedathi Sequence in the Anatomy course promoted a better academic performance, reducing the failure indicator, as well as providing a better evaluation of the professor that applied it. Thus, the application of the studied sequence can be an excellent, more significant and focused methodological learning strategy in Human and Clinical Anatomy in the Nursing Course, in addition to stimulating a major academic involvement of the evening class students and helping them to overcome the intrinsic difficulties of a working and studying routine.

## ACKNOWLEDGMENT

The authors thank all study participants and Unifametrofor having allowed the research to be conducted.

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