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Reflections of future natural science teachers on active methodologies

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ABSTRACT

The need to develop new skills and abilities for the contemporary era of knowledge reinforces the importance of changes in the organization of the teaching and learning process. Active methodologies (AMs) can be considered as allies in the construction of knowledge in different educational contexts, owing to the possibilities of integration and appreciation of plural knowledge. Therefore, teacher education is a central issue in these discussions. In this scenario, the aim of present article is to analyze the reflections on AMs of future Natural Sciences teachers studying in a government-owned university in Bahia. This qualitative study was developed by applying ten semi-structured interviews to students of the Interdisciplinary Teaching Degree in Natural Sciences and Technologies (LICNT), at the Federal University of Southern Bahia (UFSB), Paulo Freire campus, located in Teixeira de Freitas, in the far south of Bahia. Bardin's Content Analysis approach was used for data analysis. Based on the findings, it can be argued that the students recognize AMs as innovative processes that can facilitate learning. In this dimension, they pointed out that learner centeredness is an important characteristic for people's empowerment.

KEYWORDS: Active learning. Leaner-centeredness. Teacher education.

INTRODUCTION

Scientific and technological advances have brought different opportunities for the construction of learning and, consequently, they have transformed the teaching perspective, taking into account that the view of teachers as owners of all knowledge started to be challenged (MICHELETTO, 2020). Transformations are necessary with regard to teaching methodologies, teaching practices and the curricula that govern the different levels of education. Only this way can the educational scenario keep up with the innovations of today's society.

Over the years, new educational needs have motivated the design of teaching methods that combine different approaches, taking advantages of both inductive and deductive methodologies (MORÁN, 2018). In parallel, there have been increased debate and research on AMs, and one of their principles is that teachers take the role of mediators and/or advisors (DIESEL; BALDEZ; MARTINS, 2017), with the purpose of dismissing the idea that teachers are givers of knowledge (MICHELETTO, 2020).

Micheletto (2020) argued that knowledge is produced as a result of exchanges between the natural, cultural and social environments, thus generating leadership and autonomy during the construction of knowledge. Therefore, taking into account a type of professional education in which undergraduate students can construct their knowledge through active pedagogical practices that help them develop particular skills - e.g., critical and reflective thinking, empowerment and problem-posing - is a way to strengthen education at colleges and universities.

AMs are being successfully used in the field of Natural Sciences, because there has been a great deal of research and support for the practice of educating citizens to make them capable of understanding and taking a leading role in the relations between science, technology, society and the environment. Therefore, one should ponder over studies that have addressed AMs in this field.

Simões *et al.* (2020) reviewed articles published between 2008 and 2018 that focused on applying AMs to science teaching. The authors showed that secondary and higher education are the levels that appear most often in research; they reported that there was an increase in the number of publications from 2015 onwards, as a result of the growing search for journals and special editions on the subject.

To analyze the benefits of AMs in basic education, Cezar de Mello and Gonçalves (2020) applied Problem-Based Learning, through a case study on blood groups, to senior-year high school students from a government-funded school in the municipality of Duque de Caxias, state of Rio de Janeiro. Data analysis indicated that students developed skills such as engagement in the construction of knowledge, motivation and application of previous knowledge.

Silva, Sá and Batinga (2019) carried out a study that analyzed the potential of a teaching sequence on the theme of water, which was designed on the basis of approaches to Problem Solving, within a context of teaching by investigation. The study was conducted with ninth-graders from a government-funded elementary school located in the city of São Caetano, state of Pernambuco. Their findings showed that students developed skills such as development of autonomy, teamwork, communication and discussion of ideas, and problem solving.

Motivated by the importance of using AMs to strengthen students' central role in knowledge construction, and taking into account the role of future Natural Sciences teachers as mediators in such process, the present study was developed with the participation of undergraduate students pursuing the Interdisciplinary Teaching Degree in Natural Sciences and Technologies (LICNT) from the Federal University of Southern Bahia (UFSB).

The pedagogical model adopted by UFSB is underpinned by active teaching practices whose purpose is to educate students not only for the job market, but for their self-empowerment, thus helping them become critical thinkers and conscious individuals who will be committed to advancing ethics, justice and equity in society (PLANO ORIENTADOR UFSB, 2014).

The assumptions made in the above-mentioned document are intended to help develop university settings as motivating environments for a teaching and learning process that encourages vigorous debate on opportunity and choices. University settings seek to embrace students in a pedagogy of autonomy, highlighting their role in constructing their own knowledge (PLANO ORIENTADOR UFSB, 2014).

In this context, we believe that we need to analyze the reflections of future teachers on the methodologies used in their own education, as they can impact the way these undergraduates will conduct their teaching practices when working in schools.

Researching what students, teachers and other education professionals think about a given topic is important for the debate on teaching and learning processes. Matos and Jardilino (2016) argued that perception can be understood as systematization and inference on sensory data, which implies that individuals need to be aware of themselves and of the environment. Thus, the authors stressed that interpretation is an important point as far as perception is concerned.

The above-mentioned institution was selected for the application of this study because it is a government-funded university whose guiding plan is supported by MAs for teacher education degree programs in the field of Natural Sciences. Another reason was the fact that the university is located in the Northeast region of Brazil. Raising the visibility of the educational processes carried out in Northeastern colleges and universities is a way of not only showing what is being done in that part of the country, but also giving voice to the students who experience such processes.

Therefore, for research purposes in this work, we formulated the following research question: what are the perceptions of future Natural Science teachers on AMs that are being used in their education?

This question was the basis to set the objective of this study, namely to analyze reflections on AMs as experienced by future Natural Sciences teachers studying in a federal government-funded university in the state of Bahia.

ACTIVE METHODOLOGIES IN HIGHER EDUCATION

According to Borges and Alencar (2014), AMs can be understood as methodologies that have the ability to stimulate the development of teaching and

learning processes in which educators promote the critical education of future professionals, fostering autonomy, curiosity, individual and collective decision-making, which originate from the primary activities of social practice and in contexts experienced by students.

Lima (2017) underlined that, when we think about teaching practices that use these methodologies, we must take into account some characteristics, for example, developing proactivity, aligning learning and students' reality, developing a critical attitude towards the real problems and promoting collaboration between the players involved in the teaching and learning process.

Therefore, AMs can be conceptualized as ways to develop means to learn by using mechanisms of real or simulated experiences to understand facts experienced by students in their daily lives, with a view to solving problems that arise from activities of social practice in diverse contexts. Engaging students in acquiring new knowledge, based on their own understanding, interest and choice, is crucial to increase their autonomy in decision making (BERBEL, 2011).

Based on these ideas and concepts, the following principles of AMs can be listed: leaner-centeredness; learner autonomy; problem-based approach to reality and reflection; team work; innovation through the use of information and communication technologies; and teachers as mediators (DIESEL; BALDEZ; MARTINS, 2017).

Vetromille-Castro and Kieling (2022) underlined that an important premise when planning classes with MAs is to highlight the central role of students in this process, i.e., to consider students as active participants in the construction of knowledge, making it possible for them to "learn by doing". The authors also argued that on-site or blended classroom situations, in which the learning context is supported by digital technologies, are suitable for student-centered teaching practices.

Andrade (2018) emphasized that students must refrain from being mere receivers of information; rather, they are supposed to assume an increasingly active role, investigating knowledge that is relevant for them to be able to solve problems and achieve learning objectives.

Developing autonomy is essential for students to be able to successfully take different roles in a wide range of educational and professional settings. It is crucial that they engage with new knowledge to increase the likelihood of exercising their freedom and autonomy when making decisions at different stages of the learning process, thus becoming able to practice a future profession (BERBEL, 2011).

Three conditions are required for the adoption of approaches that can motivate students towards achieving their autonomy: (1) adopt the student's perspective - when considering this requirement, teachers are able to create conditions that align classroom activities with students' autonomous motivations; (2) accept students' thoughts, behaviors and feelings - teachers recognize and appreciate the motivational potential that is linked to their emotions and behavioral intentions; and (3) support students' motivational development and autonomous self-regulation capacity — thus, teacher-student interactions revolve around a daily support of academic exercises, so that students can regulate their own motivation (REEVE, 2009).

Reeve (2009) also discussed three ways in which teachers can teach student autonomy-based classes: (1) become less controlling; (2) voluntarily adopt practices that support the autonomy of subjects; (3) learn the "how to" of supporting autonomy.

Problem posing and reflection are terms that must be associated for a deeper discussion of this characteristic. In the context of educational environments, problem posing means analyzing reality to become aware of it; thus, teachers should develop the ability to instigate and motivate their students' desire to learn through a practice that addresses contents using a problem-posing approach (DIESEL, 2016).

Owing to the existing dichotomy between theory and practice, teaching often fails to connect with social contexts and, thus, becomes fragmented, causing students to lose motivation and interest. For this reason, we argue that the knowledge developed in educational institutions needs to be useful for students' daily lives. This factor can be achieved by using a problem-posing approach and reflecting on reality (DIESEL, 2016; ANDRADE, 2018).

Discussions about the role of teachers are held to tackle these issues. It is assumed that "teaching does not mean transferring or transmitting knowledge to others who receive it passively. On the contrary, it means provoking, challenging or even promoting the conditions for building [...]" (DIESEL, 2016, p. 55, our translation). Teachers who plan their classes with MAs take the role of mediators and/or advisors, i.e., the ones who pave the way to mediate learning and contribute to the promotion of subjects' autonomy (MORÁN, 2015; BERBEL, 2011).

Some MAs underpinned by these principles are: Problem-based Learning, Team-based Learning, Flipped Classroom, Project-based Learning, Peer Instruction, Just-in-Time Teaching (ARAUJO *et al*., 2021).

Costa and Miranda (2022) published a study on the use of Team-based Learning (TBL) in higher education, specifically with undergraduate dentistry students. When describing, interpreting and discussing the data from their study, the authors showed that TBL was useful for developing skills such as communication, persuasion and argumentation, in order to improve teacher-student interaction as well as peer interaction.

Singhal *et al.* (2021) produced a scientific article, developed at a university in India, on active learning based on digital devices in the virtual classroom during the Covid-19 pandemic and found that there was a 30% improvement in students' grades when active learning methodologies were used. Thus, they stressed that the proposal improves students' skills when compared to the traditional teaching approach.

Souza, Rech and Gomes (2022) conducted an integrative review work on the methodologies applied to the teaching of ethics, bioethics and health deontology, in the last decade, and they found that AMs promoted more significant learning when compared to more traditional methodologies; also, when combined with digital technologies, the results are even more satisfactory.

Despite the eminent principles and applications of MAs for more efficient learning, Mesquita, Meneses and Ramos (2016) published a study developed in 2011 that found some difficulties experienced by teachers when implementing

AMs in a nursing degree program in a federal government-funded university located in Rio Grande do Norte. The main problems were: obstacles posed by the curriculum for the application of these methodologies; the professors' reluctance to use these teaching methods, and the difficulty in understanding their applicability.

Nordi, Ogata and Machado (2022) criticized and reported weaknesses of the fad for applying more dynamic methods that, although linked to AMs, prioritize teacher-centered practices. The authors pointed out that the use of AMs without the proper theoretical-methodological background may lead to an overlap of fragmented methods that do not encourage empowering educational situations and fail to transform reality and generate dialogic processes.

As far as this statement is concerned, it should be noted that teachers usually develop systemic approaches that involve different types of approaches and, sometimes, they need to develop their teaching practices based on improvisation, in the face of a context that often takes place abruptly. We took into account the importance of bringing together the methodological proposals and the dynamics of educational realities.

Araujo *et al.* (2021), in their study on innovation in Physics teaching in higher education, highlighted that collaborative projects can be developed to involve problem situations for the study of Physics, based on economically and socially relevant aspects. However, this type of approach may be associated with possible feelings of demotivation related to "knowledge for the sake of knowledge".

METHOD

The present study was carried out at the Federal University of Southern Bahia (UFSB), on the Paulo Freire campus, in the municipality of Teixeira de Freitas/BA. The participants were students currently enrolled and attending classes from the Interdisciplinary Teaching Degree in Natural Sciences and Technologies. They were divided into two groups: initial four-month terms (first to fifth) and final four-month terms (sixth to tenth). According to the Pedagogical Course Project – PPC (2016), this degree program is based on interdisciplinarity, regular update, pedagogy of pluralism and flexibility, aiming at the construction of student autonomy.

The study used a qualitative approach to achieve the proposed objectives. According to Minayo and Sanches (1993), this type of research can bring the subject and the object of study closer together, as they have the same nature. Bauer and Gaskell (2017) also stressed that qualitative research avoids the use of numbers and deals with interpretative data of social realities.

Data collection was performed with semi-structured interviews, which were applied to 10 (ten) students from UFSB pursuing the Interdisciplinary Teaching Degree in Natural Sciences and Technologies. Therefore, in the present work, we sought to understand the participants' subjectivity within their learning context, taking into account their psychological and social realities. Using interviews, in this perspective, allowed us to understand the participants' constructions in relation to their social contexts.

Their discursive productions also have their limitations and can still be influenced by the researchers' interpretations; therefore, we must understand the findings as the result of a process of dialog between the researchers' expectations and the manifestations of the consulted partners. To minimize such subjectivities, judges are asked to discuss the results with researchers for the sake of interpreting them more effectively.

Based on this intention, we created an interview script, which was designed with open questions about the AMs used in the curriculum components of the degree program researched in the present study. First, we carried out a survey on the participants' profile, with questions about the following aspects: age, gender, place of residence, local culture, reason for choosing the degree program and the four-month term being attended. Then, we had a semi-structured conversation about AMs, based on questions that addressed: the first contact with these methodologies; how they were organized in the classes, in the students' opinion; which characteristics were evident during the application of AMs; the positive and negative points regarding the use of AMs; how these methodologies could influence their practice as future teachers; and their experiences with internships, projects or pedagogical practices.

After the interview script had been designed, it was assessed by a group of researchers (judges) who are experts in this type of data collection instrument. Then, it was pilot-tested; at this stage, we called it commented interview. After the commented validation had been completed, we adjusted the interview script as needed, and then it was applied to the target audience.

The coordinator of the LICNT degree program e-mailed an invitation to students who might be interested in participating. After the first student contacted the researchers to express their interest in the present study, the snowball technique was used to recruit other respondents (VINUTO, 2014). In other words, the first participant was asked to suggest other students who could possibly participate in the study, who, in turn, also suggested other possible participants.

The number of interviews was determined through a process called saturation, that is, data collection was suspended when the data started to be repeated.

The data were collected from the analysis of 10 (ten) interviews: four students from the last four-month terms (last year of the program) and six students from the first four-month terms. Fictitious names were used to refer to the research participants, namely Cadu, Mari, Yago, Sofia, Lara, Enzo, Omar, Otto, Noel and Dora. The respondents were four females and six males, aged between 20 and 33 years.

This part of data collection was carried out through video calls, videoconferencing and/or audio recording at previously established times agreed on with the participants, owing to the social distancing rules imposed by the Covid-19 pandemic. Audio recording was used only when really required, for example, when there were technical problems with the video calls. All interviews were recorded for subsequent transcription and interpretation. Although the study was carried out in the context of a pandemic, the data described and analyzed refer to the experiences of the interviewees in face-to-face teaching, before the pandemic.

Bardin's Content Analysis (2011) was used as a theoretical framework for description, interpretation and analysis of data. It is "a set of communication analysis techniques, which uses systematic and objective procedures to describe the content of messages" (BARDIN, 2011, p. 38, our translation). The author also highlights that this technique is based on "the inference of knowledge related to the conditions of production (or, eventually, of reception), an inference that resorts to indicators (quantitative or not)" (BARDIN, 2011, p. 38, our translation).

After transcribing the interviews, floating reading was performed with the purpose of organizing, in an unstructured manner, important aspects for analysis, following the steps of content analysis: 1) previous analysis; 2) exploration of the material; and 3) treatment of results, inference and interpretation.

Previous analysis is known as the stage of data organization; it systematizes the initial ideas, which generally refer to three factors, namely: the choice of texts that will be submitted to analysis; the construction of hypotheses and objectives; and, finally, the design of indicators that will support the final interpretation of results (BARDIN, 2011). After reading the transcript of the interviews, we started organizing and sorting the data, which were systematized according to the research objective.

In the phase of exploring the collected material, we investigated the findings to define categories, identify registration units (UR) and context units (UC) and categorization. Bardin (2011) underlines that this phase is long and tiring and consists of coding or enumeration, classification and categorization operations according to previously formulated rules. We can also define it as an analytical description, which concerns the corpus (material that was collected) of the data that are analyzed (BARDIN, 2011).

In the last stage of CA, we performed the treatment, inference and interpretation of results based on the summary of information, and then we made inferential interpretations. Here, empirical data are transformed into meaningful and valid knowledge; simple or more complex statistical operations are the mainstay of the treatment of results, followed by a validation test that summarizes and selects the data and concludes the inferential interpretations (BARDIN, 2011).

We organized the data according to the thematic categories created *a priori* and the subcategories that emerged *a posteriori*, based on the analysis of the interviewees' answers. In addition, we also systematized the excerpts based on the frequency identified in the participants' responses, taking the themes into account.

To develop the study, we took ethical issues into account in order to consider the subsequent dissemination of the findings to the community. The present study complies with the ethical principles of the National Health Council, and Resolution No. 510/2016, concerning research with human beings. It was approved by the Research Ethics Committee (CEP) of UFS, according to report No. 4.472.438 (approved on December 17, 2020), which is the proposing institution, and by the Research Ethics Council of UFSB, according to report No. 4.483.622 (approved on December 23, 2020), which is the associated research center.

RESULTS AND DISCUSSION

For the analysis, we created three categories which seemed to reflect the opinion of the students about AMs (Table 1).

Table 1 - Representations of dimensions and categories for reflections on AMs

Dimensions (fi)*	Non-exclusive thematic categories (fi)*	Examples: context units
MAs as innovative processes that facilitate learning (47)	Facilitation of learning (3)	"Active methodologies are quite productive and have a meaningful result, at least for me. Though I felt some impact at first, I could adapt well to them, and they really helped me construct my knowledge in my degree program" (Yago, 22 years old)
	Motivation and Innovation (8)	"I find the methodologies used in most of the courses of my degree program to be innovative methodologies that manage to integrate students in an active and collaborative way" (Sofia, 21 y/o)
	Student-centeredness (15)	"In my future practice as a teacher, I realize that, in today's society, we must stop placing so much emphasis on purely explaining the content, on lectures, this emphasis that is known as banking education, and start to educate citizens in society to become critical and active, to take a leading role in their stories and their learning" (Enzo, 20 years old)
	Construction of knowledge (6)	"I want to approach contents in the most active and participatory way possible so that my students [pause] as well as I [pause] can take a more central role [pause], an even more active one in the construction of knowledge" (Sofia, 21 years old)
	Previous knowledge and community knowledge (7)	"so what I have to say about these methodologies is that, in my opinion, they are very efficient and I really like them, because I have room to show how much I know already" (Omar, 22 y/o)
	Collaborative work (8)	"I think it is a very good opportunity to get to know the active methodologies in higher education and replicate them in basic education. I think it is very interesting, because it is a form of interaction, and it is also collaborative work" (Mari, 33 y/o))
Curriculum component of Pedagogical Practices as a guiding principle of the	Alignment between line of thinking and Pedagogical Practices (5)	"The curriculum components always have this role of being aligned with the practices, and this is also very good, because we can develop projects or classes for basic education students, which makes us part of the school environment" (Omar, 22 y/o)

Dimensions (fi)*	Non-exclusive thematic categories (fi)*	Examples: context units
curriculum and the relations between university, school and community (14)	Pedagogical Practices in the classroom and with the community (9)	"I think it was important to put into practice what we had learned in the components of pedagogical practices and also to take active methodologies to basic education, as a way of having a beneficial result with the students" (Mari, 33 y/o).
Logistical and pedagogical barriers to the use of AMs (20)	Logistical barriers (infrastructure) (4)	"I really like the proposals of active methodologies, but during my practicum observations, I noticed that things are not so easy in public education, because classrooms are very full, there are 40 students in a small room, for example" (Noel, 21 y/o)
	Pedagogical barriers (16)	"As you may already know, UFSB tends to adopt active methodologies, but not all professors use them, some are actually more traditional, most of the active methodologies I learned about were in the Practices component" (Omar, 22 y/o)

Source: Author's own data (2020).

*The values indicated in parentheses refer to the simple frequency (fi) of the themes taken from the answers of the participants in each category.

We noticed that AMs, as processes that facilitate learning, is the dimension that had the largest number of themes (47). Then, we created seven other subcategories, which deal with characteristics that interviewees considered as essential to promote active learning: (1) Facilitation of learning; (2) Motivation and innovation; (3) Student-centeredness; (4) Problem-based approach to reality; (5) Construction of knowledge; (6) Previous knowledge and community knowledge; and, finally, (7) Collaborative work.

In the second dimension, Curriculum Component of Pedagogical Practices as a guiding principle of the curriculum and the relations between university, school and community, we identified two thematic subcategories, namely (1) Alignment between line of thinking and pedagogical practices and (2) Pedagogical practices in the classroom and with the community. In this context, we discuss how the Pedagogical Practices component has helped to strengthen the course curriculum, the connection between Higher Education and Basic Education, as well as the communities around schools.

The third dimension, named "Logistical and pedagogical barriers to the use of AMs" (20), included two thematic subcategories: (1) Logistical barriers, which indicate some problems with infrastructure that hinder this process; and (2) Pedagogical barriers, which are related to failure in the applicability of AMs and some teachers' reluctance to use them.

1) ACTIVE METHODOLOGIES AS INNOVATIVE PROCESSES THAT FACILITATE LEARNING

In this dimension, we highlight the contributions pointed out by the participants in the use of AMs for teacher education. In the first thematic category, we highlight the **facilitation of learning (3)**, which is marked by the answers given by the students concerning optimal use of their teaching and learning process.

> I found the application of active methodologies to be very productive and important for my education, and I am looking forward to the next practicums in the community. I will have a few more throughout my program. I can detect improvements in my learning, in the way I construct my knowledge (Sofia, 21 y/o).

The answer above shows aspects related to meaningful learning, based on the productive aspect attributed to teaching practices that are supported by AMs. This provides further insights for reflections about themes that involve the entire context of society, promoting aspects of social conscience.

Pires (2015), in her experiences with the station rotation sub-model of the rotation model - used in blended learning to promote active learning - underlined that, during her classes, students developed skills that effectively improved teaching and learning processes, providing significant gains for construction of social criticality.

Based on this perspective, when thinking about more practical and interactive teaching models for higher education, whose aim is to bring real contexts closer to professional experiences, it is important to emphasize the opportunity to develop meaningful learning, which can provide greater depth in the construction of knowledge (MICHELETTO, 2020).

The second thematic category was the one that we identified as **Motivation and innovation (8)**. The students' answers describe AMs as innovative, which allows students to enjoy motivating contexts in individual or collective learning environments.

> My first contact with active methodologies was at UFSB. I liked it a lot right from the start, because I was always into asking many questions and participating in class, so it was very motivating to be educated with methodologies that give me this opportunity (Sofia, 21 y/o).

> I felt very motivated to see the students participating and interacting when developing the projects, with dynamic and innovative classes. The students' feedback was positive, and this motivated me (Yago, 22 y/o).

Also, we can highlight the motivation for future teaching practices that could be produced in educational contexts with AMs. One participant explained that these methodologies encouraged her to continue pursuing her teaching career.

> The methodologies were and are essential for my degree, especially because they motivate me to continue in this career, which we hear is very outdated (Lara, 22 y/o).

To motivate and engage students, professors use MAs as a tactic to develop the problem-posing ability, because, when faced with adversities, students create

strategies to re-signify their discoveries and construct knowledge to solve the impasses associated with the questions asked. Thus, solving problems that are present in the local or professional reality is one of the possibilities for students to lead the construction of their own knowledge (MITER *et al*, 2008).

In the second half of the 21st century, the use of innovative teaching strategies and resources in the classroom has revealed a potential to improve the quality of learning and promote the construction of knowledge, as the process of innovation in the educational area is not about merely repeating ready formulas that are considered as innovative, but rather seizing opportunities that can lead student to development, based on the reflection of personal and professional aspects (BERGONSI, 2020).

The third thematic category was the one with the largest number of themes in this dimension. We defined the category as **student-centeredness (15)**. In the highlighted excerpts, we could observe the promotion of empowering identities, as students lead the construction of their own knowledge by developing their student voice.

> Active methodologies are very important to me, because they really work for me. I really love the fact that I have the opportunity to talk, question and contribute my knowledge. I think I have a voice in the classes (Otto, 20 y/o).

> Something remarkable that I see in my classes is that most teachers avoid these traditional methods. They always use active methodologies so that students themselves take the leading role in constructing their own knowledge (Dora, 23 y/o).

In higher education, it can be seen that there is great eagerness for educational transformations and that students are more willing to accept these changes to streamline the innovation processes. If, on the one hand, teachers are more reluctant to change, on the other hand, students are increasingly favorable to innovation and are easily involved in activities that offer more opportunities for participation (DEBALD; GOLFETO, 2016).

Debald and Golfeto (2016) also pointed out that one of the most striking pillars of pedagogical models based on active learning is learner centeredness, which takes place through the effective participation of students in the activities proposed by their teachers. The authors argued that AMs have arisen with the purpose of involving students at all times in class, and this becomes real and achievable when students are challenged with proposals that make sense and are practice-oriented.

Still from this perspective of developing learner centeredness, there is a marked presence of terms that highlight possible changes in the participants' attitude towards their learning and also in the way they intend to exercise their future profession as teachers, i.e., by adopting practices that promote such active learning, as a way of highlighting learner centeredness.

> After adapting to active methodologies, I can only see benefits for my education, for example, the practices in the courses led students to play an important role in their learning, so I feel involved in the classes and I changed a lot the way I used to see the teaching process (Yago, 22 y/o).

> [...] thinking about my practices and stop repeating only that traditional teaching of verbalization, in which all knowledge will come only from me without acknowledging the students I will have, it is important to encourage learner centeredness, with students as active beings (Lara, 22 y/o).

We can highlight that when individuals take a leading role in the construction of their knowledge, they will have the primary responsibility for opening paths to have new experiences. Importantly, teachers can play a mediating role in this process by providing opportunities for students to enjoy autonomy through reflection skills and quest for knowledge, i.e., teachers can help students to take the lead throughout their learning (DIESEL, 2019).

The fourth thematic category emerged on the basis of discourses that expressed AM-based earning as constructions developed by the subjects involved in the teaching and learning process, which is why we called it **Construction of knowledge (6)**.

> [...] I noticed that the most students managed to construct their knowledge more easily, so as a future teacher, I will always to use active methodologies as much as possible (Otto, 20 y/o).

> I usually like it a lot. I can learn a lot more, actually... to construct my knowledge a lot more (Omar, 22 y/o).

Berbel (2011) pointed out that, to promote autonomy and establish efficient constructions in the teaching and learning process, using the Problem-based Methodology, for example, some characteristics have to be taken into account. One of them emphasizes the importance of constructing knowledge, which learners can do by becoming involved with data from their local experience, since student's opportunity to observe and critically analyze a problem in their reality makes them responsible for the construction of their knowledge.

The researchers Debald and Golfeto (2016), after analyzing interviews with 68 students from all degree programs at the Faculdade Comunitária União das Américas community college, found that 83% of the participants said they liked the new methodology adopted by the higher education institution. The reason was the fact that they promote the construction of knowledge through processes of interaction between colleagues, in addition to pleasant situations that develop autonomy within the classroom.

In the fifth thematic category, **Previous knowledge and community knowledge (8)**, the following excerpts of students' answers indicate the importance of considering the previous knowledge that they bring to the learning environment, whether at school or colleges/universities:

> The issue of a problem-posing approach to reality is also something interesting, I don't know if I've already mentioned it, but I remember now that it's important to be aware of what students already know, the issue of prior knowledge, this makes me feel important (Omar, 22 y/o)

> [...] always with classes that make students express their opinions, argue, put forward counterarguments so that we can think about a certain subject and about possible solutions (Dora, 23 y/o).

In the discussions that take place around the teaching and learning process, the construction of meaning should be combined with the constructions of meanings. The purpose of learning must be associated with the signification socially established by the cumulative knowledge produced by science, culture and technology, that is, the contextualization of knowledge is linked to the context of life and the meanings attributed by students, which leads to a first step towards the active construction of knowledge (ANDRADE; SARTORI, 2018).

The last thematic category of this dimension highlights meaningful learning by sharing knowledge in a group, which promotes *Collaborative work (8)*.

> Therefore, active methodologies, in my point of view, promote collaborative, participatory and meaningful learning, they really have a positive result in students' learning (Mari, 33 y/o).
>
> It is a methodology that teaches not only group work, as the activities are always carried out in groups, but also compliance with rules, deadlines and the like, and also because we are always reading, writing and making presentations, so there are several ways to help our learning at the end of the day (Cadu, 20 y/o).

Teamwork is an important feature from the perspective of AMs, as it enhances analysis, discussion and reflection in educational environments. Group work allows students to share knowledge by expressing their points of view on the problem in question, and also give their opinions in debate and discussions (ANDRADE, 2018). The constant interaction with colleagues and professors allows students to produce arguments and express themselves (DIESEL, 2016).

2) CURRICULUM COMPONENT (CC) OF PEDAGOGICAL PRACTICES AS A GUIDING PRINCIPLE OF THE CURRICULUM AND THE RELATIONS BETWEEN UNIVERSITY, SCHOOL AND COMMUNITY

This dimension deals with the integration between the CC of Pedagogical Practices, from the perspective of the interviewed students, and the course curriculum, as well as their relations with the experiences developed a the schools of the communities in the region, as a way of establishing an interaction between the university and school environment.

Two thematic categories emerged in this dimension. The former deals with the connection between Pedagogical Practices and the curriculum component of LICNT, with a line of thinking that addresses theoretical scientific knowledge in the fields of Natural Sciences. We named this category as *Alignment between line of thinking and pedagogical practices (5)*. Excerpts of the students' discourses show that they consider the CC of Pedagogical Practices as a link between scientific knowledge and classroom practices.

> I think that the line of thinking of the program is very consistent with the pedagogical practices, because we are studying in an interdisciplinary program, so active methodologies, taking interdisciplinarity into account, is an unbeatable pair, they are essential (Cadu, 20 years old).

The interdisciplinary format evidenced in the program can be seen as a factor that aligns students' daily problems with their educational process, thus encouraging debate and sharing of experiences in different fields of knowledge.

Bonato *et al* (2012) conducted a study to analyze the importance of interdisciplinarity in Natural Sciences as a bridge to better understand these courses and the related fields. The authors found that, when contents are integrated, students tend to construct knowledge in a broader manner, which increases the relevance of interactions in the social environment.

A study carried out with high school Natural Sciences teachers investigated how they understand the concept of interdisciplinarity and how they could develop a theme, e.g., the greenhouse effect, based on this proposal. The collected data showed that the interviewees understand aspects of interdisciplinarity, but they had not fully formulated their own concept of it. Another interesting finding is that, when proposing an interdisciplinary activity on the target content, some of the teachers approached multidisciplinarity instead of the topic in question (AUGUSTO *et al*, 2004).

The second thematic category highlights the connection of *Pedagogical practices in the classroom and with communities (9)* and shows the importance of this CC for future teachers to enter the educational environment. The respondents underlined the development of projects that are applied with basic education students, in the components of Practices VI and VII, as a way of connecting student teachers to their future workspace. This aspect can be highlighted in the following answers:

> These were moments that made me learn a lot, because it was the first time I have entered the classroom as a teacher, and during the practicum component, right, we had the opportunity to apply active methodologies with the students while teaching our classes (Yago, 22 y/o).
>
> I became familiar with most of the active methodologies in the practicum component, because the teachers used them a lot and we also used them at the schools in the community (Omar, 22 y/o).

The purpose of the CCs of pedagogical practices is to promote integration between the other components of the courses that are offered in each four-month term. This favors the sharing of contents between specific fields, which will reflect on the teacher's performance as an educator, in addition to enabling an interconnection between scientific knowledge and pedagogical and practicum-related principles. Thus, these CCs are planned together (PROJETO PEDAGÓGICO DE COURSO LICNT, 2016).

The moment in the curriculum in which students will have contact with specific education in the field of Natural Sciences is called line of thinking. It should be noted that this principle is related to the component of practices and that the result of this connection will be reflected in the workload of the Supervised Practicum (PROJETO PEDAGÓGICO DE COURSO LICNT, 2016).

The interviewees underlined this characteristic of the curriculum proposed by LICNT, i.e., conducive to an integration between the specific components and the pedagogical practices. It can be not only a positive point that significantly contributes to teacher education, by placing future teachers in the educational

environment, but also a means of providing opportunities to create teaching activities with AMs, while involving scientific knowledge. However, there may be barriers to effectively applying them in practice.

3) LOGISTICAL AND PEDAGOGICAL BARRIER TO THE USE OF ACTIVE METHODOLOGIES

The use of AMs can be very efficient in the current educational context; however, they may face obstacles against their application and acceptance by students and teachers alike. Thus, there should be an effort to review the methods that will be used, in order to study strengths and weaknesses, as a way of improving the use of such methodologies (MARIN *et al*, 2010).

Based on these assumptions, the third dimension will be presented next. It had the second largest number of themes, considering the guiding principle about AMs when applying our interview. Based on this dimension, two thematic categories emerged. The first one is **Logistical barriers (4)**, pointed out by the interviewees in their discourses through the experiences they had with students at schools, which is related to the lack of infrastructure in basic education schools.

> A negative point is that many schools usually do not have adequate support for applying these methodologies, they do not have materials available (Yago, 22 y/o)
>
> [...] is that unfortunately, in government-funded schools where we have access to practicums and everything else, there are still great barriers, in terms of both infrastructure and the culture previously established at schools (Lara, 22 y/o).

In their study, Pinheiro, Azambuja and Bonamigo (2018) addressed the facilities and difficulties experienced in health education. Among the most eminent problems in the application of innovative methodologies in the classroom is the lack of infrastructure in educational institutions to adapt to this new reality. In addition, the use of technology is an innovation strategy in the teaching and learning process.

In the second thematic category, we described the **Pedagogical barriers (16)** to the application of AMs, which realities to the fact that some higher education professors are somewhat reluctant to use these methodologies, as pointed out in the following excerpts:

> Some professors do not use active methodologies in their classes; most professors use them in our classes, but some professors do not use them; they teach classes in our program, but they are not members of our faculty (Cadu, 20 y/o).
>
> There are some who do not like to work with active methodologies, right, because they are used to traditional teaching (Dora, 23 y/o).

Another important pedagogical barrier is related to the fact that students need to break paradigms when faced with methodologies that need skills that they were not familiar with in basic education.

> [...] the teachers have been behaving in a certain way for many years, there's already a certain hierarchy, let's say a hidden hierarchy, like, each person at the school actually has a role, and they play it that way, so if you come up with something different, it's scary at first, it feels strange (Lara, 22 y/o).
>
> I was familiar with banking-style classes in elementary school, which were more focused on lectures, so going through a process of new and very different methodologies from what I was used to was a little complicated, so I see it as a negative point (Enzo, 20 y/o).

In their study, Seixas *et al* (2017) reported the difficulties and challenges regarding the application of MAs in higher education, in an undergraduate degree program in tourism. Although the surveyed professors adopted methodological pluralism when teaching the courses, they tended to use traditional methodologies. The professors explained that they had to manage a large number of students per class, who came from different social realities, and many of them are not used to methodologies different from those they were exposed to in high school (SEIXAS *et al*, 2017).

Marin *et al.* (2010) heard from the students participating in their study that there is an abrupt change from approaches used in more expository methods to those seen in AMs, and this rupture ultimately generates weaknesses in the quest for knowledge in basic courses, thus causing students to feel insecure.

In contemporary times, it is common for teachers to perceive the need to use new teaching methodologies, and the active ones are recognized in this context as having capabilities that can improve student learning, as well as teaching processes, breaking old paradigms and increasing student engagement. However, professors also perceive the lack of teaching experience and the deficient teacher education process, which are considered as negative aspects that can impact the adoption of innovative methods (NASCIMENTO *et al.,* 2019).

We can show that AMs have been the subject of debate in the fields of education and teaching; they are linked to innovative methods in the teaching and learning process. However, as can be seen, there are still significant difficulties in effectively applying them in the classroom. Based on this perspective, it is important to rethink strategies that can circumvent these problems, e.g., investments in technological artifacts in educational institutions, reduction in the number of students per classroom, as well as investments for educating teachers who work in both basic and higher education.

FINAL REMARKS

This paper presented some reflections on the AMs present in the discourse of future Natural Sciences teachers, in the context of a federal government-funded university, which is underpinned by a guiding plan that prioritizes active learning. Importantly, when analyzing the perceptions of student teachers on the topic of AMs, based on their answers during the interviews, there were limitations with regard to the inferences established in the study. The data were produced on the basis of evidence from the experiences of the interviewees during their degree program.

In this way, we identified student-centeredness as one of the most evident characteristics in this process of knowledge construction, which causes individuals to feel empowered as an active member of the teaching and learning process.

In addition to the above-mentioned student-centeredness, other characteristics were mentioned, and they are important in this context. MAs are considered to be innovative because they have a more dynamic character, which encourages students to be proactive as they learn.

Also, assumptions are developed with a view to promoting the construction of knowledge, e.g., autonomy, which offers students the opportunity to develop their skills and choices; problem-based approach to reality, which addresses constructions that emerge from their realities; as well as the prevalence of considering the previous knowledge and community knowledge that surround them. All these factors converge to the development of meaningful learning in the different fields of teaching.

However, it should be noted that these future teachers have reported some barriers to the application of AMs. Taking into account that no methodological approach can be considered as the one and only solution for teaching processes, given the diversity of ways of learning, adopting only one teaching methodology is incoherent. Clearly, there will be infrastructural and pedagogical obstacles to the implementation of AMs. We therefore advocate teaching strategies aimed at methodological pluralism, which allows the students to develop different skills.

Reflexões de futuros professors de ciências da natureza sobre metodologias ativas

RESUMO

A necessidade de se construir novas competências e habilidades para a contemporânea era do conhecimento reforça a importância de mudanças na organização do processo de ensino e de aprendizagem. As metodologias ativas (MAs) podem ser consideradas aliadas na construção dos conhecimentos em contextos educacionais diversos, devido às possiblidades de integração e valorização de saberes plurais. Sendo assim, a formação docente torna-se um eixo importante nessas discussões. Nesse cenário, o presente artigo tem como objetivo analisar as reflexões sobre MAs experienciadas por futuros professores de Ciências da Natureza, no contexto de uma universidade pública federal da Bahia. Metodologicamente, o trabalho, de abordagem qualitativa, foi desenvolvido com base na aplicação de dez entrevistas semiestruturadas, para discentes do curso de Licenciatura Interdisciplinar em Ciências da Natureza e suas Tecnologias (LICNT), da Universidade Federal do Sul da Bahia (UFSB), campus Paulo Freire, situada em Teixeira de Freitas, no extremo sul baiano. Para a análise dos dados, utilizamos a Análise de Conteúdo, de Bardin. Com base nos resultados, foi possível destacar que os discentes reconhecem as MAs como processos inovadores que favorecem a aprendizagem e, nessa dimensão, apontaram o protagonismo discente como uma característica importante que participa de um processo de emancipação dos indivíduos.

PALAVRAS-CHAVE: Aprendizagem ativa. Protagonismo discente. Formação de professores.

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