

What professors think about the use of bioinformatics in biology teaching

ABSTRACT

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Pointed as an innovative didactic resource for Biology Teaching, Bioinformatics enables the interpretation of genomic and proteomic data with the aid of computing. This resource, as a didactic tool, is little widespread in Brazilian Basic Education when compared to the most developed countries. To understand the panorama about the use of Bioinformatics as a methodological resource in Biology Teaching, we carried out an exploratory research through data collection. The survey consisted of the application of a questionnaire for graduated (N=59) and undergraduates (N=17) of Biological Sciences. The answers were analyzed quantitatively and qualitatively through Thematic Analysis. It was found that 56% of respondents defined Bioinformatics satisfactorily; which was correlated with the year of training of teachers. The potential of Bioinformatics in Basic Education was associated, from the perspective of teachers, with the possibility of contextualizing abstract themes to digital native students, the dissemination of the area and the possibility of interdisciplinarity. Regarding the limitations regarding its use, the lack of experience/knowledge of the professors, the curricular plastering and the lack of infrastructure were pointed out. The results indicate that, despite recognizing the potential of Bioinformatics as a didactic resource, teachers do not have adequate training for its use, and it is necessary to offer them training for this type of tool, which would demand a closer relationship between the university and Basic Education.

KEYWORDS: Bioinformatics. Biology teaching. Teacher training.

INTRODUCTION

The Teaching of Genetics and Molecular Biology presents a high level of abstraction and decontextualization with the reality of students (LEAL; RÔÇAS; BARBOSA, 2015), requiring the development of new methodologies and teaching resources to overcome this barrier. So, we suggest the use of Bioinformatics.

Presenting its first reports in the late 1960s, the term “Bioinformatics” was used to refer to the combination of computing, technology and Molecular Biology (HAGEN, 2000), being defined as “the study of informatics processes in biological systems” (HOGEWEG, 2011, p. 1). According to Hagen (2000), its rise is due to three factors: exponential increase in the amount of amino acid sequences; the idea that macromolecules carry biological information; and, researchers' access to high-speed computers developed during World War II. The current biological data used in Bioinformatics are mainly derived from the Human Genome Project, which groups this area into three sub-areas: (1) genomics, which includes DNA sequences; (2) proteomics, which includes the function, shape and interaction of proteins; and (3) biological systems, which includes the analysis of the role of the interaction between proteins and DNA in the function of cells, tissues and organisms (WEFER; SHEPPARD, 2008).

However, only recently – since the mid-2000s – Bioinformatics has been pointed as an innovative didactic resource for the Teaching of Biology. This occurs, it is believed, due to its possibility of promoting interdisciplinarity between Natural Sciences and Mathematics, as well as providing insertion in the digital world (MARQUES *et al.*, 2014). According to Form and Lewitter (2011), Bioinformatics can be inserted in High School because it allows students to solve biological problems through tools that represent the 21st century in an interactive way that encourages critical research skills. Also, Wood and Gebhardt (2013) argue that access to Bioinformatics databases offers opportunities in Biology Teaching to bring scientific research closer to Basic Education.

Since then, some works have been published describing the experience of teachers with the introduction of Bioinformatics in High School. Among the topics addressed, we find: didactic proposals with the aim of evaluating different types of mutation and their consequences for cell functioning (AMENKHIENAN; SMITH, 2006; CEZAR-DE-MELLO, 2017), the search for specific genes (HACISALIHOGU *et al.*, 2008; CEZAR-DE-MELLO, 2017) and the analysis of the characteristics of proteins based on the teaching of Biochemistry and Evolution (TENÓRIO, 2014), using tools such as BLAST (Basic Local Alignment Search Tool), NCBI (National Center for Biotechnology Information) Protein, PDB (Protein Data Bank), Clustal and Omega.

Currently in Brazil, university extension courses represent one of the most common ways of spreading Bioinformatics. However, it is not an exclusive tool of the university, and it can be used for a pedagogical purpose in Basic Education (FREIRE *et al.*, 2018) despite the shortages of Brazilian works published in the area. One of them is the work of Rosa and Loreto (2013), who carried out an activity with a group of 2nd year of High School students about Protein Synthesis through access to GenBank, which, according to the authors, allowed a significant advance in relations concepts of content.

Analyzing this panorama and the potential benefits of Bioinformatics in Basic Education, such as bringing contents closer to the student, reduction of abstraction and access to digital platforms, we question the reasons why Bioinformatics is still a little-known and studied resource in the Teaching of Science and Biology in Brazil. In this sense, our research proposes to answer these questions through an exploratory study about the perception of graduates (professors) and in training (undergraduates) in Biological Sciences.

METHODOLOGICAL ASSUMPTIONS

Within the scope of this research, we sought to understand the perception of teachers and undergraduates about the use of Bioinformatics as a pedagogical resource for the Teaching of Biology. With this objective, we adopted an exploratory research (GIL, 2008), based on a survey, having as data collection instrument a self-applied questionnaire (GIL, 2008), descriptive (PINSONNEAULT; KRAEMER, 1993) and in cross-section (SAMPIERI, 1991).

The questionnaire was elaborated in the Google Form tool and had semi-structured questions (GIL, 2008) distributed into three sections: (1) interviewee profile, which sought to identify the background of the respondents; (2) understanding of Bioinformatics, which aimed to identify the respondents' previous understanding of the definition of Bioinformatics, its tools and its application as a teaching resource for Basic Education; and, (3) updating, in which we tried to identify the respondents' interest in conducting training courses for the use of Bioinformatics as a teaching resource.

In order to ensure the validity and accuracy of the questionnaire before its release, a pre-test was performed using non-probabilistic convenience sampling (MAROTTI *et al.*, 2008; GIL, 2008). The group of respondents included sixteen Science and Biology professors who were asked to evaluate the questionnaire and score the questions according to: (1) clarity and precision of terms, (2) form of questions, (3) order of questions and (4) introduction of the questionnaire. In addition, we sought to evidence possible flaws in the questionnaire, such as complexity, exhaustion and embarrassment (GIL, 2008). The pre-test did not result in significant changes to the questionnaire. Thus, after its validation, the form was published through social networks – Facebook and Instagram – and also by email, remaining available for two months (between May and June 2019).

The answers to the open questions were analyzed qualitatively, according to the assumptions of the Thematic Analysis proposed by Fontoura (2011), which consists of classifying the answers into units of meaning (UM) and units of context (UC). The UC are classified as long stretches that represent a certain group, while the UM are short words and expressions that define the essence of the group (FONTOURA, 2011). The US were defined by the researcher, according to the pattern of responses. The most representative responses from each UM were used as an example for the UC. In this way, all responses were organized according to Chart 1, followed by a representative response for each identified UC. Respondents had their names encoded with the letter “R” followed by a number (example: R1).

Chart 1 – Thematic Analysis Standard

Identification	Units of Meaning	N
Numerical identification of the UM	Main idea of the answer	Number of respondents

Source: Authors (2020).

The research was approved by the Research Ethics Committee of Colégio Pedro II, under CAAE (Brazilian Certificate of Presentation for Ethical Consideration) 09699419.0.0000.9047. All participants, including the pre-test respondents and the validated questionnaire respondents agreed to take part in the research by signing the Informed Consent Form.

RESULTS AND DISCUSSIONS

Prior concepts about bioinformatics

Hogeweg (2011) and Hagen (1998) report that Bioinformatics began its diffusion among researchers in the late 1960s, the term being coined only in the 1970s. According to these authors, Bioinformatics is understood as the use of computing tools and informatics for the analysis of biological data. Currently, Bioinformatics can be understood according to its strands: genomics, proteomics and biological systems, which may involve the use of online databases (WEFER; SHEPPARD, 2008). In this study, we explore Bioinformatics as a pedagogical resource, from the perspective of the use of databases and other publicly accessible online tools.

In general terms, this study sought to understand the knowledge, relationship and degree of involvement of teachers in Bioinformatics area. Our study included sixty-nine people, including undergraduates (N=17) and graduates (N=59) who teach Science or Biology in the state public network (N=11), municipal (N=10), private network (N= 20) or who do not teach yet (N=34). The majority graduated between 2010 and 2019 (N=30) and the minority between 1990 and 2000 (N=4).

We believe it is necessary to investigate what are the previous conceptions about the definition of Bioinformatics. Respondents defined Bioinformatics in three ways (Chart 2).

Chart 2 – Bioinformatics Definitions

Identification	Units of Meaning	N
UM1	Biological systems information processing, with the aid of technology	39
UM2	Fusion between science and computing	14
UM3	Use of Informatics in Biology Teaching	12
UM4	I don't know	5

Source: Authors (2020).

The majority of respondents correctly defined Bioinformatics as the "processing of information from biological systems, with the aid of technology":

R68 - In my view, Bioinformatics would be the field of knowledge that encompasses any information processing techniques related to biological systems obtained with the aid of informatics and computing tools. (...)

A group of respondents defined Bioinformatics in a partially correct manner, using only the etymology of the word, as a fusion between biology and informatics:

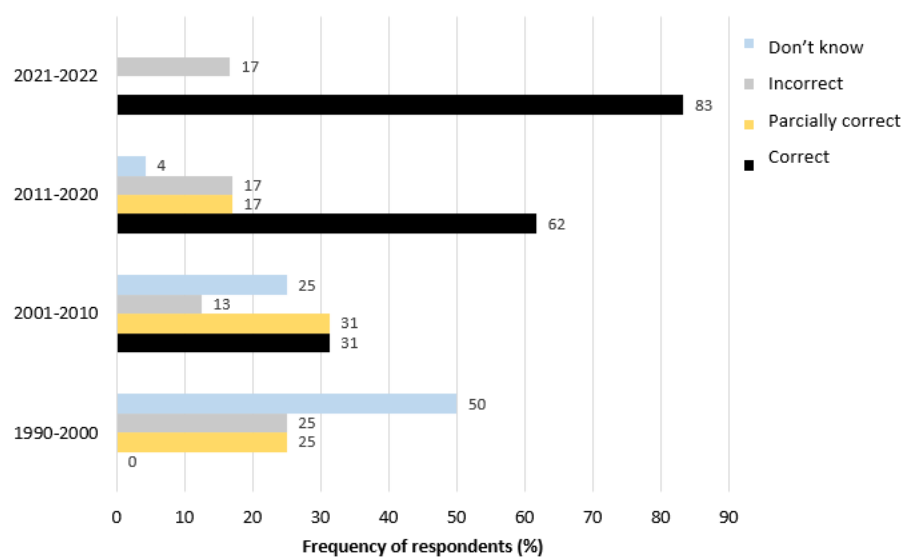
R31 - Hybrid between Biology and Information Technology. Use technology to apply Science.

Interestingly, a third group of respondents incorrectly defined Bioinformatics as the use of informatics in Biology Teaching:

R66 - Use of computer technology for educational purposes. Creation of tools that contribute to the improvement of teaching biology content in digital such as 3D illustration and so on.

By correlating the definition of Bioinformatics with the year of education of the respondents, there was a trend: the older their education, the more unsatisfactory the definition of Bioinformatics of the interviewees. It was observed that no respondent graduated between 1990 and 2000 (N=4) defined Bioinformatics correctly. Among graduates between 2001 and 2010 (N=16), 31% defined correctly, 31% partially, 13% incorrectly and 25% did not know how to define. Among graduates from 2011 to 2020 (N=47), 62% defined correctly, 17% partially, 17% incorrectly and 4% were unable to define. Among respondents with expectations of graduation from 2021 to 2022 (N=6), 83% defined it correctly and 17% defined it incorrectly (Figure 1).

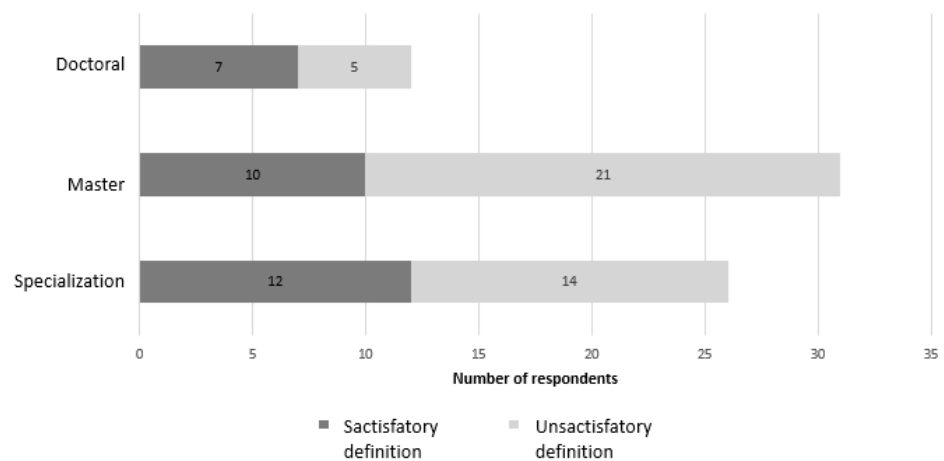
Figure 1 – Relationship between the definition of Bioinformatics and the year of training of respondents



Source: Authors (2020).

Regarding the respondents who defined Bioinformatics unsatisfactorily (N=31; Chart 2: UM2 – UM4), it was observed that, among those who have a postgraduate degree, most are attending or have completed a specialization or master's degree. Among the respondents who satisfactorily defined Bioinformatics (N=39), among those who have a postgraduate degree (N=25), most are attending or have completed their specialization or master's degree (Figure 2).

Figure 2 – Continuing education of respondents who defined Bioinformatics satisfactorily and unsatisfactorily



Source: Authors (2020).

These results suggest that the degree of academic training of teachers is not directly related to knowledge about Bioinformatics, which supports the observation that the respondents' graduation period may be the most relevant factor. Most respondents with a PhD degree who responded unsatisfactorily were graduated in the period of 2001 – 2010. In this context, it is important to highlight that the first report on the use of Bioinformatics as a research tool in Brazil occurred in 1999, through the sequencing of the bacteria *Xylella fastidiosa*, funded by the Genome Project of the Foundation for Research Support of the State of São Paulo (FAPESP) and coordinated by researchers João Meidanis and João Setúbal (CASTRO, 2009). Thus, it is proposed that the late introduction of Bioinformatics in Brazil may reflect the above data, since during the period of academic training of a portion of the interviewees, Bioinformatics was not a widely disseminated tool.

Also, there was the presence of a group of respondents with continuing education that did not satisfactorily define Bioinformatics. It is interesting to note that, among the *stricto sensu* graduate programs belonging to the four areas of assessment of Biological Sciences by Brazilian Coordination of Superior Level Staff Improvement (CAPES) (Biodiversity, Biological Sciences I, Biological Sciences II and Biological Sciences III), computing is a discipline mostly inserted in programs specific in Molecular Biology, Genetics and Bioinformatics (MEDEIROS and LETA, 2020). This suggests that the continuing education of these teachers did not provide access to Bioinformatics, either because it was not in an area related to their training or because it was carried out during a period in which this tool was not widespread among researchers

Bioinformatics in respondent training

From this point on, we explore the relationship between Bioinformatics and the academic background of the interviewees, as well as the perception of teachers regarding the insertion of Bioinformatics in Biology Teaching. Thus, we chose to make a sample cut and analyze only the responses of the group that satisfactorily conceptualized Bioinformatics. Thus, although the data collection instrument in the present study reached 76 respondents, only 39 were selected to assess their responses regarding the use of Bioinformatics in the classroom (Chart 2: UM1). It concerned us to remove from the analysis those respondents who did not conceptualize Bioinformatics satisfactorily because we infer that their misconceptions would reflect less informative answers. However, the exclusion of 31 respondents (44%), per se, points to an explicit lack of knowledge on the topic by them.

When asked about the presence of Bioinformatics during their academic training, fifteen respondents reported the lack of contact with Bioinformatics during their training (Chart 3).

Chart 3 – Contact with Bioinformatics throughout training

Identification	Units of Meaning	N
UM1	No	15
UM2	Yes, during post-graduation or graduation	16
UM3	Yes, in complementary courses or throughout the development of the research (Scientific Initiation, Masters or Doctorate)	7
UM4	Not specified	1

Source: Authors (2020).

Among those who did not have contact with the tool (N=15; Chart 3: UM1), it was observed that some respondents mentioned that they used tools that are not Bioinformatics:

R5 - Yes. In graduate school we had a discipline that involved subjects such as creating a 3D model for students, creating applications, etc.

Among those who had contact (N=24; Chart 3: UM2-3), the majority indicated that they learned about Bioinformatics during their undergraduate or post-graduate studies (N=16; Chart 3: UM2):

R48 - During my bachelor's degree at UEZO, I took a course in Bioinformatics with a theoretical and practical approach.

R6 - I have a master's degree in the Computational Biology and Systems program and I'm doing a doctorate in the same program. In my master's I worked with transcriptome analysis and in my doctorate I will do metagenome as well.

In addition, seven respondents described contact with the tool during complementary courses or during research development (Chart 3: UM3):

R33 - (...) We used specific programs to "read" genomic sequences, to search for specific sequences within that genome and also to design primers (...), we

also used a database to compare the gene sequence we found with the genome of other species of living beings (...).

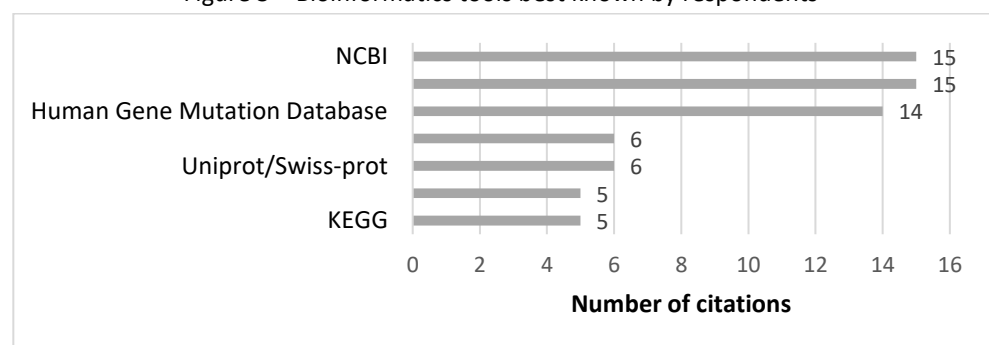
The number of respondents who indicated having contact with Bioinformatics during their postgraduate studies, elective courses or complementary courses is significant. This data indicates the relevance of continuing education for teacher updating. Regarding the initial training of teachers, Mello (2000) indicates that the rupture between the acquisition of specific knowledge and the constitution of teaching skills makes changes in pedagogical practice difficult. In this perspective, it is believed that changes in the structure of teaching depend on reflection on pedagogical practice, which acts as a "master spring to analyze and evaluate educational actions put into use, which leads them to the construction of new perspectives and new reflections" (PINHEIRO *et al.*, 2015, p. 2).

In a society of constant technological evolution, teachers need to be able to incorporate technological tools during the teaching and learning process. In a survey conducted by Pinheiro *et al.* (2015) about the relevance of reflective practice, 76% of the interviewed teachers believe that student learning is influenced by the continuing education of teachers. In this sense, it is believed that the inclusion of technology in the classroom and continuing teacher education are relevant factors for the development of meaningful learning. Bioinformatics, as a didactic resource, has the potential to insert technology into the teaching of Biology, promote teachers' updating through continuing education and expand the students' view of the area.

The respondents were asked about the Bioinformatics tools that were best known to them. Thirteen respondents stated that they did not know any Bioinformatics tools among those listed in the applied questionnaire. In this group, eight of them had no contact with Bioinformatics during their training and five of them said they had contact during their undergraduate or post-graduate studies.

Those who know (N=26), in the majority indicated: BLAST, Human Gene Mutation Database (HGMD) and NCBI (Figure 3).

Figure 3 – Bioinformatics tools best known by respondents



Source: Authors (2020).

BLAST has the function of finding regions of similarity between biological sequences (nucleotides or proteins). HGMD makes it possible to search a database with information on human genes associated with diseases. The NCBI is a consortium that includes databases with information at the molecular level of several organisms.

Coincidentally, NCBI and BLAST are the most used banks as a teaching-learning tool, both in higher education and in Basic Education (MORAES; CEZAR-DE-MELLO, 2020). The use of these databases for teaching content with a high level of abstraction to students can be a potential tool for their contextualization, enabling the appreciation of the "interaction pedagogy", in which the student has an active role in the construction of the knowledge (GEMIGNANI, 2012). From this perspective, conditions are offered for the student to "learn by doing" and, in it, Bioinformatics is able to promote the possibility of using ideas, concepts and integrated skills in solving a relevant scientific problem (MACHLUF; YARDEN, 2013).

Bioinformatics in basic education

Among the respondents who demonstrated knowledge of Bioinformatics, eight were unable to identify its relevance for Basic Education. Those who described it indicated that it is associated with the dissemination of the area and/or a decrease in the level of abstraction of the content (Chart 4).

Chart 4 – The relevance of Bioinformatics in Basic Education

Identification	Units of Meaning	N
UM1	Dissemination of the area, expanding the view on biology	11
UM2	Making content less abstract and more contextualized through technology and/or interdisciplinarity	21
UM3	Was unable to answer	8

Source: Authors (2020).

The group that cited the relevance of Bioinformatics as its dissemination as an area of knowledge and action, points out that:

R61: Ensure access and visibility of the area to ensure student interest and consequently development of new usable tools.

The tool's correlation with the dissemination of this area corroborates the findings of Kovarik *et al.* (2013). To assess the influence of using Bioinformatics as a teaching resource in the dissemination of STEM areas, Kovarik *et al.* (2013) conducted a course with high school teachers and students interested in the development of Science. The course, called Bio-ITEST, was divided into two units: "Using Bioinformatics: Genetic Testing", which uses Bioinformatics to teach basic concepts of Genetics and Molecular Biology, and "Using Bioinformatics: Genetic Research", which uses Bioinformatics for the teaching of Evolution. In the activity, in addition to using databases – NCBI, BLAST, Cn3D, BOLD and ORF Finder – the technological and social implications of Bioinformatics were discussed. At the end of the activity, the authors concluded that high school students learned more about careers involving Science, Mathematics, Technology and Engineering, and high school teachers felt more capable of bringing the same type of approach to the classroom.

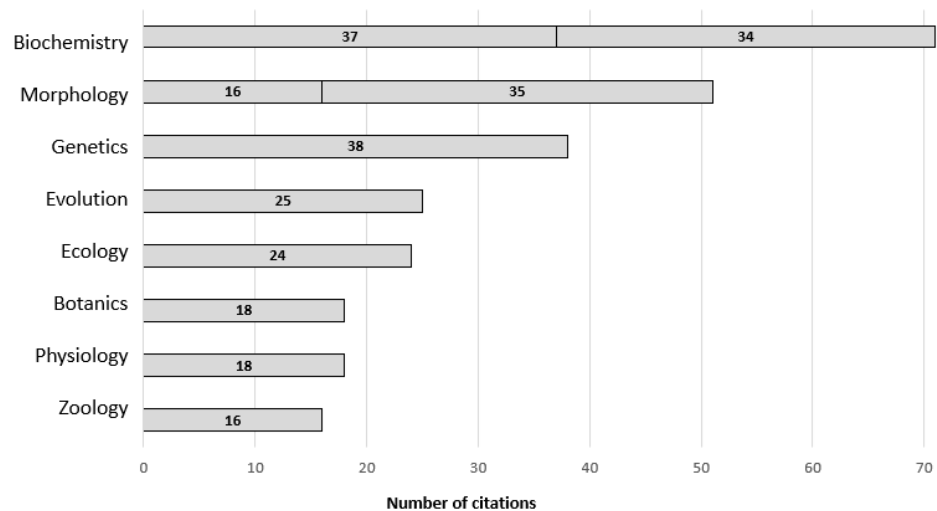
Another group (Chart 4; UM2) highlighted the ability of this resource to make the approach to content less abstract and more contextualized, due to the approach of native-digital students through the use of computers and interdisciplinarity:

R3: I believe it is a way to attract the students, to make them have a greater interest in the subject discussed.

The decrease in the abstraction of concepts involving Molecular Biology through Bioinformatics is described by Rosa (2011), who carried out an activity with 2nd year high school students in which she used access to GenBank as a didactic resource for teaching Molecular Biology. In the activity, students followed a script to access databases such as OMIM, NCBI Gene, Gene Info, NCBI Ref Seq and Uniprot. Their results indicated that students improved their understanding of protein synthesis, in addition to realizing that the activity contextualized the content with a tool often used by researchers.

Mostly, thirty-two respondents indicate that Bioinformatics can be used as a tool for teaching Science and Biology, and can act as a didactic resource for the teaching of Cell Biology, Molecular Biology, Biochemistry and Genetics in Basic Education (Figure 4), areas which are more abstract, which requires a greater effort from students to understand and teachers to use different teaching strategies. Interestingly, it is observed that Bioinformatics, as a didactic tool in Basic Education, has been described for these three areas (AMENKHIENAN; SMITH, 2006; HACISALIHOGU *et al.*, 2008; TENÓRIO, 2014; CEZAR-DE-MELLO, 2017; MORAES ; CEZAR-DE-MELLO, 2020).

Figure 4 – Contents that could be taught with Bioinformatics

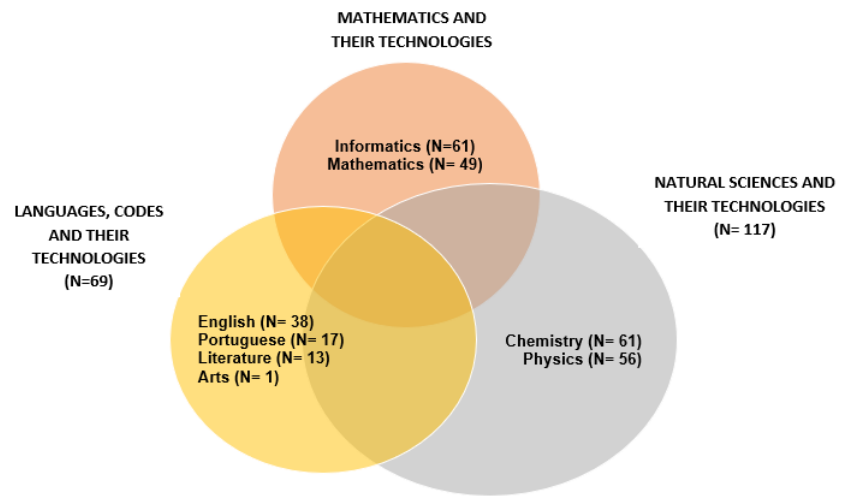


Source: Authors (2020).

Contents organized by Area of Knowledge of Biological Sciences (CNPq, Brazilian National Research Council). The areas of Biochemistry and Morphology comprise, respectively, Molecular Biology (N=37) and Biochemistry (N=34); and Anatomy (N=16) and Cell Biology(N=35).

Also, according to most respondents, Bioinformatics in Basic Education can enable the interdisciplinarity of Biology with the disciplines of Physics, Informatics, Mathematics and Chemistry. Therefore, there was a perception that it is easy to propose interdisciplinary activities between the areas of knowledge of Natural Sciences, Mathematics and their Technologies and the discipline English (Languages, Codes and their Technologies) (Figure 5).

Figure 5 – Interdisciplinarity that can be made possible by Bioinformatics



Source: Authors (2020).

According to the respondents, subjects that allow interdisciplinarity with the teaching of Biology through Bioinformatics, organized according to the Knowledge Areas of the Common National Curriculum Base.

Interdisciplinary practices usually face some difficulties, such as: excessive workload, low pay, high number of students in the classroom, lack of infrastructure, plastering of the school curriculum and difficulty in working in groups (AUGUSTO; CALDEIRA, 2007). Reflecting on the data presented here, we also suggest another difficulty for this interdisciplinary use: the need for training of professors in Bioinformatics.

The data obtained indicate that one of the greatest limitations for the implementation of Bioinformatics in Basic Education is the deficient teacher training (N=18):

R19: Mainly, the mastery of techniques that are quite specific.

Silva and Rocha (2019) argue that the lack of mastery and awareness of the impact of new technologies available leads the teacher to develop a practice that is not consistent with reality. In this sense, teacher training for the use of Bioinformatics in the classroom is related to the concept of pedagogical praxis, understood as "the performance of an activity or work with a view to acquiring a certain skill" (SILVA; ROCHA, 2019, p. 125) and depends on the involvement of both professors and students. Positive experiences with the use of Bioinformatics as a teaching resource in High School report the need for teacher training (MARQUES *et al.*, 2014; MACHLUF; YARDEN, 2013). The development of the "Bioinformatics at School" project in Portugal began in 2007 and gave rise to an online platform with several projects to be carried out by students (MARQUES *et al.*, 2014). For this, Marques *et al.* (2014) describe the need for teacher training, since most of them did not have knowledge about Bioinformatics. In this training, which has a workload of 25 hours, the teachers had the help of bioinformatics to carry out the same activities that their students would do and to understand basic concepts of Bioinformatics and what was behind each activity in the program, indicating an approximation between the university and basic education. In Israel, the development of a similar project invested in updating Basic Education teachers

with training courses in Bioinformatics with a workload of 56 hours and workshops for learning and development of materials with a workload of 28 hours (MACHLUF; YARDEN, 2013).

In this context, we can observe that another actor can contribute to the implementation of Bioinformatics in basic education: the university. As discussed by Scheid *et al.* (2009), the distance between the university and basic education is one of the crucial factors for the deficient training of teachers. It is believed that the exchange of knowledge between basic education professionals and academics would allow teachers to update themselves and, as a consequence, the application of tools used in the academic sphere in classroom practice. As an example, a project developed in the state education system of Rio Grande do Sul pointed out the importance of the presence of an academic in the school routine to act as a didactic-scientific advisor in the development of practical classes and field trips in basic education. Experience that motivated teachers to use new didactic techniques and modalities (SCHEID *et al.*, 2009).

Even with adequate education and training, teachers would face another difficulty in implementing Bioinformatics as a didactic resource in Basic Education: the curriculum plastering and the lack of infrastructure, which was the limiting factor most cited by respondents for Bioinformatics in Biology Teaching (N=32).

R23: Mainly lack of resources in the public network, lack of interest both on the part of the school and some teachers.

For a successful activity, the institution must have access to computers, internet and, depending on the level of approach, different programming languages (MACHLUF; YARDEN, 2013). This lack of infrastructure is a Brazilian reality and an important limiting factor for getting closer to “digital native” students, who were born and raised with computers and the internet and have shown interest in accessing online games and programming.

Even facing difficulties, 89% of respondents indicated using technologies or digital media in the classroom, such as data projector, applications that facilitate learning, social networks and videos. Given that the databases best known by respondents such as the NCBI and BLAST are available online and can be accessed by smartphones, it is inferred that this would not be a barrier to the basic application of Bioinformatics in the classroom, through training of the teachers. In this sense, the elaboration and application of pedagogical practices in the classroom and the report of experiences with the use of Bioinformatics in Basic Education are interesting for the dissemination of the use of this tool in different Brazilian realities.

Reflecting on the difficulties of teachers in implementing activities with Bioinformatics in the classroom, Form and Lewitter (2011) suggested ten pedagogical guidelines for the development of an effective activity in the development of cognitive skills for the target audience. According to the authors, the reflection on these guidelines, together with the identification of the target audience, the presence of access infrastructure and teacher training would enable the construction of appropriate activities for students.

FINAL CONSIDERATIONS

The proposal to use Bioinformatics as a didactic resource in Regular Basic Education did not, at first, include the development of programming skills in students, despite being an essential element in bioinformatics researchers and more accessible for application in Technical High School. The perspective of this research was based on two premises: Bioinformatics in the classroom (1) democratizes access to knowledge developed by researchers through the use of databases that are available in the public domain and (2) enables the development of skills cognitive skills through searches in online databases and the decrease in the level of abstraction of some contents, as enumerated by respondents, such as Cell Biology, Molecular Biology, Biochemistry and Genetics.

The results allowed the inference of advantages and limitations regarding the use of Bioinformatics as a teaching resource in Basic Education. Among the advantages, we found the possibility of contextualizing abstract themes, disseminating the research area, bringing teaching closer to digital natives and using interdisciplinarity. As for the limitations, it is reiterated the lack of knowledge of the professors in the area – which was represented in the unsatisfactory definitions of Bioinformatics by the respondents –, the plastered in the curriculum and the lack of infrastructure.

It is concluded that, despite recognizing the potential of Bioinformatics as a teaching resource, teachers do not have adequate training and/or security for its use, requiring training for this type of tool. From this perspective, we point to the existence of an empty niche with regard to the continuing education of teachers in the area of Bioinformatics. It would be desirable and relevant to offer more extension courses for this purpose, bringing University and Basic Education closer together, and expanding the range of pedagogical possibilities for Science and Biology teachers.

O QUE PENSAM OS DOCENTES SOBRE O USO DA BIOINFORMÁTICA NO ENSINO DE BIOLOGIA

RESUMO

Apontada como um recurso didático inovador para o Ensino de Biologia, a Bioinformática possibilita a interpretação de dados genômicos e proteômicos com o auxílio da computação. Esse recurso, enquanto ferramenta didática, é pouco difundido no Ensino Básico brasileiro quando comparado aos países mais desenvolvidos. Para compreender o panorama acerca do emprego da Bioinformática enquanto um recurso metodológico no Ensino de Biologia, realizamos uma pesquisa exploratória através do levantamento de dados. O *survey* consistiu na aplicação de um questionário para licenciados (N=59) e licenciandos (N=17) de Ciências Biológicas. As respostas foram analisadas de forma quantitativa e qualitativa, por meio da Análise Temática. Verificou-se que 56% dos respondentes definiram a Bioinformática satisfatoriamente; o que se correlacionou com o ano de formação dos docentes. A potencialidade da Bioinformática no Ensino Básico associou-se, na perspectiva dos docentes, à possibilidade de contextualização de temas abstratos aos estudantes nativos digitais, à divulgação da área e à possibilidade de interdisciplinaridade. Com relação às limitações quanto ao seu uso, foram apontados a falta de experiência/conhecimento dos docentes, o engessamento curricular e a carência de infraestrutura. Os resultados indicam que, apesar de reconhecerem as potencialidades da Bioinformática enquanto recurso didático, os professores não apresentam a formação adequada para a sua utilização, sendo necessária a oferta de treinamentos para este tipo de ferramenta, o que demandaria uma maior aproximação entre a universidade e a Educação Básica.

PALAVRAS-CHAVE: Bioinformática. Ensino de Biologia. Formação de professores.

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