

**Cell biology for visually impaired people: a study on inclusion methodologies**

**Biologia celular para deficientes visuais: um estudo sobre metodologias inclusivas**

**Biología Celular para personas con discapacidad visual: un estudio sobre metodologías inclusivas**

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**Abstract**

**Introduction:** Inclusive Education is a consequence of changes in social attitudes that have been established throughout history. **Objective:** This study analyzed the conceptions and practices of teachers who taught blind students and the benefits of using a didactic model (3D cell) adapted for these students. **Methodology:** 10 teachers were selected from the departments of Biology, Chemistry and Morphology at Universidade Federal de Sergipe. As for the 3D cell analysis, three visually impaired students from Biology, Physical Education and Physiotherapy courses were invited. **Results:** The research demonstrated the main weaknesses in the teacher training process and the little support they receive, thus leading to difficulties in the learning process and the relevance that didactic models can have in this

context. **Conclusion:** Considering that theoretical and methodological foundations of Inclusive Education are based on a conception of quality education for the whole society, a more qualified teachers' participation is essential to meet the educational needs of all students, with or without disabilities.

**Keywords:** Education; Visual disability; Didactic models.

## Resumo

**Introdução:** A Educação Inclusiva é uma consequência das mudanças nas atitudes sociais que se estabeleceram ao longo da história. **Objetivo:** Este estudo analisou as concepções e práticas de professores que ensinavam alunos cegos e os benefícios da utilização de um modelo didático (célula 3D) adaptado para esses alunos. **Metodologia:** Foram selecionados 10 professores dos departamentos de Biologia, Química e Morfologia da Universidade Federal de Sergipe. Quanto à análise das células 3D, foram convidados três alunos com deficiência visual dos cursos de Biologia, Educação Física e Fisioterapia. **Resultados:** A pesquisa demonstrou as principais fragilidades no processo de formação de professores e o pouco apoio que recebem, levando a dificuldades no processo de aprendizagem e à relevância que os modelos didáticos podem ter neste contexto. **Conclusão:** Considerando que os fundamentos teóricos e metodológicos da Educação Inclusiva se baseiam em uma concepção de educação de qualidade para toda a sociedade, uma participação mais qualificada dos professores é essencial para atender às necessidades educacionais de todos os alunos, com ou sem deficiência.

**Palavras-chave:** Educação; Deficiência visual; Modelos didáticos.

## Resumen

**Introducción:** La Educación Integrada es consecuencia de los cambios de actitudes sociales que se han ido instaurando a lo largo de la historia. **Objetivo:** Este estudio analizó las concepciones y prácticas de los profesores que impartían clases a estudiantes ciegos y los beneficios de utilizar un modelo didáctico (celda 3D) adaptado para estos estudiantes. **Metodología:** Se seleccionaron diez profesores de los departamentos de Biología, Química y Morfología de la Universidad Federal de Sergipe. En cuanto al análisis de las células 3D, se invitó a tres estudiantes con discapacidad visual de los cursos de Biología, Educación Física y Fisioterapia. **Resultados:** La investigación demostró las principales debilidades en el proceso de formación docente y el poco apoyo que reciben, lo que genera dificultades en el proceso de aprendizaje y la relevancia que pueden tener los modelos didácticos en este contexto.

**Conclusión:** Considerando que los fundamentos teóricos y metodológicos de la Educación Integrada se basan en una concepción de educación de calidad para toda la sociedad, una participación más calificada de los docentes es fundamental para atender las necesidades educativas de todos los estudiantes, con o sin discapacidad.

**Palabras clave:** Educación; Discapacidad visual; Modelos didácticos.

## 1. Introduction

Inclusive Education is intrinsically linked to people with some kind of disability, physical or functional. This movement is a consequence of changes in social attitudes that have been established throughout history regarding the recognition given to these people. Despite having developed in the 70s, it is important to highlight that, according to the Ministry of Education (MEC) in Brazil, the care for people with disabilities began in the imperial period. During this period, two institutions were created: Instituto dos Meninos Cegos in 1854, now called Instituto Benjamin Constant - IBC, and Instituto dos Surdos e Mudos in 1857, now called Instituto Nacional da Educação dos Surdos – INES, both in Rio de Janeiro.

Another historic point that narrows education and disability is, without a doubt, the statement by Salamanca (1994) (Breitenbach et al., 2016), where the various United Nations statements culminated in the document "Standard Rules on Equalizing Opportunities for People with Disabilities", which demands that States ensure that the education of people with disabilities is an integral part of the education system. Noting with satisfaction an increasing involvement of governments, advocacy groups, communities and parents, and in particular organizations of people with disabilities, in the search for improved access to education for those who have long been excluded (Breitenbach et al., 2016).

In 1996, the LDB (Lei de Diretrizes e Bases) was created, which in the context of special education, addresses in its art. 85th - which is understood by special education as the type of school education offered preferably in the regular education network for students with disabilities. In its 2nd paragraph, the law states: Educational assistance will be provided in classes, schools or specialized services, whenever, due to the specific conditions of the students, it is not possible to integrate them into the regular classes of Regular Education (L. M. T. Lima et al., 2020).

The inclusion of these students in regular classes does not in itself guarantee an inclusive practice that promotes learning. The school becomes inclusive as it recognizes the

diversity of individuals and responds to it with pedagogical efficiency. To respond to the particularities of each student, an essential condition in inclusive educational practice, it is necessary to adapt to the different curricular elements, in order to meet the peculiarities of each and all students. It is essential to develop alternatives, adopting differentiated strategies and adapting the educational action to the students' peculiar ways of learning, always considering that teaching and learning processes presuppose meeting the diversification of students' needs at school (Oliveira-Formosinho et al., 2009).

In this context, the inclusion of students with disabilities represents an important legal advance in assuming an institutional mission in response to demands. The arrival at higher education leads the student to face a new educational reality, necessarily more complex and demanding than basic education. From a simple reasoning, from the word University, which originates from universality, totality, as a whole, the following question can be asked: why can't we integrate them all?

If we are constitutionally and structurally better prepared to receive and work with PwD, (People with Disabilities) can we say the same regarding our teachers? This is one of the main issues for us to reflect on. We support these students before the legislation, providing them more and more with an efficient and satisfactory structure and, in parallel to this, we neglect the main point – teacher training (Fernandes et al., 2016).

Some statistical data has shown that there is a tendency to teach an increasing number of students with disabilities in any educational sector. INEP made a survey from 2004 to 2014 showing that enrollments in higher education increased by 518.66%. In view of this reality, Higher Education Institutions have been called upon to respond in an increasingly satisfactory manner to the specificities of these students. Thus, in some institutions, internal policies, regulations, programs and actions aimed at the inclusion of students with some type of disability have emerged. These actions reflect some international guidelines, while at the same time, there are more spaces for debate on the topic within the academy (Bisol et al., 2018).

In the teacher training process, a greater sensitivity towards our teachers is needed and an understanding that this process is a fundamental part of the whole gear that made up our educational system. Teachers are often overloaded with activities and responsibilities and that, in parallel, so devalued by our society. However, how to get around this situation? There is a demand, which only increases, while there is no time to become an expert teacher in the various methodologies for PwD. There will be questions, errors and frustrations; however, the important thing is that attempts never cease to exist, since only then will we be closer to



success. It is always worth remembering: The choice to be a teacher was an intrinsically decision of everyone who embraced this career, but disability was not (Rocha, 2017).

To make things worse, teachers in Brazil are poorly paid and, being a teacher is not a popular career. If, in the past, it was considered important, nowadays this is no longer the case. As it can be noticed, inclusion creates a scenario with plenty of challenges for teachers, without giving them any consistent support to face them (Cenci et al., 2016).

Throughout the text, legislative points that guarantee education in all sectors for PwD are addressed; however, it is also essential to deal with affirmative policies that help the continuity of these students in universities. They aim to increase the chances of people from discriminated social segments to ascend socially, that is, they contribute to mitigate structural inequalities in society as they decrease them in the distribution of educational opportunities in institutions that form the country's elite.

The Divisão de Ações Inclusivas (DAIN) is the sector for guidance and support for students with disabilities and for the coordination of the actions developed by inclusion programs such as Programa Incluir from MEC and the Programa de Ações Inclusivas from Universidade Federal de Sergipe, in addition to the Espaço Acessibilidade (Gomes et al., 2018).

DAIN competences: Assist students with disabilities; Develop accessibility campaigns in the academic community; Guide teachers and technicians about the academic rights of students with disabilities and pedagogical adaptations; Promote pedagogical accessibility strategies; Provide technology-assisted equipment and services to students with disabilities; Sensitize the different sectors of the UFS about the issues of pedagogical, communication, architectural or cultural accessibility (Gomes et al., 2018).

The Espaço Acessibilidade - BICEN / UFS aims to promote and / or facilitate access to information for students with disabilities, in addition to providing some services and products that assist in the graduation of these students; Loan of Braille books and Audiobooks; Braille printing; Computer availability with accessible software (DOSVOX and NVDA); Electronic magnifiers for people with low vision; LIBRAS translator and interpreter; High-relief image reproduction; Spoken scanner for reading printed texts (D. R. de Lima, 2018).

With regard to Inclusive Education, there is a clear need to propose the use of didactic models for regular education, which also enable students with visual impairments, an opportunity to get involved and understand the content to be addressed without feeling excluded.

Didactic models are representations, made from concrete material, structures or parts of biological processes that favor the development of students' learning. Such models can provide ways to motivate and involve them in the studied themes, providing content understanding and interpretation, in addition to providing students with opportunities for skills and competences development (T. G. da C. Oliveira & Marques, 2016).

In this context, it is essential to think about a different educational organization from its functional structure, its philosophical principles to its political-pedagogical project. With these findings, the present work sought the presentation of a tool that helps teachers in training on the learning process, fully adapted for undergraduate students in the health field with visual impairment, and mainly, a material that incites reflection for the need to debate and find solutions to the inevitability of adapting to this new “cliente”.

Therefore, it is essential that in addition to a good structure, it is necessary to have professionals prepared and engaged, and that everyone who works in this institution have the slightest notion of concepts such as: socioeconomic, cultural and racial inequalities. Knowing this, students will be welcomed in an egalitarian, democratic way and the institution will be able to offer that student a good education, that is, quality education (Pereira et al., 2020).

## **2. Material and Methods**

### **Research outline**

The present study had a design of a qualitative and quantitative approach and the debate between these two approaches is very old. In a simplified manner, the basic difference is the way in which scientists represent the real, perceiving social reality through numbers (for the quantitative) or subjective aspects (for the qualitative). The origin of quantativism is associated with science philosophy of science, such as Galileo and Newton, and is present in the line of empiricist and positivist thought. Regarding the qualitative approach in research, there are some basic characteristics, such as the performance of the empirical study out in its natural environment, as the social facts have to be observed and analyzed inserted in the context to which they belong, through direct contact (Ferreira, 2015).

Data were obtained from the application of a questionnaire – Inclusive Education – for teachers bounded to the Biology, Chemistry, Physiology and Morphology departments at Universidade Federal de Sergipe (UFS). In addition, a didactic model, made of BISCUIT

material, completely adapted for PwD was applied, and its benefits were analyzed. For this observation, a form (attached to the present study) was used.

### **Inclusion criteria**

10 teachers were selected from Biology, Chemistry, Physiology and Morphology Departments at UFS. The main criterion used for this selection was the fact that they had had at least one experience teaching the discipline related to their area of activity, in which a student with visual impairment was part of the student body.

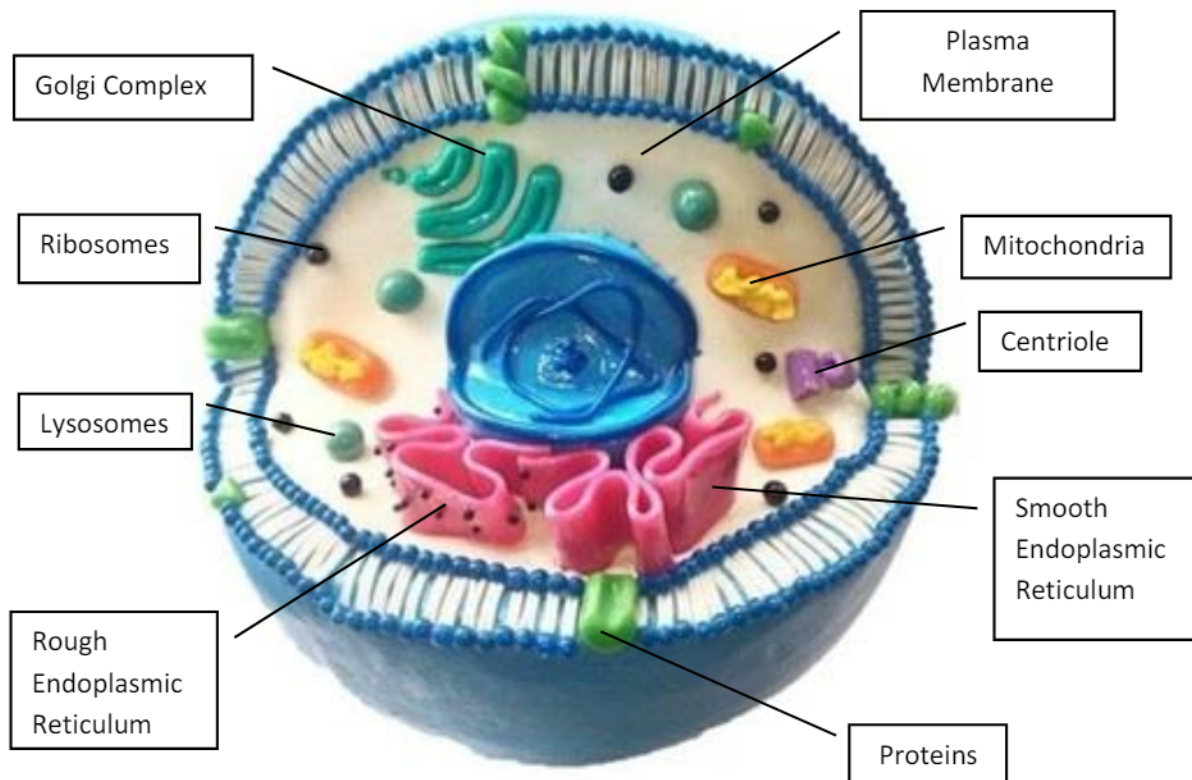
As for the 3D cell analysis, three visually impaired students from UFS were invited to take courses in Biological Sciences, Physical Education and Physiotherapy. The method of choice was related to the conjuncture that was part of the student's curriculum, the Cell Biology discipline.

### **Data collection**

One of the instruments used in the research to obtain data on Inclusive Education was a questionnaire composed of nine questions, classified as: open, closed (dichotomous), closed (trichotomous) or multiple choice. While creating this questionnaire, questions were divided as six closed questions of the dichotomous type (the individual chooses the answer having only two options; yes or no, for example), two trichotomous and, finally, an open question (M. L. Oliveira et al., 2011).

Another instrument used for data collection was the observation form, a method that allowed flexibility to obtain qualitative information about the 3D cell model of the project, made of BISCUIT material (30 cm x 30 cm), represented in Figure 1. This required good prior planning and skill researcher to follow a script with the possibility of introducing variations that are necessary during its application. Options formulated to classify the effectiveness of the 3D cell were unsatisfactory, regular and excellent. The model was applied individually according to the availability of the students participating in the research at times after classes, according to each shift of those referred.

**Figure 1:** 3D animal cell model (BISCUIT material).



Source: own author (2020). Figure 1 shows the teaching model in which appears demonstrated the major cellular structures. The model presents details of different shape and size to enable the visually impaired spatial understanding of the architecture and distribution of these structures within the cell.

### Data processing

In the formulated questionnaires, two types of analysis were worked on within a research (quantitative and qualitative), asking within the questions, reports, justifications for the choices of certain alternatives, thus enabling a better interpretation than what was proposed in our research. With regard to the observation sheet, practically the same process was performed, since, in addition to presenting alternatives integrated to the didactic model, it was also asked the participating students why they chose each item, adding points to be improved and positive points to our didactic model in a very effective way.

### 3. Results and Discussions

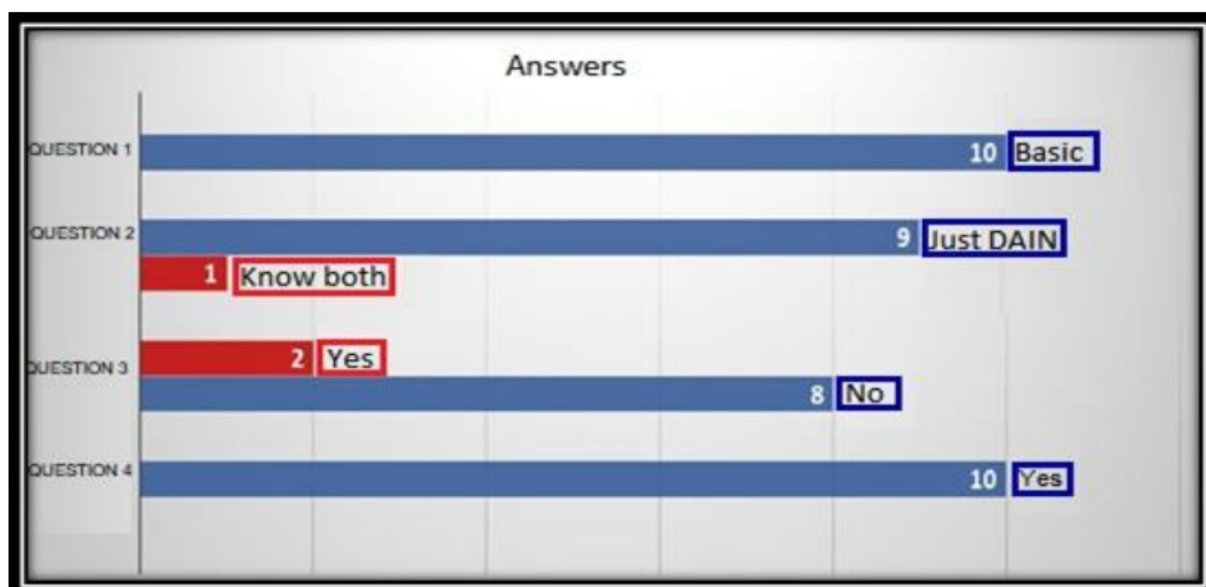
Currently, seventy-six students classified with low vision and ten who are completely blind are enrolled at UFS. The first stage of the research aimed to evaluate, mainly, the



quality of work that some teachers had before the challenge of teaching people with visual impairments in their subjects.

Figures 2 and 3 represent the answers to questions 1 to 9 of the questionnaire applied to teachers participating in the research.

**Figure 2:** Data regarding the answers from the questionnaires applied (Questions 1 to 4).



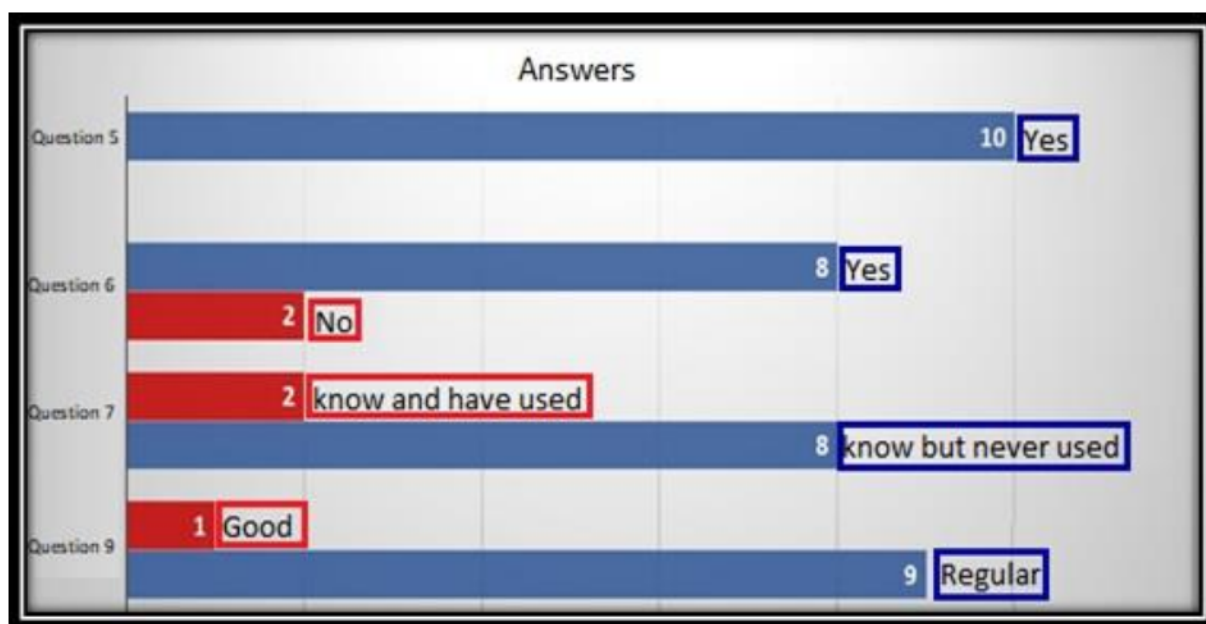
Source: own author (2020). Figure 2 shows the number of responses to the first four questions in the applied questionnaire, among 10 teachers. The blue color highlights the highest number of responses from the participants, while the red color corresponds to the lowest number of these participants.

**Question 1.** Regarding the rights that support PwD in the educational field, what degree of knowledge do you have on the subject?

**Question 2.** Do you know Divisão de Ações Inclusivas (DAIN) and the Accessibility Area (BICEN / UFS)?

**Question 3.** During your initial and/or continuing education, did you receive any theoretical and practical support to work with visually impaired students in the classroom?

**Figure 3:** Data regarding the answers from the questionnaires applied (Questions 5 to 9).



Source: own author (2020). Figure 3 depicts the responses to questions 5 to 9, which appeared in questionnaires. It can be observed according to the alternatives chosen that the participants, demonstrated a willingness to work with visually impaired students in the best possible and feasible way, and attributed a self-criticism regarding performance through question 9.

**Question 4.** Were you previously informed by the department to which you are bound, that you would work with a class, in which a student with visual impairment was part of the student body?

**Question 5.** Would you use any didactic model suitable for a visually impaired student?

**Question 6.** In your experience with the visually impaired student (s), at any time did you seek alternatives to actively include him in the discipline?

**Question 7.** With the increased number of visually impaired students in universities and other educational sectors, new strategies that enable these students to follow the content given in the classroom are becoming more and more frequent. An example is a software specific for these students. As a teacher, do you know this resource and have you used it?

**Question 8.** Despite all the legislative support and structural changes that have taken place at universities, in your opinion, what are the main challenges that visually impaired students face at the university?

**Question 9.** We know that these challenges include many steps: Teachers, departments, universities and society need to walk together to better serve these students.

More specifically, and considering the time you worked with a visually impaired student, today, how would you evaluate your performance?

In the first question, among the options (advanced, basic or none), all participants highlighted that they have a basic level of knowledge regarding the rights of PwD, which is undoubtedly a relatively positive point, since they are teachers of a reference public institution in the state and such legislative “commitment” is necessary. According to Silva (2018) it is from this scenario that we can seek a more reflective action comprising this more conceptual part, in the context of what was asked – the legislative – according to the report, it would allow a better dialogue on the rights that affect the students with disabilities (Silva, 2018).

Regarding the question about DAIN and the Espaço Acessibilidade, these are two essential sectors in helping students with disabilities, as well as teachers who need some guidance for working with these students. Unfortunately, despite the excellent work that the Accessibility Space and BICEN / UFS performs, it is a place still little known by the teaching and student community and only one participant indicated to be aware of them. A better dissemination of the services provided is necessary, since the space has several alternatives to support students with disabilities and practical resources for teachers who will teach these students.

Question three is a point that allows a lot of interpretation since the two participants who scored positively argued that it was more of a theoretical/practical ampoule coming from their own colleagues and not necessarily from the institution. For several authors in the educational field, as in the example of Santos et al., (2017) continuing education in addition to practical and theoretical support is classified as essential for a qualitative development of learning. It transcends a mere scientific, pedagogical and didactic update and becomes the possibility of creating spaces for participation, reflection and training. The author also emphasizes that continuing education is a way to face the growing demands for professional updating (Santos et al., 2017).

With regard to the question raised about the information that a student with a disability would integrate into the class, all participants pointed out positively, but stressed that they received this information “on the eve”, that is, they didn’t know that a blind/low vision student would join the class in advance before the period start. So, they would prepare to deal with the new challenge either through learning acquired as a listener through lectures directed to this theme or through the exchange of experiences with other professionals who have already dealt with this panorama (Vieira et al., 2018). Vieira et al., (2018) endorses this dialogue between the teacher and the department, warning that the least that the teacher

expects from his work environment is that the secretariat and coordination work in an orderly manner for a better quality of teaching and be informed about the characteristics of your class is a fundamental department service (Vieira et al., 2018).

In question five, all teachers stated that they would use a didactic model to assist students' learning and some even reported that during the period they requested that students themselves end up developing didactic models and these were used in class. According to Souza and Alves (2016), it is important that the teacher has the sensitivity that the didactic model meets a basic prerequisite: to be used by any student, reinforcing the main point of always include and never exclude (Souza & Alves, 2016).

When questioning about the attempts to include students with disabilities in the discipline, most participants who worked with students who had low vision explained that they included or at least tried through various teaching resources, field classes, film screenings, documentaries, among others, always opting for those with narration. However, not all participating teachers have been successful and some have unfortunately made no attempt. The negative note in relation to this context was that one of the teachers tried to refuse the student in the discipline in which he taught, because he believed that there would be minimal support for the work and the student would be just a mere listener. Regarding such findings, two points need to be highlighted: the first is related to alternatives for inclusion and, according to Caetano (2012), didactic resources are necessary tools that help students learn (Caetano, 2012). These attract the attention of students, causing them to give due importance to what is being worked on Caetano (2012). The second is associated as mentioned by one of the participants, in the absence of support. However, for Almeida, et al., (2019) the teacher must adapt to the demands of the class he teaches, teaching all students with respect and responsibility for the needs that each student may have, regardless of the situation (Almeida et al., 2019).

In question seven, most teachers know the didactic alternative mentioned above; however, they never got to use it. According to Bisol, et al., (2018) it is a fact that the technological area has been increasingly incorporated into the quotidian of teacher and student, and the use of the software directed to people with low vision requires minimal training (Bisol et al., 2018).

As for question eight – one of the main ones contained in this research – all participants, without exception, were emphatic about the lack of teacher training, in addition to the small number of tutors to accompany students, lack of materials, support and also the inevitable limitations that they would face in certain areas of study. This goes with the



described by Bisol et al., (2018), stating that the main challenges for students with disabilities are in teacher training, highlighting that this is a barrier that prevents the inclusion policy from effective (Bisol et al., 2018).

Regarding the last question of the first stage of the survey, a self-assessment regarding performance was requested. Nine teachers reported their performance as regular and only one teacher reported it as a good performance. Some researchers Almeida et al., (2019) mention that most teachers do not have the professionals support which can help them better understand the types of students' disabilities in a more in-depth perspective, thus being able to improve and adapt their teaching methodologies according to the class needs, consequently improving professional performance and offering students more appropriate learning (Almeida et al., 2019)

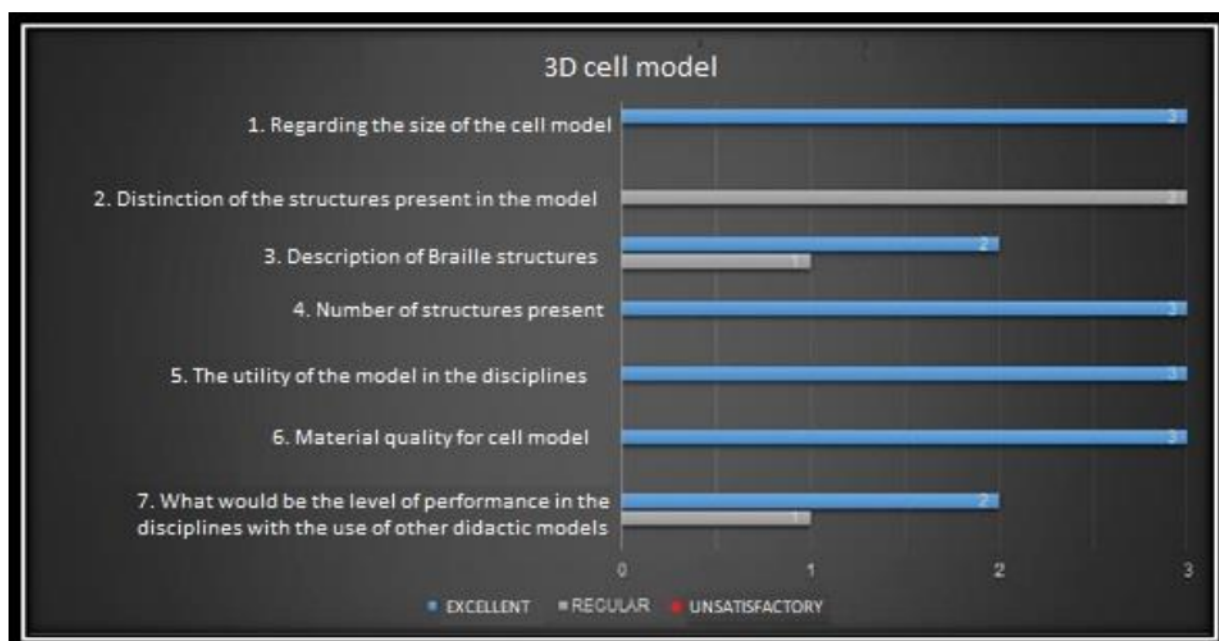
**Figure 4:** 3D animal cell model (BISCUIT material).



Source: own author (2020). Figure 4 represents a 3D animal cell model (BISCUIT material). The didactic manner of his illustration could possibly be used not only by students with visual impairment, but for any student in the learning process.

In the second stage of the research, a didactic model of a 3D animal cell made of BISCUIT material was analyzed (Figure 5). This model aimed to evaluate the effectiveness both in terms of the piece production, as well as its benefits on learning, emphasizing that it is a basic model with a demonstrative character. Of the three students invited to answer the seven discriminated questions represented in Figure 5, only one had low vision and the others were blind.

**Figure 5:** Answers regarding the observation sheet applied.



Source: own author (2020). Figure 5 shows the responses regarding the application of the observation form. Were all responses from students regarding the teaching model of research, appearing mentioned in the figure. It is worth mentioning that none of the participants described the model as unsatisfactory.

As for the dimensions of the model, the three students classified it as excellent, mainly due to its easy handling. Morais and Marques (2017) report that these colored didactic models in high-relief – such as the one used in the research –facilitate learning and allow the student to manipulate the material in a simplified way, thus improving the content understanding (de Morais & Marques, 2017)

In the question about the structures distinction in the model, participants classified it only as regular; however, we have to emphasize that, as they themselves reported, structures had certain differences – this was one of the purposes while elaborating the Cell in Biscuit. It is a point that due to the dimensions of the model, which was not very large, it could have a better variation in texture. Oliveira and Marques believe that a material in high-relief is

crucial for the learning of blind people, so despite the adaptations made, as will be seen below, we understand the effectiveness that the material brings, as well as the sensitivity that some aspects can be improved (T. G. da C. Oliveira & Marques, 2016).

Regarding the implementation of Braille description, two students indicated that this tool as excellent for identification, whereas one of the participants identified it as regular since he believed that everything was a matter of adaptation to the model and that there was no need for Braille descriptions. Moraes (2017) adds the importance of the Braille System for Inclusive Education as the learning of this system provides the included student with greater independence in writing and reading, as well as in the practical activities that can be developed in the classroom (Moraes, 2017).

When considering the amount of cellular structures present in the model, only one participant classified it as regular, reporting that since it is something that could be used in higher education, it might require a higher level of complexity, such as some cellular processes, substances transportation, etc. The others believe that the quantity was excellent. Alves (2016), describes that despite being one of the most used resources in Biology classes to show objects in three dimensions, didactic models can present several limitations, we emphasize here, that all the fundamental structures of a cell are present. This study model managed to extract a very high level of reliability from something “handcrafted” and, as mentioned in the literature, such models have limitations (Souza & Alves, 2016).

When evaluating the model usefulness in the disciplines, all students classified it as excellent. It was clear that, after some adaptations, the 3D cell would be able to be used in any other sector of education where it was necessary to exemplify an animal cell. For Nicola and Paniz (2017), innovation does not necessarily have the sense of the unusual. Great innovations are often the realization of the obvious, the simple, of what is possible to do, but which needs to be unveiled, so that it can be understood by everyone and accepted without much resistance. That what this study wanted to demonstrate, using biscuit for the construction of pedagogical alternatives, a material that is not new but it is simple to handle, with low cost and yet very effective (Nicola & Paniz, 2017).

In question six, we sought to assess the quality of the material for those who handled it and a positive response from everyone was obtained. Alves (2016), states that the implementation of new educational practices, among which the use of didactic models with Biscuit stands out. The author reports that the advantages of using this material in making these molds are found in consistency and durability, which facilitates the teaching-learning



process since they can be used by different classes (G. S. Santos et al., 2016; Souza & Alves, 2016).

In our last question, we referred to the level of performance that students would have used didactic models in certain subjects. One of the students considered that their performance with the didactic models would be regular, as it is an alternative with a context for the student's learning. The others ended up classifying it as excellent despite recognizing the challenges. Caetano (2012) brings a great reflection about this context, saying that the use of this alternative is only a part of a whole class process involving teacher and student and that there will be up to the members to understand what could best meet the needs of the class (Caetano, 2012).

#### **4. Conclusion**

The theoretical and methodological foundations of Inclusive Education are more than necessary to carry out broad and efficient debates on the process of training our teachers to meet the educational needs of all students with or without disabilities.

The gap present in teacher training is of public knowledge; however, it is not the only nor the main problem. The present studied reported a sum of factors and the urgency admitted by the participants in changes and for that greater integration from all educational sectors is fundamental. Making Inclusion occur without losing sight of opportunities, ensuring the advancement of learning, essentially aiming at the alternatives and creativity of the teacher is essential.

In this aspect, we were able to test the barriers faced in production, cost, and the application of a didactic model, questions raised by the members (if the student would be receptive to the model, what adaptation can be made and especially if it would be really useful for the student with visual impairment), considering that the answers were extremely positive.

It is worth mentioning that there are still points to be improved in the 3D cell. But we believe that this alternative meets all the criteria and essence of a practical class and, above all, the learning process of the research participants, as well as other students with deficiency.

Finally, this research presented an entire project designed to assist teachers and students with visual impairments. There is an imminent need for research related to Inclusive Education. In this work, only one disability was addressed, but there are several others, each with a different approach to be taken in all educational sectors. Students, teachers and



researchers are responsible for presenting and sharing this field of research for the enrichment of Education, which must become democratic and never exclusive.

## 5. Acknowledgments

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## References

- Almeida, E. P. de O., Oliveira, J. L. S., Alves, C. A. A., Santos, T. M. M., & Silva, E. (2019). Percepção de professores sobre a educação inclusiva em uma instituição de nível superior no semiárido paraibano. *Scientia Plena*, 15(1). 2-4.
- Bisol, C. A., Valentini, C. B., Stangherlin, R. G., & Bassani, P. P. P. (2018). Desafios para a inclusão de estudantes com deficiências físicas: uma revisão de literatura. *CONJECTURA: Filosofia e Educação*, 23(3), 601–619.
- Breitenbach, F. V., Honnef, C., & Costas, F. A. T. (2016). Educação inclusiva: as implicações das traduções e das interpretações da Declaração de Salamanca no Brasil. *Ensaio: Avaliação e Políticas Públicas Em Educação*, 24(91), 359–379.
- Caetano, R. T. B. (2012). *A inclusão: o aluno cego e a formação de professores no ensino fundamental II*. Monografia de especialização, 13-14.
- Cenci, A., Bôas, D. F. V., & Damiani, M. F. (2016). The challenge of inclusive education in a Brazilian School: teachers' concerns regarding inclusion. *Research, Society and Development*, 2(2), 94–106.
- de Moraes, G. H., & Marques, R. C. P. (2017). A importância do uso de modelos didáticos no ensino de citologia. *IV Congresso Nacional de Educação*.  
[https://editorarealize.com.br/editora/anais/conedu/2017/TRABALHO\\_EV073\\_MD4\\_SA17\\_I](https://editorarealize.com.br/editora/anais/conedu/2017/TRABALHO_EV073_MD4_SA17_I)

D4130\_17092017235502.pdf

Fernandes, A. C. R., Oliveira, M. C. S. L. de, & Almeida, L. da S. (2016). Inclusão de estudantes com deficiências na universidade: Estudo em uma universidade portuguesa. *Psicologia Escolar e Educacional*, 20(3), 483–492.

Ferreira, C. A. L. (2015). Pesquisa quantitativa e qualitativa: perspectivas para o campo da educação. *Revista Mosaico*, 8(2), 173–182.

Gomes, C. R., da Silva, J. P., & Souza, R. de C. S. (2018). Educação inclusiva de estudantes surdos na Universidade Federal de Sergipe. *Revista Docência Do Ensino Superior*, 8(1), 61–76.

Lima, D. R. de. (2018). *Avaliação do serviço de referência da biblioteca da Universidade Federal de Sergipe: estudo comparativo entre os ingressantes e os concluintes do curso de Biblioteconomia e Documentação da UFS*. Monografia em Biblioteconomia e Documentação, 28-31.

Lima, L. M. T., Souza, L. L., Lima, J. C. P., Oliveira, M. M. G. T., Azevedo, C. S., & Coutinho, D. J. G. (2020). Educação inclusiva e sua trajetória nas políticas públicas/Inclusive education and its trajectory in public policies. *Brazilian Journal of Development*, 6(3), 15295–15310.

Moraes, L. (2017). A Educação Especial no Contexto do Plano Nacional de Educação. *Série PNE Em Movimento*, 6, 48.

Nicola, J. A., & Paniz, C. M. (2017). A importância da utilização de diferentes recursos didáticos no Ensino de Ciências e Biologia. *InFor*, 2(1), 355–381.

Oliveira-Formosinho, J., Azevedo, A., & Mateus-Araújo, M. (2009). A formação em contexto para a Pedagogia-em-Participação: um estudo de caso. *Desenvolvendo a Qualidade Em Parcerias: Estudos de Caso*. Lisboa: Ministério Da Educação-Direcção-Geral de Inovação e de Desenvolvimento Curricular, 79–98.

Oliveira, M. L., Antunes, A. M., Rocha, T. L., & de Sabóia-Morais, S. M. T. (2011). Educação inclusiva e a formação de professores de ciências: o papel das universidades federais na capacitação dos futuros educadores. *Ensaio Pesquisa Em Educação Em Ciências*, 13(3), 99.

Oliveira, T. G. da C., & Marques, R. C. P. (2016). *UTILIZAÇÃO DE MODELOS DIDÁTICOS NO ENSINO DE BIOLOGIA E O PROCESSO DE INCLUSÃO NA CIDADE DE APODI-RN*. Universidade do Estado do Rio Grande do Norte – UERN.

Pereira, R. F., da Silva Barroso, M. C., de Oliveira Holanda, F. H., & de Goes Sampaio, C. (2020). Qualidade na educação: uma discussão teórica sobre o sistema educacional brasileiro. *Research, Society and Development*, 9(8), e102984341–e102984341.

Rocha, A. B. de O. (2017). O papel do professor na educação inclusiva. *Ensaio Pedagógicos*, 7(2), 1–11.

Santos, R. M. R. dos, Melim, A. P., & Paniago, M. C. L. (2017). Formação continuada de professores universitários na rede social facebook: interagir, trocar, dialogar, compartilhar, aprender e conviver. *Interações (Campo Grande)*, 18(2), 13–20.

Santos, G. S., Oliveira, L. X., Marin, D., Braz, J. D. M., Daniel, I., & Barreto, D. C. (2016). Epidemiological aspects of congenital syphilis associated with maternal education. *Revista de Enfermagem UFPE on Line*, 10(8), 2845–2852. <https://doi.org/10.5205/1981-8963-v10i8a11352p2845-2852-2016>

Silva, L. C. S. da. (2018). *Relação entre educação em direitos humanos e educação inclusiva nas concepções e práticas de professores de um estudante cego*. Brasil. Dissertação de mestrado, 87-92.

Souza, R. T. B., & Alves, M. H. (2016). Modelos didáticos com massa de biscoito: inovando no ensino de ciências e biologia. *Revista ESPACIOS*, 37(29). 7-8.

Vieira, A. B., Ramos, I. de O., & Simões, R. D. (2018). Inclusão de alunos com deficiência e transtornos globais do desenvolvimento: atravessamentos nos currículos escolares. *Educação e Pesquisa*, 44. 6-11.

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