Just genetics: An inclusive material for deaf students

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ABSTRACT

In order to teach biology to deaf students, it is necessary to use didactical resources that properly give the access to the biological specific content. In this work, we described a didactical material called Just Genetics to teach meiosis and mitosis, two genetics topics that are related to syndromes and biotechnological aspects. The material was constructed with simple materials and its main advantage is the simple preparation and low cost that allows the production by anyone. To identify the effectiveness of this didactical material, we performed an evaluation with deaf students, which confirmed its potentiality for using in teaching not only for deaf but also for other students presenting an inclusive perspective. The material allows not only teaching this complex topic but also others regarding genetics or other biological themes.

Key words: School enrollment, genetic, deafness, inclusive education.

INTRODUCTION

The education of whole society including those with special needs in all levels including higher education is still a challenge. The task is truly complex when it involves the uses of different tools or languages such as those requested by people with hearing impairments (Sapon-Shevin, 1995; Gotti, 2006).

According to the literature, the education of deaf children should attend their personal characteristics in their first year of life (Coppens et al., 2012). The observation of the results at early school and clinical care will indicate whether the child will adapt better in a regular or special school. The children with hearing loss should be attended with emphasis on preparing them for adult life, making them responsible for their own educational process and aware of their rights (Gil, 2002; Coppens et al., 2012). Therefore, it is important that the universities prepare the future teachers with an inclusive attitude and knowledge about inclusive teaching and learning techniques to stimulate the potential of each student on all levels of education (Gotti, 2006).

Brito (1993) points the sign language as the only way to guarantee deaf student development with full linguistic and cognitive potentials. On that case, sign language allows socialization similar to the listeners’ language (Chiesa et al., 2012). Therefore, sign language is the most important instrument for deaf social integration.

According to Missagia (2005), the deaf culture concept of this community instead of seeing deafness as a disability may be an attempt to allow this integration without previous prejudice.

Currently, bilingual schools where sign language is one of the instructional languages are requested for teaching deaf students in Brazil. According to Gotti (2006), the Bilingualism - two languages (e.g. Portuguese and LIBRAS) - should be taught and used but in general an interpreter should participate in this process.

The teaching of biology and scientific vocabulary is a great challenge to teachers regardless the: a) culture, b)
socioeconomic status, c) education level or d) special educational need. However this task is more difficult in case of deaf students, which require specific signals that are not always available or known or even established (e.g. haploid) (Lucena et al., 2008).

Among the complex issues of biology, Genetics is a broad topic with almost no signals in the Brazilian Sign language (LIBRAS). One of the main difficulties with this topic is the great dynamism of the area that continuously requests the creation of new scientific terms and concepts, often extremely complex even for students with no special needs (CID et al., 2005).

The cell cycle has several stages (e.g. DNA synthesis, mitosis and meiosis) that have to be understood in the books where they are presented in a language that are not the sign language and in a restricted way (Griffiths, 2001). The use of the computer is not always feasible for class with 40-60 students or the software available is not clear enough to explain these themes at Brazilian High Schools.

Currently, there are few textbooks and teaching resources that address topics related to genetics in a simple and inclusive way and that can be used in the classroom for everyone. Therefore there is a demand for materials that allows teaching and learning of these topics and that can be easily produced with low cost.

In order to help the deaf student’s inclusion in the scholar system of and also in their ability to understand genetics questions we created a didactical visual material called Just Genetics addressing the theme meiosis and mitosis, using low cost materials in a simple way.

MATERIALS AND METHODS

Deaf public, selection of the theme and setting of the material

The deaf students that participated in this study were from a public high school located in Niterói, a city from Rio de Janeiro state in Brazil. This school was chosen because it has an inclusive policy since the year 2000. It attends approximately 3200 students in regular classes and among them 23 students, aged 10-25 years, presents special educational hearing needs. In this study eight deaf students, 16 to 25 years, responded to the questionnaires and participated in the testing of the didactical material whereas eight hearing students (total n = 8) participated serving as a control group for comparison.

Initially, we previously interviewed deaf students of the final year to choose the theme that confirmed Genetics as a complex subject. Thus the sub-themes Cell Division - haploid and diploid, homozygous and heterozygous, and mitosis and meiosis were selected from this starting point to produce the didactical material (Figure 1).

In order to construct the Just Genetics material, we have used a metal plate of 79 × 50 cm (low cost option = baking sheet) with 7 blue magnet circles that represent the nucleus of a) one diploid parent cell (22 cm), b) two diploid daughter cells (19 cm) and c) four daughter haploid cells (11 cm) (Figure 1). The material also contains four colored magnetized chromosomes to represent the division and replication of genetic material (Figure 1). To keep it simple, the nucleus of the mother cell contained only two chromosomes, which lead to a later discussion about the exact chromosomes number of some species including humans.

This model can be constructed with colored paper but the durability of the magnet pieces is higher and more interactive. A smaller set can be produced by the students with colored cardboard so it can be used simultaneously during the class.

Evaluation of the ability of deaf and hearing students in answering essay questions

For this evaluation a questionnaire was constructed with five essay questions addressing mitosis, meiosis, genotype, phenotype among other topics of genetics from Brazilian annual evaluations of different undergraduate institutions to get into them and whose approach ranges from a direct question (FUVEST-SP) to a more interpretive (Campinas-SP) (Figure 3).

Application of didactical material

The material was tested with deaf students and the interpreter did simultaneous translation and the terms that had no specific signals were identified in a list on the wall. A lesson was previously given to the interpreter in order to allow her to do her work. Sá (2002) reported that an interactive class serves to create new signs on a deaf class, however, during our activity we did not create new signs for the terms used.

At the time of cell division, two magnets were fixed in the mother cell nucleus representing the two chromosomes of diploid cell. The representation of mitosis ended with the numbers of chromosomes present in the nuclei of the daughter cells equal to the mother cell and two daughter cells. To show meiosis, another division was added, showing the initial cell giving rise to four cells with half of the number of chromosomes. Thus the observation of meiotic division finalized the model, calling attention to the fact that specific cells perform this kind of division (e.g. sperm and oocytes).

At the end of the demonstration of the two divisions in the model, students were still confused by the differences between meiosis and mitosis. The fact that the interpreter along with them on a daily basis, allows her to have the sensitivity to notice the doubts of each student, even if they do not express it directly. Thus, when the interpreter

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noticed some difficulty she interrupted and started a new way for the theme until it is completely understood.

**Evaluation of the material as a didactical tool**

We used a questionnaire with multiple choice questions for the evaluation of the material and testing some of the concepts discussed in class. We used the aid of an interpreter to guarantee students understanding.

**RESULTS AND DISCUSSION**

In this paper, we described the construction of a didactical material for teaching cell division in a schematic and simplified way. Our material is composed of the nucleus of a mother cell, four nuclei of daughter cells, four chromosomes and six division arrows used to show mitosis and meiosis (Figure 1).

The didactical material was based on different science books where cell division is shown in a simplified manner without mentioning the intermediate phases but only the mother cell nucleus with chromosomes and the nucleus of daughter cells. For the deaf students that use the sign language, which does not present most of the signs for approaching this topic, keeping it simple is the best strategy for introducing the themes.

The current material allows viewing only the final of duplication and the chromosome amount (Figure 1) without the inclusion of other information such as the formation of the mitotic spindle, which could complicate the explanation and compromise the deaf students’ full understanding. Despite of that, this material allows showing the duplication of chromosomes and proceeds to the discussion of cell division, mitosis and meiosis processes (Figure 1).

To evaluation the didactical material, we used it with seven deaf students in the presence of an interpreter and along with a genetics key terms list. The LIBRAS interpreter makes the simultaneous translation and new terms were identified in the list (Figure 2). The interpreter translated
terms known (nucleus, cell replication and germ cell) to Brazilian Sign Language (LIBRAS), but during the demonstration scheme she almost did not perform signs, only pointing to the didactical model. This suggests that the material can transmit the information without the need for continuous LIBRAS interpretation (Figure 2).

The use of the material Just Genetics revealed the serious problem involving the absence of signs for the scientific terms in LIBRAS. At the end of the demonstration of the two divisions on the board, students were still confused about the differences between meiosis and mitosis due to this the terms absence. Thus the interpreter had to explain and create simultaneously these new terms, which allowed the topic to be completely understood.

Interestingly, despite the interpreter having to translate the known terms to LIBRAS, she almost did not perform signs during the demonstration of the material, mostly pointing to the didactical material, which suggests that since the terms are previously defined, the material is able to transmit the information without essentially requesting an interpreter.

The evaluation of this material as a didactical tool was performed by applying a questionnaire with five questions that tested the understanding of some of the concepts discussed in class (Figure 3).

The result showed a significant improvement after using the material, since no questions were correctly answered before the application of the material (not shown). This reinforced the literature which reports that teaching with other resources besides textbooks is a more efficient, interesting and pleasant way (Campello, 2007) also for students with special needs. However the comparison between deaf and hearing students using a questionnaire to evaluate their level of understanding on the subject Genetics as whole, revealed an insufficient overall knowledge for both groups probably due to a weak teaching-learning system that are currently present in the Brazilian public educational system for all students (deaf and hearing).

**Conclusion**

We constructed a didactical material formed by a frame with magnets that can represent cell division (mitosis and meiosis). The material is inclusive and suitable for working with deaf students. It apparently does not significantly require the LIBRAS interpreter, which gives more accessibility also for teachers on using it. The production of materials that assist students’ learning in general complex subjects of biology becomes increasingly necessary and this work may help on this context especially for students with
If mitosis occurs in a cell with genotype AaBbCc, and the three pairs of genes are in different pairs of chromosomes. Thus the genotypes of the daughter cells will be:

a) ABC, ABc, aBC, AbC, Abc, abC, abc
b) ABC, abc
c) Aa, Bc, Cc
d) AABBCC, aabbcc
e) AaBbCc

A cell with 20 chromosomes, extracted from the root meristematic region of maize, undergoing mitosis should develop:

a) 2 cells with chromosome 20 each
b) four cells each with 20 chromosomes
c) 2 cells with 10 chromosomes, each
d) 4 to 5 cells each chromosome
e) 4 cells with 10 chromosomes, each

The domestic fly has 12 chromosomes. The number of chromosomes found in the zygote and gametes are, respectively:

a) 12 and 12
b) 24 and 12
c) 24 and 6
d) 12 and 6
e) 6 and 12

If meiosis occurs at the cell with genotype AbBbCc, where the three pairs of genes on chromosome pairs are separate genotypes. What are the daughter cells?

a) Aa, Bb and Cc
b) ABC and abc
c) ABC, ABc, aBC, aBc, AbC, Abc, abC and abc
d) AaBbCc, AABBCC and aabbcc

During mitosis, a diploid cell form:

a) two diploid daughter cells.
b) two haploid daughter cells.
c) four haploid cells.
d) four diploid cells.
e) two diploid and two haploid cells.

Figure 3. The five questions used in the questionnaire applied after the application of the didactical material and the level of success (%) of deaf students represented by the grades (0-10) showing that no student missed all topics (grade > 4-10), suggesting that the material helped the learning of deaf students.
special hearing needs.

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REFERENCES


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