



Bean cultivation: the research in the teaching process and learning in science study

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ABSTRACT

Education is of major importance to the development of a just and egalitarian society. In this context, the present study aims to awaken and improve the technical knowledge of students in science classes with scientific research from experimentation with the planting of bean seeds. The present study took place in the July to August 2023 in science classes from elementary school II in a municipal school from the city of Caicó – Rio Grande do Norte (RN), in which it was developed the planting of bean seeds by the respective students, in order to arouse curiosity and the investigative power that science has about the day to day of the human being as a society. Furthermore, a thorough was carried out search per academic Works on the platform “google acadêmico” to reinforce and highlight the importance of the from practical classes with the theory taught in the classroom. It concludes that the students responded satisfactorily to the proposed activity. In synthesis, working with investigative experimentation is a great challenge, not just for scientific interest, but its methodological procedures have to be of interest mutual in between teacher/student.

RESUMO

A educação é de grande importância para o desenvolvimento de uma sociedade justa e igualitária. Nesse contexto, o presente estudo tem por objetivo despertar e aprimorar os conhecimentos técnicos dos estudantes nas aulas de ciências com a pesquisa científica a partir de uma experimentação com o plantio de sementes de feijão. O presente estudo ocorreu no intervalo de julho a agosto de 2023 nas aulas de ciências do ensino fundamental II em uma escola da rede municipal da cidade de Caicó – Rio Grande do Norte (RN), no qual foi desenvolvido o plantio de sementes de feijão pelos respectivos alunos, afim de despertar a curiosidade e o poder investigativo que a ciência tem sobre o dia a dia do ser humano enquanto sociedade. Além disso, foi realizada uma minuciosa busca por trabalhos acadêmicos na plataforma “google acadêmico” para reforçar e destacar a importância das aulas práticas com a teoria ensinada em sala de aula. Conclui-se que os estudantes responderam satisfatoriamente a atividade proposta. Em síntese, trabalhar com experimentação investigativa é um grande desafio, não apenas o interesse científico, mas os seus procedimentos metodológicos têm que ser de interesse mútuo entre professor/aluno.

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Introduction

Education is of paramount importance for a person's development as a social subject and should be available to all, so that they can participate in a fair and equal society (CAVALCANTE, 2011; GEGLIO; SANTOS, 2011; RIBEIRO, 2002).

In relation to science and biology education, official documents have emphasized the power of science education in the teaching and learning process of children, understanding the social relevance and helping to explore scientific knowledge, connecting with other areas of knowledge, allowing them to enjoy opportunities to face the challenges of a society that is constantly changing, as well as reinforcing the power to make decisions according to their objectives (BRASIL, 2002).

The authors Santos and Souza (2011) corroborate this by highlighting that this educational method can encourage students to reflect on their skills in research and the study of science, improving their power of reflection by contextualizing their environment in a critical manner, weighing up their needs and setting goals as citizens. As a result, these people become capable of taking a stand on issues related to science, technology, society and the environment (SASSERON, 2008; SASSERON; DUSCHL, 2016).

In recent years, research has been transformative, supported by the sciences, explaining and converging discussions between the main authors in the field of education (ALMEIDA & NARDI, 2020; CACHAPUZ et al., 2005; GIL-PÉREZ et al., 2001; GUERRA et al., 2013; KRASILCHIK, 2000; MOREIRA, 2004; PRAIA et al., 2007). The authors also point out that the research and practices developed are consolidated on the basis of dialog and multiple interactions between educational institutions, resulting in debate with respective solutions to the challenges and possibilities in the course of the teaching and learning process in the sciences.

The processes of knowledge production that arise from these conversations are characterized by social interactions (BAKHTIN, 2011). The author also points out that this idea reinforces the significance of a dialogical stance that projects the knowledge and understandings involved in the process of building knowledge, valuing the point of view and understanding the constant changes, as we are individuals who learn from each other.

Among the many questions that circulate throughout the process of planning, teaching and reflecting is the methodology of teaching by investigation, guaranteeing dialog, argumentation, discussion of findings and, finally, an exchange of knowledge between all the students facilitated by the teacher, answering questions and understanding the learning process (GÜLLICH; WALCZAK; MATTOS, 2016; WALCZAK; MATTOS; GÜLLICH, 2017). In

addition, experimentation and science teaching should aim to contextualize theory with practice (WYZYKOWSKI; GÜLLICH; ARAÚJO, 2016; BREMM & GÜLLICH, 2019).

In this context, the aim of this study is to awaken and improve the technical knowledge of students in elementary school science classes in scientific research by experimenting with the planting, germination and growth of bean seedlings. Providing the opportunity to teach the investigative process through research.

Methods

This study took place between July and August 2023 in elementary school science classes at a municipal school in the city of Caicó - Rio Grande do Norte (RN) with 24 students in the afternoon, in which the respective students planted bean seeds.

When planting, cultural treatments were carried out, such as choosing the substrate, container, type of seeds, irrigation, lighting, environmental conditions and checking for pests and diseases. In addition to checking the seedlings' stages of development. This reinforces the investigative nature of the project, since the students have become aware of the importance of the variables in the quality of healthy seedlings. At the end, the students presented a report describing the processes employed, as well as presenting the positive and negative points of the process.

In order to base this research on consolidated scientific knowledge, the study relied on a thorough search for papers on the “google acadêmico” platform, in which terms such as “education”, “beans”, “experiment”, “germination”, “research”, “primary education” and “practical science lessons” were searched. After a careful analysis and observation of compatibility with the proposal of the work, 36 manuscripts were selected to debate and reinforce the importance of research in elementary school II in science classes. Thus maintaining the essence of the work.

Experience description

From this perspective, it is possible to report on a student's experience of carrying out research into bean planting from an investigative perspective in science classes.

Initially, the student used the cultivar *Vigna unguiculata* (L.) Walp. or popularly known as macassar beans, string beans, cowpeas, blackeyed peas, pigeon peas and cowpeas. Afterwards, a “transparent” plastic container was reused because, as well as being recyclable, it is possible to observe the first stages of plant germination. It is also worth noting that small holes were drilled in the bottom of the container to ensure good water drainage. The substrate was then prepared using red clay, tanned manure and sand, achieving a pleasant texture (sandy-clay), providing nutrients, maintaining good aeration and water filtration. Five seeds were planted, increasing the germination rate.

Results and Discussion

During the course of the experiment, the students reported various events, such as disorganized control of the seedlings, difficulties in preparing a good substrate, how often they should water the seedlings, photoperiod time, failure of the seeds to germinate, the need for thinning or even how to prepare a good report.

Table (1) shows in detail in a student's report the events and variables that affected the development of the bean seeds. It can be seen that a good basis for scientific knowledge begins with curiosity, which leads to questions that need answers. The table also shows that the student detected and reported the effect of environmental variables on her experiment, such as the quality of the prepared substrate (red clay, manure and sand), irrigation, the species of bean used, exposure to the sun, competition between the specimens, the degree of development of the experiment and even made empirical observations in the search for answers to the questions that arose during the experiment.

Table 1: Report on the development of the experiment planting macassar bean seeds (*Vigna unguiculata* (L.) Walp.) between July 24 and August 2, 2023.

24/07/2023: Preparing the substrate (red clay, tanned manure and sand), planting the bean seeds (5 seeds in the container) and watering the soil.
25/07/2023: Irrigation of the soil and exposure of the experiment to photoperiod.
26/07/2023: Germination has not yet taken place, and the methodological procedures of observation, irrigation and photoperiod exposure control are still being followed.
27/07/2023: Germination process underway, with a break in the topsoil observed after the seeds have hatched. It is also possible to see that a root is showing at the bottom of the transparent container. In addition to these observations, the soil was irrigated and exposed to the photoperiod.
28/07/2023: In this part of the experiment it is already possible to see that the beans are immersing themselves. The soil has been irrigated to maintain an adequate layer of water for the plants to develop properly.
29/07/2023: On this date it can be seen that of the 5 bean seeds planted, only 4 have germinated, and structural development is also visible in relation to their hatching time. This development may be associated with the organic fertilizer (manure) incorporated into the substrate, and may also have been influenced by the phase of the crescent moon. According to Simão (1958), the moon has a decisive influence on sowing and harvesting. It was found that the leaves and roots are well developed, and in relation to the roots, it is possible to see them clearly through the bottom of the container.
30/07/2023: The beans are still growing well and have adapted very well to the composition of the substrate. On that day, the soil was watered, the pests were checked and the photoperiod was exposed.
31/07/2023: In this part of the experiment it was possible to see a good development of the leaves, stem and roots, including two of the specimens releasing the cotyledons, indicating that the plants have already consumed the energy reserves contained in these parts and that the plant can nourish itself with the photosynthesis and mineral nutrition of the prepared substrate.
01/08/2023: You can see that the bean seedlings are very vigorous, but of the four specimens, one is showing less development than the others. This may mean that although the plants are developing well at the moment, the first traces of competition between the seedlings for nutrients, water and light in the container are appearing.
02/08/2023: Delivery of the experiment in science class.

Source: Researcher's data.

At the end of the proposed activity carried out by the students, it was possible to see that they reported different questions and the most varied solutions to the problems faced in their respective experiments. It was also found that at least 50% of the students described the procedures carried out in detail in their report, such as the day and the specific activity carried out during that period.

At the end of their experiments, the students handed in a report and the seedling with its degree of development in their science class in the afternoon. The seedlings were then analyzed and the appropriate observations made. Figure (A) shows the first stages of seed hatching, in which they break through the shell and the first superficial layers of soil. Figure (B) shows the first hatching of the seeds with their cotyledons, their first nutritional reservoirs. Figure (C) shows the considerable development of the root system, as well as the first signs of the loss of the cotyledons.



Figure (A)



Figure (B)



Figure (C)

One of the main factors that reduce bean productivity is disease. This can result in partial or total production losses, reducing the physical quality of the seeds, which reflects negatively during germination, as well as interfering with the success of the crop (MESQUITA et al., 2017).

As can be seen in figure (D), in one of the experiments there was a fungal attack caused by *Sclerotinia sclerotiorum* during the initial development of the plant, popularly known as white mold, which according to Del Río, Venette and Lamey (2004) leads to major losses in production. According to Siqueira et al. (2021) beans are a legume of great importance in Brazil, and one of its limitations is the attack by white mold. The authors also point out that within its phytosanitary control it is possible to use resistant variables, as they present low environmental risks, as well as being economically viable, allowing access from small to large producers.

In addition, this fungus is a dangerous pathogen, not just for beans, as it can infect a range of other species, and can produce sclerotia in which it has a high degree of resistance, surviving in the soil for long periods of drought in the absence of a host species (BIANCHINI FILHO; MARINGONI; CARNEIRO, 2016).

Figures E and F show the different stages of development of the bean seedlings, with different characteristics such as height, number of leaves and development of the root system. According to Freire et al. (2005) the macassar bean is a species from the legume family and is widespread in arid and semiarid regions, as well as being an excellent nutritional source for human consumption. The authors also stress that the species has a short production cycle, low nutritional requirements and is hardy. Oliveira and Carvalho (1988) add that the species grows well in the temperature range of 20° to 30°, while high or low temperatures are extremely harmful, causing low root nodulation and delayed seedling development.



Figure D



Figure E



Figure F

Various biological and abiotic stresses that alter plant growth and development have the potential to negatively impact crop productivity (Silva et al. 2012). Among these, salinity stands out as one of the main abiotic factors, as it can damage the physiological and biochemical functions of plants by causing osmotic stress, which can lead to alterations in water relations, as well as changes in the way essential nutrients are absorbed and used, and the accumulation of toxins in the morphological parts of plants (Assis Júnior et al., 2007; Calvet et al., 2013).

According to the National Supply Company's assessment of the 2020/2021 harvest, the total volume of bean production is expected to be 3,136.6 thousand tons. According to this estimate, there would be a decline in production of around 6,5% compared to the results of the survey carried out in 2019 - 2020, mainly in the southern regions in the state of Bahia (CONAB, 2021).

Macassar beans are widely grown around the world, especially in tropical regions (OLIVEIRA et al., 2015). According to Santos et al. (2017), it is an excellent source of protein and one of the basic components of human nutrition. In addition, its cultivation generates jobs and income, from small to large producers, in rural and urban areas. With the highest production and consumption, Brazil ranks first among producing nations (FAOSTAT, 2019). Its structural parts, such as leaves and stems, are also used as fodder and silage in various regions of the world (PEREIRA E MENESES, 2019).

Due to its good climate adaptation, the bean plant can be grown all year round in Brazil, and is cultivated in three distinct seasons: the “water season” (from August to November), the “dry season” (from January to March) and the “winter season” (from April to July) (CONAB, 2020). Silva et al. (2016) adds that the crop has high potential, as it is in full expansion in the regions of the Brazilian cerrado, since they have good tolerance to water deficits caused by long periods of drought, having a better adaptation compared to varieties of corn and soybeans, they also have low implementation costs, enabling good yields, being a great attraction for producers.

In the teaching and learning process, it is necessary to have the theory, test it in practice, analyze it, come up with new ideas and test them all in experimentation. Because, according to Castro and Carvalho (2001), it is essential to train the next generation of teachers, we can also support the assertion that, in order to learn effectively, teaching must be done well (GÜLLICH, 2017).

Conclusion

Several factors can contribute to teaching practice, as actions that bring together the exchange of knowledge between teacher and student in relation to issues in the scientific field, in addition to the student’s own knowledge, reinforce the investigative nature of the teaching process.

Therefore, at the end of the experiment, it was possible to conclude that it is increasingly necessary to initiate students into scientific research, not just to produce for the sake of producing, but to awaken from a young age the keen spirit of understanding the process and the questions that drive the sciences. As well as giving students broad access to information, accessing the right tools and strengthening their understanding of their actions in society as individuals.

It is also possible to conclude that the experimental lesson on growing beans provided students with active participation, as well as a better understanding of the investigative methods of science, not only in the technical context, but especially in relation to the nature of the world and how it interacts.

In summary, working with investigative experimentation is a great challenge, it awakens interest not only in science, but its methodological procedures have to be of mutual interest between teacher and student. Therefore, the results are very satisfactory, as the student is active in the teaching and learning process.

The conclusion is that the students responded satisfactorily to the proposed activity, since they all handed in the seedlings they had grown, as well as a report on the relevant environmental variables during bean planting. In addition, during the science lessons it was possible to explain any doubts that arose during this process, as well as to see the evolution from student's scientific curiosity.

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