

Literature in the education of future scientists: a lesson of *Frankenstein*

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Abstract

Educators dedicated to higher education in the health area, which, since the beginning of last century until recently, has prioritized the technical-professional character, have been stressing the necessity of educational proposals that can offer an education encompassing a broader approach to human being and its social relations. In this respect, it is of particular interest to examine the education of students who will conduct their activities as future scientists. We focused on this subject to conduct a study about the implementation of a methodology – developed by an academic humanities center – that privileges literature as a source of education. The method was used in the discipline of philosophy, with students in the first year of a biomedical sciences program at a public university in the State of São Paulo. Mary Shelley's *Frankenstein* was the book that was chosen to achieve the goal of establishing a reflection point through which the exclusively technical-professional focus could be widened. The material we analyzed was drawn from accounts made in class and reports of students, in addition to notes from the field notebooks of the course's professor and monitor, which we examined according with a phenomenological hermeneutic analysis. The results we obtained reflected questions and concerns experienced in students' daily routine, pointing to the identification of the following topics: methodology impact; personal and shared reflection; an expanded notion of the concept of science; and an awakening of the individual and social responsibility which the scientist should have. In conclusion, the methodology achieved its goals, and the results should serve as the basis for further research.

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A literatura na formação de futuros cientistas: lição de Frankenstein

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Resumo

Os educadores voltados para a formação universitária na área da saúde, que desde o início do século passado até pouco tempo priorizou o caráter técnico profissionalizante, têm chamado a atenção para a necessidade de propostas educacionais que possam oferecer um ensino que contemple uma abordagem mais ampla do ser humano e suas relações sociais. A esse respeito, particular interesse se apresenta quando da formação de alunos que desenvolverão suas atividades como futuros cientistas. Com esse enfoque, empreendemos um estudo com a implantação de uma metodologia – desenvolvida por um centro de humanidades acadêmico – que privilegia a literatura como fonte de educação. Realizado a partir da disciplina de Filosofia, o método foi aplicado aos estudantes de primeiro ano do curso de ciências biomédicas de uma universidade pública do Estado de São Paulo. Frankenstein, de Mary Shelley, foi a obra escolhida para cumprir o objetivo de estabelecer um ponto de reflexão pelo qual se pudesse ampliar o foco exclusivamente técnico-profissional. O material para análise foi extraído de relatos feitos em aula e relatórios dos estudantes, mais anotações dos cadernos de campo do professor e monitor examinados de acordo com análise da hermenêutica fenomenológica. O resultado obtido refletiu questões e inquietações vivenciadas no cotidiano dos estudantes, apontando para a identificação dos seguintes tópicos: impacto da metodologia; reflexão pessoal e compartilhada; noção ampliada do conceito de ciência; despertar da responsabilidade individual e social que o cientista deve ter. Em conclusão, a metodologia empregada teve seus objetivos cumpridos e os resultados deverão servir de base para novos estudos.

Palavras-chave

Educação – Literatura – Ciência – Pesquisa científica.

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Introduction

Nearly a century ago, in the late 1920's, the Spanish philosopher José Ortega y Gasset was invited by students at the University of Madrid to give a conference on the mission of universities. He pointed to a tendency for the university to become predominantly a center of research and technical-professional education, thereby losing its dimension of *space for culture experience*, an element that, the philosopher said, was fundamental for the human education of future professionals and scientists. His conferences, published as a book first released in 1930, became prophetic.

In the wake of what Gasset pointed, Heschel notes more recently that one should not reject the achievements of science to man's life. But there is still a pressing need for a focus on what pertains specifically to humanity, a task that exceeds the scope of these sciences (HESCHEL, 2010).

In the last few decades, the rapid development of science, helped by complex technology instruments, has turned university centers into places of advanced research where the role of culture in its original, more universal concept – as the provider of a critical, humanistic education – has been obscured by the lack of space in the curriculum, largely due to the pragmatic disinterest that has come to prevail in modern societies' vocational actions (ORTEGA Y GASSET, 1999).

Within the scientific-technological pragmatism in which culture has lost space, we increasingly find new parameters that set the guidelines to be followed by university students, which currently prioritize the speed in doing and performing tasks to the detriment of quality or content. Time is "marked by hurry, demands, competition, eternal surveillance and assessment, the perverse mechanisms of operational reporting and efficiency measurement", as pointed out by Teresa Cristina Rego in *Epistemologias e subjetividades*. In that work, Teresa comments

two other works which discuss "the richness of possibilities of exploiting autobiographic accounts and formative narratives for studying human development and themes related with teaching and learning" (REGO; RENESTO, 2012). Her article, which includes a study comparing renowned writers and scientists, shows that both are guided "by a rigorous humanist belief from the perspectives of both ethics and logic". And it draws us conclusively towards the importance of knowledge as a construction involving, among others, "time to think, to doubt, to question, and to postulate a few certainties" (REGO; RENESTO, 2012).

As we direct our focus to the areas of health sciences, we can see that higher education questions in the field of humanities have been increasingly reduced in function of an extraordinary growth of exact sciences through the employment of new scientific methods. Education has come to have a content of an experimental nature in every aspect of human behavior, with new laws being discovered each day which sustain theories formulated in the field of natural sciences (GALLIAN; PONDÉ; RUIZ, 2012). This Cartesian-Newtonian worldview holds strong sway over the whole of biology. As a result, the health professional is trained as a technician who must examine damages in a machine – the human body – and try to repair it in the best possible way. The knowledge acquired has grown rapidly and imposed its fragmentation in various parts, which now constitute specialties, bringing about the loss of an integral view of human being in its complexity (DE BENEDETTO; BLASCO; GALLIAN, 2013). In this project of professional higher education, the humanities approach has been progressively losing space and rapidly vanishing from education's horizon, to the point that it is now reduced, in higher education curriculums, to a mere curiosity, which Ortega Y Gasset denominated *general culture* (ORTEGA Y GASSET, 1999).

The restriction of humanities to a room of nostalgia with little place in the modern world,

which stems from the priority given to technical education in universities, has resulted in the dehumanization that is evident in the various sectors of present daily life. Such phenomenon seems to be closely related with what has been lately designated a process of *dehumanization of health* (GALLIAN; PONDÉ; RUIZ, 2012), noticeable particularly in the context of health care, but certainly transcending it. Also in the sphere of research, where the participation of human beings, as well as that of animals, have had an increasingly significant growth, ethical questions related with this so-called phenomenon of dehumanization emerge and require increasing attention.

In this context, the ground of the education of future scientists, particularly the ones who will dedicate to biomedical research, emerges as a field that requires particular caution regarding the role of culture or humanities in the professional training process.

The New National Curriculum Guidelines (DCNs) for Undergraduate Biomedicine Programs and the Challenge of Educating the Future Biomedical Scientist

According to what is set forth in the DCNs (Ordinance CNE/CES 2003), the expectation about the profile of those who graduate from a biomedicine program or work in the area is that “the biomedical scientist should have a generalist, humanistic, critical and reflexive education to work at every level of health care, based on scientific and intellectual rigor”; this regulation also determines that the structure of undergraduate biomedicine programs should ensure “the valuing of ethical and humanistic dimensions, building in the student and in the biomedical scientist attitudes and values oriented towards citizenship and solidarity”. Such guidelines aim to direct the student of health undergraduate courses towards an education that builds on knowledge apprehension, i.e.,

“learning to learn, which encompasses learning to be, learning to do, learning to live together, and learning to know, thus ensuring the training of autonomous, discerning professionals” so as to allow “the integrality of attention and the quality and humanization of the care provided to individuals, families and communities”.

In view of this scenario, where one can identify the need for offering disciplines that provide occasions of reflection to promote the desired ethical and humanistic education indicated in the goals of DCNs, several initiatives have taken place in recent years in areas of health such as medicine and nursing (DE BENEDETTO; BLASCO; GALLIAN, 2013). These disciplines are often elective and their content builds on the field of arts.

According with Teixeira Coelho (2001), in their various forms of manifestation, the arts allow expressing a “widening of the sphere of being” by detaching from the limits imposed by a rationality of parameters that imposes itself on a scientific path that is controlled, demonstrative and to be verified with one’s eyes or with complex technology instruments. It is a somewhat bold, even rebel attitude to insert into an educational process – which has been shaped by Cartesianism for many decades – feelings, as well as the perceptions and affections they involve, which undeniably exist but consciously exceed the human capacity to understand them. These are subjects that escape the control of protocols, disturb all probabilistic and statistic data, in sum, reveal the presence of true human complexity in its full extent, which is not susceptible to transcription into the *scientific alphabet* with all its technological apparatus, as it belongs to another domain (TEIXEIRA COELHO, 2001).

In this universe of the arts and humanities, understood here as a means that allows conducting a reflexive and critical approach in the educative process, it is worth stressing the special role of literature. In his book *Six Memos for the Next Millennium*, Italo Calvino points to the prominence of literature

in that it tends to be universal (CALVINO, 2006). In another book, Calvino refers to the classics of literature by remarking that “This youthful reading can be [...] formative in that it gives form or shape to our future experiences [...] terms of comparison, schemes for categorizing them, scales of values, paradigms of beauty”. And he adds: “There is a particular potency in the work which can be forgotten in itself but which leaves its seeds behind in us”. The author describes the classics as “books which exercise a particular influence, both when they imprint themselves on our imagination as unforgettable, and when they hide in the layers of memory disguised as the individual’s or the collective unconscious” (CALVINO, 2007, p. 10-11). In the same line of thought, Antoine Compagnon, in his book *What is Literature for?*, points us to the possibility of using literature or the literary approach as a teaching methodology (COMPAGNON, 2012). The contemporary philosopher Emmanuel Lévinas – who is rooted on the tradition of writing – also recognizes a special place for literature, the excellence of which is in the classics. To him, reading books exceeds or extends beyond the condition of a simple learning, as they are “food for thought” for man. “Indeed, to read is to keep oneself above the realism – or the politics – of our care for ourselves [...] without coming, however, [...] to the normative idealism of what ‘must be’” (LÉVINAS, 2013, p. 11).

However, it is important to stress that students’ interaction with books today has another facet which did not exist before and which one must take into account when thinking in terms of education. Students now have a different relationship with books compared to the recent past. Even the physical space where knowledge is stored is different, if we consider the space dedicated to books within universities. The historian Robert Darnton focused on the subject in his description of how libraries used to be viewed within universities, as well as their very character, or the role they used to play within such institutions.

According with the author, considered *cities of knowledge* by students in the 1950’s, libraries used to occupy a privileged space, including in terms of territorial allocation: they used to be at the center of the university campus, or at a distinguished site in it. Today, although libraries are still respected, the fact is that they are less populated. Librarians try to offer a better infrastructure to receive students, but the latter are no longer the same: “modern or post-modern students do most of their research in computers in their bedrooms” (DARNTON, 2010, p. 51). So, for many students, the knowledge found within the boundaries of a library seems to be a limited one, while the online digital world offers an unlimited character or, at least, the prospect of a wider range. Darnton also looks into the question of books and reading as an element of the history of humanities: “They reveal patterns of a culture: the segments that went into it, the stitching that connected them, the tears that pulled them apart, and the common cloth of which they were composed” (DARNTON, 2009, p. 188).

Reading *Frankenstein* in the discipline of Philosophy of Science

The curriculum committee at the course of biomedicine, in line with the new curricular guidelines and guided by internal demands at the Universidade Federal de São Paulo, where the present study was conducted, instituted the disciplines of philosophy of science and bioethics in its curriculum since 2005. These disciplines aim to offer an opportunity for students’ reflection, most of all with regard to the ethical aspects of a scientific research in relation with an education based on humanities.

In the pursuit of new strategies to face this challenge, during the exercise of the discipline of philosophy for the biomedicine course, a methodology has been employed which has been developed since 2003 at a laboratory of humanities teaching in the

sphere of medical education. This laboratory proposes reflection based on the reading of the classics of universal literature as a resource for the humanistic education of students, in the condition of an elective discipline in undergraduate courses (medicine, nursing, speech therapy and biomedical sciences) and a discipline in graduate courses. Bittar, Sousa and Gallian (2013) and Lima et al. (2014) describe the activity in detail and present the findings of research where the proposal was the object of study. These findings inspired the adoption of the model in the discipline above.

In order to remain faithful to the educational model to be followed, a humanities-based teaching was conducted – humanities understood here as “in principle, a moral education” – towards a teaching that defines itself “rather, and mainly, by an esthetic and rhetoric education, but also equally by a moral and civic one” (CHERVEL/COMPÈRE, 1999, p. 150-152), with the purpose of rousing in students a reflection about individual and social responsibilities.

The method comprehends the reading of a literary work, a classic of literature, which is conducted according with a specific logic. The first meeting is dedicated to students’ story with the proposed reading, i.e., an opportunity for each participant/student to report how the reading has affected him intimately – therefore not focusing on a critical analysis of the work that was read. The themes which emerge at this first meeting will serve as a guide and a roadmap for discussing the shared reading of the book at subsequent meetings. There are six meetings, always mediated by the coordinator or professor. The questions raised are interactively discussed, as feelings, experiences and insights emerge from these discussions. The last meeting is dedicated to students’ stories about their interactions at the meetings, which is when participants/students manifest orally about how the shared reading was for them, as well as the impact it had on them.

Particularly with regard to the discipline of philosophy of science, six two-hour meetings

were held with thirty students. The dynamic was conducted in the classroom, and students would sit in a large circle so their disposition in the physical space could promote interactivity between colleagues even before discussions had begun. Following the method above, the students shared their reading stories in the first class, followed by discussions on the themes that had most caught their interest during subsequent meetings. Finally, at the meeting to talk about their interaction in previous sessions, they exchanged their impressions and reflections about the shared reading. In addition to this participation in class, students also submitted an individual written report with an account of their reflections about the work that was read.

Using this methodology and this dynamic, the present article aims to present the findings of a study the primary aim of which was to examine the impacts generated by the reading and discussion of Mary Shelley’s *Frankenstein: or the Modern Prometheus* on a group of students in the first year of the biomedicine course, particularly in the sphere of themes of bioethics. The secondary goals of the study were: to verify whether the book proposed was suitable to lead students to an individual critical reflection in the higher education process – in the sense of a classical education, or “an education of the spirit which tends to develop a certain number of qualities, i.e., a clarity of thought, [...] a rigor in linking ideas and propositions; a care for measure and balance; a fine adequacy of tongue to thought” (CHERVEL; COMPÈRE, 1999, p. 155). Moreover, to note whether the studied book can generate the problematization of existing questions in their professional activities as scientists and, finally, to estimate whether the reading of, and reflection about this book allow to rouse students’ attention to the dilemmas and impasses that emerge in the daily work they will face.

Method

In virtue of the questions investigated, we chose an analysis by means of qualitative methodological processes. The study is of an

observational nature, in which we collected narratives from the following sources: participant observation, the use of field notebooks (the notebooks of both the course professor and the monitor) where students' comments were written down in classroom; and reports individually written by the students and submitted at the end of the discipline.

The texts generated in this way are a profitable material for evaluation, and they were organized and interpreted according with immersion/crystallization techniques inspired in *hermeneutic phenomenology* (BORKAN, 1999). The sub-themes that initially emerged were grouped together under main themes which will be presented and illustrated below by the students' sentences. We omitted the collaborators' names, thus ensuring their anonymity.

Results and discussion

The learning process, which was designed to promote internal reflection for a participative world, was aimed at greater knowledge fixation and involved mechanisms to evaluate the personal convictions internalized by students. Without promoting this internal immersion, philosophical learning would become only an acceptance of knowledge that can be discarded at the end of each explanation. And the reading of literature, and of this book in particular, as it attracts students because of the theme related to their area of professional training, led them to an evident appropriation of the text that was read. Here we consider the concept of appropriation as approached by Roger Chartier, mainly with regard to the possibility of free interpretations, ideas and feelings by readers/students. Freedoms which we view as necessary for students to come into possession of a given content and build knowledge of the world. In the sense that "[...] it allows a liberation of spirits which, by means of the information apprehended or the fiction invested, can escape the mandatory repetitions of a narrow daily routine" (CHARTIER, 2003, p. 233).

It is from this mass of such heterogeneous experiences, in the sense of experiences of individual appropriations of the reading, collected from classroom discussions and the written accounts in the form of reports about impressions of the reading, that we list a few significant comments, and present them as the result of students' perceptions with the text.

The reading of *Frankenstein* and the subsequent discussions in classroom were a really intense experience. Young Mary Shelley [...] rendered a range of ideas for a relevant subject: science. A class of future researchers used this singular book, written nearly 200 years ago, to reflect on the limits of the most powerful weapon man has ever had in his hands: knowledge. [...] By holding on to fragments of talks of my colleagues at the debates, I can paraphrase some of what I heard: 'Reading *Frankenstein* is to review the dream of immortality, to question science's range and power [...] and the consequences of breaking with what we call moral ethic towards humanity. It is to test the dark and the absurd, sympathy, and the unexpected'. (Collaborator 1).

In the biomedicine course, the discipline of philosophy of science is often rejected in the curriculum grid right from the start by students, who have apparently chosen such an opposite path. However, as seen above, this experience based on the methodology of the humanities lab had a reflexive impact, particularly because the book was anchored in a context of history of science. That choice ended up promoting the interest of the group of students. So, the book chosen, or its suitability to the course, proved fundamental mainly when applied to the model of reflexive and shared discussion.

Shelley should be read by health professionals and researchers, since reading her [...] awakens reflections regarding the directions of advanced science. (Collaborator 14).

[...] this book is very pertinent to be read by students in the area of research as it provides a panorama of how simple things at the lab can take on a wider panorama as they are released to the world. (Collaborator 19).

Frankenstein was a book that made good impressions on me. (Collaborator 9).

Totally up-to-date, the book covers the various aspects of life, bringing a reflection on attitude, not only in professional terms, but also existential. (Collaborator 3).

The excerpts above confirm what is in the introduction of the book *Frankensteiniana* (VEGA, 2002), which mentions Mary Shelley as having started her literary career with a work of that was remarkably prophetic.

The merit in choosing classic literature resides in its *timelessness*, in which themes are treated regardless of period, since they are connected to questions of the human existence, which pervade time in an always up-to-date manner. According with López Quintás, the great literary creations operate not only as fictions but as “nuclear realities” (QUINTÁS, 2014).

Mary Shelley’s book is much more than a simple fiction. It opens doors to various reflections and questionings. [...] It addresses very up-to-date subjects, with deep correlations with our society. (Collaborator 15).

Shelley’s work is important for this discussion. Not only because it helps thinking about questions approached here. But because the events in the story lead us to reflections and feelings that are purely human. (Collaborator 4).

The study of literature by means of a classic with a theme that is closely related with the development of science and the

scientist led students to realize the importance of philosophical reflection not as an activity dissociated from future practice, but one that is necessary to the process of consciousness formation in their education as scientists (QUINTÁS, 2002).

The importance of philosophy in a course of biological sciences becomes clear; after all, the sciences dialogue with each other and they need each other so they can exist and grow. Most freshmen start in a biomedicine course and don’t feel excited to see philosophy in their grid. [...] The book certainly contributed in making me open my mind [...] and reflect about what it is to be a scientist. (Collaborator 8).

In the methodology used, which was guided by the reading, there was space and time for students to manifest themselves. The fact that there were no closed, predetermined or immediate targets to be achieved allowed moving along individual circuits, dialoguing with colleagues, respecting each one’s personal feelings, emotions and perceptions as they emerged in due time.

It was important to offer students enough time for reading, reflecting and exposing ideas that were shared in a common environment with no urgency for a conclusion or the intention to fully cover a pre-programmed content to be learned. Conducting a climate of dialogue avoids rushing, demanding, competing and evaluating, all of which can corrupt the mechanisms of an in-depth appreciation of the contents of the text. As Teresa Cristina Rego says: “This draws us conclusively towards the importance of knowledge as a construction involving, among others, time to think, to doubt, to question, and to postulate a few certainties (REGO; RENESTO, 2012).

Frankenstein proved a book not only to be read, but also to be thought about. It stimulates a reflection process that a

superficial reading is unable to provide. So, the time dedicated to discussing the book was fundamental for delving into the ideas that emerge throughout the reading. [...] Looking deeper into many questions can propose a reflexive stance that we don't usually reach amidst our routine of lack of time. (Collaborator 3).

The use of classics of literature as a way of leading students towards reflection was a challenge to a group of students who usually occupy themselves entirely with the reading of books of strictly scientific content from areas of basic sciences such as chemistry, physics, biology, etc. A scenario change occurs, sometimes even violently, in which the idea of the scientific as devoid of passions and feelings does not seem to respond to human existential questions.

In a process of academic education, the book emerges as a tool that can expand the boundaries of thought, providing not only specific knowledge. But also helping to educate the individual in relation with its daily routine, which encompasses various aspects of life. (Collaborator 3).

According with the interpretation technique used, i.e., hermeneutic phenomenology, a meaning was progressively (re)built among the themes that emerged, allowing them to relate with each other and to all of them. In some passages of the book, the students' accounts found ways of referring their comments to the characters and their attitudes as shown by some of the narratives they wrote. Thus, the main themes that emerged were: responsibility; the relationship with the other; dehumanization; and the limits of science.

Responsibility

Among the themes that emerged, the aspect of responsibility was the one that most frequently attracted students' attention. Reading

and *experiencing Frankenstein* was like diving into the scientist's work, the consequence of his acts and research, the personal responsibility for his experiment, the assessment of ethical limits, risks, and unpredictable results.

[...] Victor Frankenstein didn't think about the consequences, he didn't plan what he would do, he was so focused that he became obsessed with his work. (Collaborator 21). Reading this book provokes a critical reflection about the limits of science. Man has more and more the ability to progress scientifically and manipulate life, however, that ability often comes without a social consciousness. (Collaborator 14).

The accounts above show a reflection about the scientist's prudence and ethic, which are evidenced in one of the main questions of science today: "I can, but should I?" (MARKL, 2002).

As future researchers, we must know until where we can go. [...] One of the major problems of generating a new life is the 'now what?'. Once that life is generated, what's to be done now? [...] What are the possible impacts that it can generate? (Collaborator 12).

Responsibility was evaluated for the different phases of the scientist's work with his experiment, i.e., what the students realized was that there can emerge no *surprises*. It is a duty of the scientist to reflect before acting, so that unforeseen events may stem from consequences that really could not be assessed in advance. The excitement about the knowledge acquired cannot cross the limits of the consequences of using whatever means available. According with the students' accounts:

Being fully conscious of scientific experiments and their possible outcomes can aid one's wisdom regarding the best way to be followed. (Collaborator 5).

That was Frankenstein's first mistake. There was no reflection whatsoever about the relationship between the scientist and the experiment like there must always be. (Collaborator 2).

The considerations above promote an openness to understanding science in modernity, giving up the image of the scientist as a being isolated from others, with ideas for a work that is incomprehensible to most people and without consequences, and building, instead, the perception of a professional whose importance grows in the community through the results of his research, which can interfere with the lives of many. Consequently, the responsibility of a scientist in the making must expand to encompass the possible interferences with society's daily life, including the possibility of changing paradigms, habits and customs. As said by the students:

A scientist must think about why he does science and for whom he does it. It became explicit how important it is to think not only within the lab, but also to have a global view and awareness that we do science for the world. (Collaborator 8).

The book has not only changed but also expanded my view of science and the impact it has on society. (Collaborator 11).

[...] it has made us reflect particularly about questions of science that exceed the scientific sphere as such. [...] it makes us see the Other from closer, making us rethink our own attitudes and how they can affect the life of the whole humanity. (Collaborator 7).

This reading has shown to me that science cannot be simply separated from the other fields of society. When a researcher studies and discovers something, the consequences of that discovery spread beyond the

scientific sphere, affecting society as a whole. (Collaborator 6).

From the analysis emerges the importance of the concepts of ethics and moral understood from the events narrated in the book. The students' reading reveals in a spontaneous way what they brought themselves to expect of the ethical-moral attitude of the researcher, as well as their ponderations on the present context. To Emmanuel Lévinas, a contemporary philosopher recognized for his line of thought guided by the *ethics of alterity*, literature has an important role in education, since life experiences (particularly initial ones) can end up being problematized through the reading of literature books: "I believe that [...] people underestimate the ontological reference of the human being to books, which is taken as a source of information or an utensil for learning, like a guidebook, when it is, in fact, a modality of our being" (LÉVINAS, 2013, p. 11).

Thinking about questions such as the consequences of our actions; the ethics and moral involved are certainly very important. However, the banalization of the subject doesn't contribute to such desired advances. Many times, we lose the notion of the meaning of a word or even a moral law which exists in our nature, and cease to add values to small acts. (Collaborator 4).

The words above point to the importance of the learning of bioethics as a guide for the scientist, rather than a punishment for actions. This *usual controversy* is perceived by students as soon as they start in college and should follow them over their academic and professional trajectory.

The delicate theme that was approached could be titled 'Responsibility for Scientific Creations' for bringing up a question that will always be polemic in the scientific

world, which is the discussion about the objectives and uses of technologies invented or the enhancement by science. (Collaborator 5).

Theoretical knowledge is necessary but not sufficient for the education of a conscious scientist. To biomedical careers, for example, disciplines such as biochemistry and histology should be present, but not without others such as philosophy and bioethics, in order to guide the use of the knowledge acquired and encourage reflection in research endeavors. (Collaborator 6).

Bioethics' multiprofessional and interdisciplinary vision can help the young scientist to prepare for the consequences of his achievements and the implications they have to society, implications which are not restricted to the scientific world, but have been expanding their range into society through breaks of paradigm, change in customs and traditions, thereby transforming cultural conceptions. All this becomes perceptible during the reading of the book.

The book allows analyzing the scientist as a social agent, as his invention provokes deep changes in the lives of many people and it could, if the *species* were to proliferate, cause unimaginable damage to human society. (Collaborator 16).

Dehumanization and the relationship with the other

Although it is usually mentioned as a book of general interest, particularly to the health areas, *Frankenstein* speaks in a special way to science researches in the biological field. The biomedical model, founded on the Cartesianist proposal, has since the sixteenth century pushed away sensations, feelings and even the spirit of man's complexity. One can

clearly see from the reading of the students' reports that the book has opened horizons to perspectives once forgotten in Cartesianism and which now reemerge in a broader cultural and social view.

The scientist, primarily as a human being, does science, which has an extraordinary impact on all aspects of nature (physical, biological, social, cultural and religious). Understanding and controlling an experiment is only one of the pieces that form science, which has a living and, therefore, transcendental essence. Technologies, as a social and cultural expression of science – and as its image – gain life as they successively reach people, and make the scientist a social and cultural agent with great powers and great responsibilities. A beneficial science is born to the scientist who is not lost from himself. (Collaborator 2).

It is worth noting that this student sees a break in the paradigm of a science focused on nature as something reduced to matter, thereby introducing science in a context where spirit-originated human feelings also exist and cannot be forgotten in the scientific experience. The body, a physical and biological presence, Descartes' machine, cannot be considered inanimate, it must be *alive*. However, it is not only a biological life like that of any other creature, but one which transcends in the universe of people who can build culture, where the scientist becomes a "social and cultural agent, with great powers and great responsibilities".

Many of the accounts we collected stressed the question of the process of dehumanization both in the intrinsic aspects of the book's protagonist and in his relationships with his family, the society and his own research, which, in this case, implied a new creature with characteristics that defied its creator. An attitude connected to the alienation

of man towards the other or his fellow man, or towards himself, which compromises his work as a researcher. The paragraph below, extracted from the book, led students to realize those transformations, as we can see:

I knew my silence disquieted them; and I well remembered the words of my father: 'I know that while you are pleased with yourself, you will think of us with affection, and we shall hear regularly from you. You must pardon me if I regard any interruption in your correspondence as a proof that your other duties are equally neglected. [...] but I could not tear my thoughts from my employment, loathsome in itself, but which had taken an irresistible hold of my imagination. I wished, as it were, to procrastinate all that related to my feelings of affection until the great object, which swallowed up every habit of my nature, should be completed. (SHELLEY, 2007, p. 57).

The novel also warned me about the importance of aspects such as family and friends. They shouldn't be put aside in the name of some goal. (Collaborator 6).

The feelings awoken in the reader by the book's characters can lead him to reflect about his own attitudes. "[...] more accessible to consciousness, the phenomena of identification or the ties woven with characters are experiences through which the personality of the subject is forged or affirmed" (ROUXEL, 2013, p. 76).

The interaction with the characters and their actions can cause the student to identify concepts and elaborate a self-understanding process accompanied by personal feelings about what is occurring and how this phenomenon impacts on his reality.

In this perspective, the experience with the reading of literature becomes fundamental as a contemporary pedagogy because it gives centrality to the student (REZENDE, 2013).

That is, it allows the student to change from his student position to that of an individual reader – which implies getting to exercise the social practice of reading. Thus, once liberated, the student-reader tends to create his own connections with the literary work and, consequently, to “know other experiences and learn from them, in a process of identity and alterity”. For literary reading “promotes, most of all, an identification and is generally experienced subjectively by the reader” (DALVI; REZENDE; JOVER-FALEIROS, p. 108-109).

In the passages below, the literal comparison with the text studied is impressive.

I seemed to have lost all soul or sensation but for this one pursuit. [...] The summer months passed while I was thus engaged, heart and soul, in one pursuit. It was a most beautiful season; never did the fields bestow a more plentiful harvest, or the vines yield a more luxuriant vintage: but my eyes were insensible to the charms of nature. And the same feelings which made me neglect the scenes around me caused me also to forget those friends who were so many miles absent, and whom I had not seen for a long time. (SHELLEY, 2007 p. 57).

Particularly, these paragraphs made me recall these last two years, in which I, firmly decided to pass a college admission test for a public medicine school, gave up most of my life. I was full-time dedicated to studying, I stopped seeing my family, going out with friends, I stopped practicing sports, attending a religious institution, and I put aside my leisure time. Unfortunately, time passed and I, for want of good psychological conditions, started attending this course and postponing the pursuit of my desire. However, being more mature, I now realize the harm of all this separation, with implications until the present (Collaborator 7).

Here is an evident case of identification with the literary text, an identification which theorists dedicated to the didactics of literature, such as Annie Rouxel, point to as the first approximation – one that is necessary to the education of readers as such. “If identification builds and nurtures the reader’s interiority, his awareness varies according with a double scale that interferes with the intensity and time of occurrence of this identification”. Identification “can be [...] emergent or fully established and lucid; it can be through adherence or projection; it can be [...] according with the disposition and experience of the reader. These elements can join together each time in a particular way” (ROUXEL, 2013 p. 77).

Moreover, the plot developed by Shelley over the narrative promoted a deep reflection on the part of students about what it is to be human. “This theme supposes that particular attention be given to the existential content of literature, [...] in that the reading of literary works allows building the human in the subject, which, in my view, is the main challenge of literary culture” (ROUXEL, 2013 p. 165).

After all this discussion, we realize that both the creature and its creator had an unhappy, miserable life full of tragedies. However, Victor wanted to be a god. The creature wanted a family. [...] Victor died fulfilling his goal of giving life to dead matter. The creature died without having a family or anyone who loved it. Victor died wishing revenge. The creature died wishing for salvation. At this point, it seems that, indeed, the creature achieved something grander than its creator could: being human. (Collaborator 4).

The Concept of Science

The scientific development established particularly since Renaissance and with an exponential growth starting in the late

nineteenth century became rooted in the concept of science as an activity fundamentally dedicated to technology. Even in the area of health sciences, where man is at the center of attentions, biology, which is the branch approached in this study, is made in association with a model basically founded on investigation resources provided by technology (PESSINI; BARCHIFONTAINE, 2012).

The biomedicine course attended by the students who participated in this study was born and developed within the so-called biomedical model. Its conception, designed nearly fifty years ago, was conducted by scientists from basic chairs who taught in the education of medicine students. The decision to create a course to educate and train not doctors, but research scientists for the health area starts with a curriculum of exact disciplines. Only after nearly forty years did the college realize the necessity to introduce the disciplines of philosophy and bioethics at undergraduate level (REGINATO; GALLIAN, 2014). The experience with *Frankenstein* provoked a new evaluation of the concept of science on the part of students.

I feel, [...] that it is my duty to reflect a little further about science than I had planned, as I chose a higher-education path that is dedicated to science. (Collaborator 5).

Reading *Frankenstein* was not the best experience in my life as a person. As a future researcher, though, during my second reading of the book, I was able to obtain introspections about the science world today and in the days of the book, including, and mainly, the author’s prophetic view concerning modernity and the possible biological advances. (Collaborator 10).

Given the methodology, a fundamental question is in the *accounts of class interaction* after the end of the reading and classroom

debates. In the final stage of the experience with the book, the students manifested their personal impressions, including what was striking to each of them, what was awakened by the whole process of reading, learning, reflecting, arguing, sharing, interacting, and seeing reality through a new prism offered by the light of the text.

Considering the analysis of results obtained in view of the students' accounts, we must register the words of one of them, which reveal the final result obtained by the experience with students through *Frankenstein* by using the educational method above:

Finally, I can say the experience with the book was a good one. I was able to take upon myself that before being a professional of science, the researcher is a citizen, a family member, a human being. I truly view science as a most special, infrequent thing. Few have the capacity to give birth to ideas that have certainly dominated the world and still dominate it. Men and women in scientific environments around the world have a really powerful weapon. [...] If the purpose of our meetings at philosophy classes was to infuse some of that awareness in us young scientists, then I believe it has worked. (Collaborator 1).

Final considerations: reflecting on *Frankenstein* in the 21st Century

Humanities applied in the form of literature offered an opportunity for teaching philosophy as an education basis that is not only theoretical but also practically applicable in students' professional future.

The goals of both individual and shared perception, awareness-raising, and reflection about the scientist's education and practice stood out as a positive result in function of the methodology applied, which favors the enrichment built by the interaction of the different readings offered by the participants.

Within that experience, two fundamental aspects were revealed by students: the factors that concur to a scientist's education beyond the technical-scientific academic sphere, particularly the scientist's ethical commitment and responsibility regarding his experiment, and the influence entailed by his actions within society.

The present study leaves open the proposal of further research that uses literature and is based on the educational methodology above as a route to a more comprehensive higher education for students, in the sense of furthering a debate and/or discussions of moral and ethical questions from the perspective of individual responsibility.

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