ETHICS IN SCIENCE:
CREATING A CONSCIOUS ETHICAL IDEOLOGY

Implementing Ethical Values within our Basic Educational System with an Emphasis on Ethics in Science

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ABSTRACT

Science and technology have helped human and social evolution move to higher levels, increase life expectancy, raise living standards and change daily patterns, as well as conquer a great deal of physical knowledge which can help us consciously shape the course of the future as we see fit. However, it seems that we have come close to what many like to call a “tipping point” in our evolution, where the negative side-effects of science and technology are becoming visible on a global scale, affecting the whole population (e.g. environmental pollution, climate change), while our vast knowledge and capabilities have brought us closer to obliteration (e.g. weapons of mass-destruction). The use of science and technology has often inflicted many problems and side dangers, but it is only through science and technology that we will find solutions to these problems and new ways of conduct. However, without a reassessment of our priorities, our personal and collective ethical values, and without a change in our social patterns and our international affairs, the risk of self-destruction becomes more and more irrefutable. It is imperative that our social maturity and our collective thinking evolves in order to keep up with our technological progress, and act as a preventive shield towards our own flawed, competitive, destructive, and often near-sighted human nature. It is crucial that we raise awareness regarding current and future problems, increase our level of responsibility towards the environment and future generations, and most importantly, raise the level of critical thinking which will allow us to question and challenge the established social norms and current rules of conduct. It is therefore vital to make some changes within our basic educational system in order to incorporate meaningful social principles with an emphasis on humanitarian and environmental values, and help students shape a conscious ethical ideology for themselves in order to evaluate and deal with the aforementioned issues successfully. Only through personal transformation and increased ethical sensitivity can people, and therefore science as well, take a more humanistic and environmental friendly approach in order to solve the dire problems that we, the future generations and our planet are facing.
ACKNOWLEDGMENTS

This research project was a very enjoyable and fulfilling experience, which required a lot of effort, extensive reading, careful contemplation, considerable time, and of course, a lot of panic and anxiety. However, the whole process, as well as the eventual completion of the project, generated a great deal of joy and gratification, so I would like to deeply thank my supervisors Anthony van Inge and Mary Beth Key for making it as easy as possible with their invaluable input, their helpful directions and all the stimulating discussions, as well as my Professor André Heck for all his help and support.

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“This evening I would like to use this lofty and historic platform to discuss what appears to me to be the most pressing problem confronting mankind today. Modern man has brought this whole world to an awe-inspiring threshold of the future. He has reached new and astonishing peaks of scientific success. He has produced machines that think and instruments that peer into the unfathomable ranges of interstellar space. He has built gigantic bridges to span the seas and gargantuan buildings to kiss the skies. His airplanes and spaceships have dwarfed distance, placed time in chains, and carved highways through the stratosphere. This is a dazzling picture of modern man’s scientific and technological progress. Yet, in spite of these spectacular strides in science and technology, and still unlimited ones to come, something basic is missing. There is a sort of poverty of the spirit which stands in glaring contrast to our scientific and technological abundance. The richer we have become materially, the poorer we have become morally and spiritually. We have learned to fly the air like birds and swim the sea like fish, but we have not learned the simple art of living together as brothers.”

Martin Luther King, Nobel lecture, (December 11th, 1964)
1. INTRODUCTION

The above quote is an excerpt from Dr. Martin Luther King’s speech during his acceptance of the Nobel Peace Prize in 1964 in Oslo. Although his speech is remarkable and worth reading as a whole, I have chosen this specific fragment as I believe touches the core of the problem our society is facing, now more than ever. Fifty years have already passed since Martin Luther King’s Nobel Lecture. During this time, our technological capabilities have dramatically increased and our scientific knowledge has expanded, however, we have still not found a way to coexist with each other in harmony, disregarding sex, culture, religious or political differences. Our rapid technological and social progress, which often seems to lack spiritual maturity, has brought us closer to elimination, either by direct means, such as weapons of mass destruction (nuclear weapons, biological weapons, biochemical weapons) or by indirect means, like the careless exploitation of our finite natural resources and the continuous destruction of our environment in the form of air, water, and ground pollution, global warming, as well as severe imbalances in worldwide animal population dynamics. However, the accelerated technological advancement is not the root of the problem; that would be a very nearsighted view. The root of the problem is that humanity has not matured in parallel with our scientific knowledge; our consciousness has not expanded enough to understand the interconnectedness of all living things on the planet and our dependence on the environment, and we are still not able to fully realize and respect our part of the responsibility towards the future generations. The crisis, as Jiddu Krishnamurti (1895 – 1986), writer, philosopher and spiritual teacher, explains, is a crisis in consciousness.

The crisis is a crisis in consciousness. A crisis that cannot, anymore, accept the old norms, the old patterns, the ancient traditions. And, considering what the world is now, with all the misery, conflict, destructive brutality, aggression, and so on... Man is still as he was. He is still brutal, violent, aggressive, acquisitive, competitive. And, he’s built a society along these lines.

Jiddu Krishnamurti, Ojai 3rd Public Talk (November 5th, 1966)

Krishnamurti worked hard to bring a fundamental change in society and he stressed the importance of bringing about a radical revolution in the human mind. However, such revolution cannot come about without providing humanity with the necessary cognitive tools in order to question and be critical towards the norms that currently guide our lives. To be critical towards the norms that guide our lives means to reexamine the values and beliefs that silently guide our actions and form the basis of our ethical reasoning and moral judgment. To question and reevaluate the very foundations of society, and our function in it, means to philosophize about our human nature, the purpose of our
existence, and consequentially, our moral priorities. However, we cannot expect humanity to discover the art and science of philosophy without proper guidance and education, just as we don’t feel content with the thought of people learning the science of mathematics and physics without formal education. If we are to provide people with a critical mind and with all the cognitive tools necessary to become morally conscious regarding their values, their priorities, their daily decisions and life patterns, then quality education with a philosophical foundation and an ethical focus is the way to do it.

With the above framework in mind, this research focused on investigating the possible effects on the ethical ideology of thirteen 16-year-old students as well as their views about ethics in science, after a carefully designed intervention based on interactive lectures, group assignments, classroom discussions and debates. The overall aim was to record students’ pre-existing ideas on general ethical matters and about ethics in science, investigate whether there were any changes in their views observed after the intervention which would indicate they had engaged in a deep cognitive process and reevaluated their core beliefs, and finally, to record their level of interest in a controversial subject such as ethics.

The research took place in a Dutch high-school in Amsterdam-Noord, and made repeated use of two questionnaires, the Ethics Position Questionnaire (EPQ) and the Ethics in Science Questionnaire (ESQ), as well as other methods for the acquisition of qualitative information, to measure the students’ views prior to and after the intervention.
1.1 Personal Motivation

Dear reader,

Before I begin describing the theoretical framework of my study, the specific aims and questions and the research methodology, I wanted to dedicate an introductory section to clarifying my personal motivation behind this study as well as some of my beliefs and preconceptions. Holding strongly to the idea that every researcher has his own personal ideas and perhaps conscious or unconscious biases which affect the kind of research s/he engages in, as well as the way the research is conducted and the output facts interpreted, I wish to openly state my own and to discuss my motivation behind the study, meaning what inspired me and drew me to the subject, hoping that the research, the selected methods and the results will be criticized and evaluated accordingly.

William Saletan, author and chief political correspondent at Slate Magazine, notes in his article about Situationist Ethics (May 12, 2004) that science isn’t all scientific. “Every experiment begins by drawing a box. Inside the box are the factors he (the scientist) decides to control or measure. The rest –including him- are left out, either because he can’t control or measure them or because he doesn’t think they are important. The box-drawing process is seldom scientific and often cultural or political. Consequently, excluded facts often turn out to be more important than included ones.” In other words, and what is of main interest to us in this case, the scientist himself is always a factor in each study, but one that is seldom measured.

According to David Goodstein (Academy, 2002), there seems to exist a foundational assumption which “arises out of the long-discredited Baconian view of scientists as disinterested seekers of truth who gather facts with mind cleansed of prejudices and preconceptions”. It is what he calls the Myth of the Noble Scientist. “The ideal scientist in this view would be more honest than ordinary mortals, certainly immune to such common human failings as pride or personal ambition.” This assumption prompts us to ask whether there is something special about uncovering scientific “truth”. Are scholars driven by a higher noble motivation or are they driven by the same self-interested ambitions for fame and fortune as the rest of us mortals? Are we too often eager to presume that scientists and scholars are far more good-spirited and public-oriented than the rest of the population? Do we perhaps cling to the idea that scientists would be unbiased and unprejudiced in the evaluation of ideas and results? Or that they would never degrade, wrongly criticize or dismiss ideas due to racial or religious biases? And just how important is their code of ethics and their personal ideology when it comes to their work?
The truth is that there have been several cases of scientific fraud disproving the idea of the noble scientist recorded through the years, and Goodstein offers a list of several potential motivations for engaging in scientific misconduct which will be presented analytically in later chapters. However, we should note that while sometimes scientists might alter results or ignore important factors or facts and knowingly conduct fraud for clear reasons such as academic pressure or monetary gain, other times they themselves fall victims to their own biases which may lead them to exclude factors or misinterpret results unknowingly.

One particularly interesting and yet not so famous case of scientific misconduct, is the story of Karl Pearson (1857 – 1936), famous mathematician, who published a quite controversial study in 1925, called “The Problem of Alien Immigration into Great Britain illustrated by an Examination of Russian and Polish Jewish Children”. He and his co-author Margaret Moul conducted a study which supposedly proved the inferiority of the “Jewish race” as compared to the gentile population of Great Britain. The study compared Jewish and gentile children on grounds such as dress code, personal hygiene, cultural expenditure patterns, and finally, intelligence. The study was widely used later as a basis for racial classification and hierarchy in particular regarding Jewish people. However, the scientists and therefore the study, were strongly influenced by Eugenics,¹ a very popular scientific discipline and a widely accepted notion around the world at the time.² Specifically, Pearson was strongly influenced by Francis Galton (1822 – 1911), cousin of Charles Darwin, scientist and famous eugenicist, who strongly believed in racial classification and Jewish inferiority (Levy & Peart, 2005). And while Galton was often upfront about his ideas and presuppositions,³ Pearson preferred to present himself as the objective, disinterested scientist, free from common vulgar failings such as personal biases and ideological motives. Pearson considered himself, on the grounds of being a

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¹ Eugenics is the study of genetic and racial classification, aiming at the hereditary improvement of the human race by controlled selective breeding.

² In the early 1900’s the United States of America stood out as an inspiration to others (see footnote 5), being the first country to implement sterilization laws based on the field of Eugenics in more than 33 states and with more than 65,000 sterilization victims (D. Kevles, In the Name of Eugenics: Genetics and the uses of Human Heredity, (1985)), beginning in 1907 in Indiana and continuing up until the 1970’s in California (A. Stern, Eugenic Nation: Faults and Frontiers of Better Breeding in Modern America, Berkeley, 2005). The original targets of these laws were the “defectives”: the mentally ill and mentally retarded, the deaf, the blind, people with epilepsy and the physically deformed, prisoners and of course other minority groups which were considered to be inferior and on the margins of society (such as Jewish or “colored people”; all based on stereotypes mainly supported by scientific studies such as that of Karl Pearson).

³ Galton presented both his presuppositions and his results in the analysis of finger prints. He was predisposed to believe that the fingerprints of black people were more uniform than those of white people but confessed an inability to find this result in the data. Galton (1892a).
scientist, as almost the only one (except for a few other like-minded scientists) qualified to make assertions regarding the appropriateness of Jewish immigration, as compared to politicians who were victims of their personal biases. This was the overall aim of his research.

_The partizans of cheap labour and the partizans of monopolistic trades-unionism were both undoubtedly acting from personal and party inspirations, and there was no one whose business it really was to find the true answer to the question of whether Great Britain could assimilate to its national profit this mass of new and untested material._ (1925: p. 7)

However, below is an excerpt from Pearson’s _National Life from the Standpoint of Science_ written already in 1901, 24 years prior to his aforementioned study, which clearly shows his preconceptions and his concerns regarding the problems of so called “inferior” races mixing with superior ones, causing him to fear the future:

_There may be a steady average ability, but where is the fire of genius, the spirit of enthusiasm, which creates the leader of men either in thought or action? Alas! It is difficult to see any light on the horizon predicting the dawn of an intellectual renaissance, or heralding social and political reforms such as carried the nation through the difficult fifty years of the middle of this century. Possibly our strong men may have got into the wrong places. (...) but I must confess to feeling sometimes that an actual dearth is upon us. And if this should be so, then the unchangeable law of heredity shows us only too clearly the source: we have multiplied from the inferior, and not from the superior stocks._ (1901: p. 56-57)

Later on, some criticized the results of Pearson’s study, pointing out that the scientists due to their personal biases neither considered nor discussed issues such as cultural differences, language difficulties, poverty, or reduced access to education and healthcare when conducting their research. Instead, these scientists presented conclusions such as that the difference in expenditure on dressing, which was lower, was a sign of “racial” inferiority, and only the demonstration of higher intelligence than the Gentile population could compensate for their “lower” physical traits and habits. But even though no difference in intelligence was found among Jewish and gentile boys, there was one found among girls. Again, without taking into consideration the possible cultural reasons that may have led to that difference, (e.g. lower education in Jewish girls), they immediately concluded the inferiority of Jews. Since the study did not prove their intellectual superiority, Pearson and Moul quickly made a case for not allowing more Jews into Great Britain, as their main interest and goal in the research (as we can read below) was “helping” to formulate a law against immigration of inferior races to Great Britain, in this case, Jews.
The whole problem of immigration is fundamental for the rational teaching of national eugenics. What purpose would there be in endeavouring to legislate for a superior breed of men, if at any moment it could be swamped by the influx of immigrants of an inferior race, hastening to profit by the higher civilisation of an improved humanity? (1925: p. 7)

What is definitely clear, however, is that our own Jewish boys do not form from the standpoint of intelligence a group markedly superior to our natives. But that is the sole condition under which we are prepared to admit that immigration should be allowed. (...) Taken on the average, and regarding both sexes, this alien Jewish population is somewhat inferior physically and mentally to the native population. (1925: p. 126)

Finally, Pearson and Moul were later on also criticized for statistical prejudice. Specifically, even though Pearson always defended strongly against the subjective discarding of outliers, in this case he decided to completely disregard the existence of any possible outliers. Even though he acknowledged the fact that the Jewish people were sometimes examples of academic superiority and excellence such as Einstein and Spinoza, he preferred to use the following argument in order to disregard such cases:

We know and admit that some of the children of these alien Jews from the academic standpoint have done brilliantly, whether they have the staying powers of the native race is another question. No breeder of cattle, however, would purchase an entire herd because he anticipated finding one or two fine specimens included in it; still less would he do it, if his byres and pastures were already full. (Pearson & Moul, 1925: p. 127)

It is evident then, that the study violated Pearson’s own statistical principles. As Levy & Peart note in Statistical Prejudice: From Eugenics to Immigration (2005, Chapter 5):

All of this suggests that prior judgments about Jews, rather than statistical principles, drove the results.

Despite the clear personal biases and agendas of the researchers presented above, the study was widely accepted with very little criticism as the indisputable truth since it was based on “scientific evidence”, and was in accordance with the mainstream scientific viewpoint at the time. And what was merely a scientifically disguised personal and biased frame of mind, eventually became a bullet-proof argument for those who supported the same ideas. In other words, the scientists had a specific idea of what they were trying to prove and they managed to ‘find’ the results they were looking for and draw far-from-

4 Stigler (1986: p. 338) notes that Pearson “would not budge on the matter of excluding extreme values from his analysis.”
objective conclusions, which further on influenced other scientists and the scientific community, as well as a great part of the population especially regarding Jewish people and eugenics laws. We need not mention how these views affected the course of history, and sadly, what most people today are still unaware of, is that the story of Adolf Hitler and the Holocaust was only the tip of the iceberg.  

The case of Karl Pearson is a clear example and certainly not the only one, of how scientists themselves can either willingly or unwillingly affect the conduct of the research and the way they interpret the results as well as how their personal ideals and beliefs influenced the type of research in which they engaged in the first place. Merriam (1998) states, “our analysis and interpretation – our study’s findings – will reflect the constructs, concepts, language, models, and theories that structured the study in the first place” (p.48). It is also proof that even scientists can be extremely influenced by the mainstream views of their time instead of being dedicated to uncovering objective truth. The discussion of this specific case however serves a dual purpose here, as it is a good example of how our personal world-view determines the type of questions we ask and influences the answers that we find, and a perfect showcase of how science (good or bad concerning its conduct) can in return affect our world-view, not only regarding the physical world around us, but also regarding human relationships as well as the established ethical codes that govern our societies. Other examples are the case of Apartheid in South Africa and the notion of slavery in general, both which were also based on scientific evidence showing the inferiority of “colored people”.

Cases as the ones discussed above have led me to the belief that the importance and influence of science in our lives stretches far from the typical view that science is a means

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5 In Stefan Kühl’s *The Nazi Connection: Eugenics, American Racism and German National Socialism*, (2002) we read that after World War II, when Nazi administrators went to the Nuremberg trials for war crimes, they justified their “purification” laws (over 450,000 mass sterilizations in less than a decade) and their euthanasia programs (responsible for the killing of more than 200,000 mentally-ill or handicapped people prior to the Jewish genocide (Horst von Buttlar, *Forscher öffnen Inventar des Schreckens at Spiegel Online* (2003-10-1)), by citing the United States as their inspiration. They claimed they failed to understand the difference between the American policies and the eventual genocide of the Holocaust. In fact, one historically famous remark was made prior to WWII by an eugenics activist in Virginia who complained “The Germans are beating us at our own game”. According to the Population Research Institute (*Fact Sheet on Sterilization Campaigns around the World*, February 23, 1998), sterilization programs were enforced in about 24 countries, (such as Australia, Brazil, Canada, China, Denmark, Estonia, Finland, France, Germany, Iceland, India, Japan, Norway, Panama, Peru, Switzerland, the U.S.A. and more), many of them starting already in the late 1800s, where in some cases (as in the case of California) they continued even until the 1970s. After WWII and the massacre of six million Jewish people, the Eugenic movement was “buried” but did not completely disappear. Due to the vast unpopularity it gained, the name Eugenics simply changed in University departments and scientific journals to “Human Genetics”. (Black, 2003)
by which the physical laws governing the universe can be explained, or as a basis for technological advancement. In addition, science reaches far into the deeper philosophical questions that deal with who we are and how we ought to live, how we ought to treat one another, what is right and what is wrong. There is a lively debate on this topic which we will present extensively later on in the theoretical framework, but since my starting argument was about researchers expressing their personal ideas and preconceptions in an honest way, I prefer to openly state in advance my views and concerns which have led me to this study.

If our perception about ethics, the world and human relations can have such a huge impact on our societies and the course of history, the future generations and the planet altogether, either through science, politics, or generally the established social norms, I believe we should be cautious about the world-view and the ethical codes that we pass on to the future generations.

When the Nazi party seized power in Germany in 1933, one of their prime interests was to convey totalitarian principles across the German educational system. With a main emphasis on the promotion of racial doctrines, schools were transformed into incubators of nationalism and Anti-Semitism (Pine, 2010). Hitler and other members of the Nazi party realized straight away the importance of the youth’s core beliefs which would affect their future behavioral codes, so if they were to implement a lasting ideological shift in Nazi Germany, education was the key and it had to become more ideologically driven. In order to prevent any form of ideological controversy and questioning, education was reduced to an elementary level, free thinking was suppressed and replaced by forms of brain washing, and essays became no more than the rewriting of propaganda handouts.

Sitting on the far other end that supports open-mindedness, freedom of thought and expression as well as rigorous debate, if we are dedicated to protecting high ideals such as equality, respect for human rights, and the preservation of the environment, should we not try to nourish a world-view of brotherhood and peace in a meaningful way through our educational system, a world-view based on mutual respect regardless of culture, race, sex or religion, based on cooperation rather than competition, and one that sees the global population as one and understands humans’ dependence on the environment and therefore the importance of its protection? Famous astrophysicist and cosmologist Carl Sagan already discussed this shift in consciousness regarding the way we view our planet in the *Cosmos* television series in 1980:

> The old appeals to racial, sexual and religious chauvinism and to rabid nationalism are beginning not to work. A new consciousness is developing which
sees the Earth as a single organism and recognizes that an organism at war with itself is doomed. We are one planet.

Or as Albert Einstein, this great scientist and philosopher said more than half a century ago:

A human being is a part of a whole, called by us “ Universe”, a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest... a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.


Apart from affecting our core beliefs and our social norms which have the power to alter the course of the future, science also has a great influence on almost all practical aspects of our lives as it has given us great capabilities and opportunities, especially through the technological advancements of our era. At the same time however, it has brought us near to a tipping point, for through our progress and development we have come closer to our self-destruction. It is well understood that the use of scientific knowledge and technology has two sides, one that can be used to benefit humanity and one that can be used against it. Perhaps we cannot characterize science as good or bad, but we can characterize its usage depending on the potential consequences. Once again, the ethical code and the world-view of scientists or anyone who makes use of scientific and technological knowledge (be that politicians, military officials or businessmen) is crucial to the survival of our world.

For all the aforementioned reasons, it is my belief that the future generations should be very aware of all the potential dangers behind the wrongful or inconsiderate use of science and technology, they should be conscious about protecting human rights and values of unity and peace through their work and their daily actions, and they should be nourished and supported to cultivate a sensitized and respectful world-view towards the environment. It is my belief that all these ideals and aims should be implemented in our basic education system either through a separate line of courses dedicated to achieving these goals or at least through humanizing our current science lessons which would enrich students’ understanding and respect towards scientific usage.
In the following chapters I discuss the problem that young people are not being trained to recognize and be concerned about, nor to analyze and critique, scientific and technological advancements and discoveries as they are reported by scientists and others in research journals and general media such as newspapers, television, and the Internet. Embedded in this is the sometimes wrongful and/or misleading behavior of scientists and the resulting reports about their work. There is a need for young people to be educated in some study of ethics, especially as it pertains to science so that they may be in a better position in future to make decisions. My general aim in undertaking this research was to develop and try out a small intervention with school-level students who met the concepts of ethics for the first time and to motivate them to consider them critically.

In chapter 2 I begin with the aims of this research study and my research questions before providing some theoretical underpinning of the research in chapter 3 where I present the main arguments for and against the teaching of ethics in science and discuss the importance of cultivating a conscious ethical ideology with an emphasis on humanitarian and environmental values, as well as values of peace, unity, equality and co-operation. In chapters 4-9 I present analytically the methodology that was used, the statistical analysis, and the attained results, conclusions and limitations, followed by a final discussion. Following this, I reflect on this research and add a few more personal comments.
2. RESEARCH AIMS AND QUESTIONS

The aims of the research are manifold and they can be categorized as follows:

The first aim is to contribute to the discussion about ethics in science and technology, and raise awareness regarding the importance of students’ moral reasoning and ethical education. More specifically, we are interested in:

A) Discussing the problem caused by scientific development and technological advancement which is often caused by the lack of an ethical framework and a global perspective on behalf of scientists, funding organizations and society in general.

B) Discussing whether it is necessary and appropriate to deliberately intervene through our basic educational system (primary and secondary level) and teach students about the social responsibility of science and technology with an emphasis in humanitarian and environmental values.

C) Discussing the importance of raising critical awareness and moral reasoning in students while helping them create a conscious ethical ideology by which they will be able to make conscious decisions regarding their behavior and their place in society.

The second aim of the research is to investigate whether an ethical intervention would be possible in the form of interactive lessons, classroom discussions and group assignments. More specifically we are interested in answering the following questions:

R.Q.1 Can students’ personal ethical ideology be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

R.Q.1.b What kind of effect might the intervention cause on students’ ethical ideology?

R.Q.2 Can students’ views regarding ethics in science be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

R.Q.2.b What kind of effect might the intervention cause on students’ views regarding ethics in science?

R.Q.3 Is there a correlation between students’ personal ethical ideology and their views about ethics in science?
R.Q.3.b What kind of effect might the intervention have on the correlation between students’ personal ethical ideology and their views about ethics in science?

R.Q.4 Do students acknowledge the importance of scientists’ moral reasoning and ethical education?

R.Q.5 Do students enjoy hearing, researching and discussing about ethical issues in science and do they find it meaningful?

Paragraphs A-C were the main focus of the Theoretical Framework while R.Q.1-R.Q.5 are the research questions and the focus of the investigation that took place which is discussed in chapters 4.Research Design, 5.Quantitative Analysis, 6.Quantitative Results, 7.Qualitative Analysis & Results, and chapter 8.Conclusions & Discussion.
3. THEORETICAL FRAMEWORK

The Theoretical Framework comprises four sections that aim to contribute to the discussion regarding scientists’ ethical responsibility, and the debate over the inclusion of ethics in science in our basic educational system.

First, it seems important to call attention to the social nature of science and technology and discuss how it has affected social evolution, social norms, and the quality of life (section 3.1). Many benefits of scientific and technological progress, also cause dilemmas due to negative side effects. Such dilemmas should become clear and recognizable to students and discussions about them could cast some light on future problems that society will eventually have to deal with (energy issues, finite natural resources, environmental pollution). The aim is to raise awareness among students regarding the nature and importance of scientific ethics, and discuss how the problem of science’s negative side effects becomes more troublesome when is combined with a lack of social responsibility, environmental concern, and generally a lack of ethical consciousness on the part of some scientists, often leading them to engage in scientific misconduct.

Second, I present the main arguments for and against regarding the official inclusion of ethical matters involving science within our educational system that can be found in existing literature, and discuss possible aims for such inclusion (section 3.2).

Thirdly, it seems imperative to open a general discussion on the importance of cultivating a conscious ethical ideology with an emphasis on humanitarian and environmental values in students, which will serve not only as a basis for moral judgment, but also as a basis for a constructive reevaluation of our current social and ethical norms; something that is necessary in order to address some of the dire issues that humanity is facing (section 3.3). It is therefore important to discuss the possibility of attempting to cultivate ethical reasoning in students, possibly through a line of specialized courses within our basic educational system, instead of relying on the sole transmission of strict rules in the form of commandments and prohibitions that often do not involve critical thinking. The aim is to bring attention to the fact that scientific ethics, which is our subject matter, is a byproduct of ethical and philosophical reasoning in general, which arises from our personal world-view, our core values and our way of relating to each-other.

The problem devolves around issues related to scientific and technological advances including both their advantages and disadvantages, but which may be largely unknown or unrecognized by young people. Thus, we wish to address the point that young people
should be educated to recognize both advantages and disadvantages and weigh them in the light of a personally developed system of ethics.

3.1. Background to the Problem

While becoming the master of nature, he (man) has become the slave of the machine which his own hands built. With all his knowledge about matter, he is ignorant with regard to the most important and fundamental questions of human existence: what man is, how he ought to live, and how the tremendous energies within man can be released and used productively.

(Fromm, 1947, Man For Himself: A Psychological Inquiry into Ethics: p.2)

The last two centuries, there has been tremendous growth in scientific knowledge and technological advancement and our societies have gone through major shifts and changes through historic large-scale transitions, such as The Neolithic Revolution, The Renaissance Revolution, The Agricultural Revolution, The First Industrial Revolution and The Second Industrial Revolution (consisting of: The Atomic Age, The Jet Age, The Space Age, The Information Age as marked by the Digital Revolution), The Social Age, and finally what some like to call The Third Industrial Revolution, which is based on a renewable energy regime (Rifkin, 2011). All these transitions have picked us up and lifted us to higher spheres of knowledge and consciousness, while they have entirely affected the quality of our life and our living standards, and have continuously altered our world-view while shaping our current and future ethical and social norms. As Leslie White, former president of the American Anthropological Association, wrote in his book The Evolution of Culture: The Development of Civilization to the Fall of Rome (1959) “Social systems are determined by technological systems”, supporting that technology is the most important factor in his theory of socio-cultural evolution. Considering that the technological advancements progress at an almost exponential rate, it is fascinating trying to foresee the shifts and major transitions that our civilization will go through in the near and far future and to try and prepare ourselves for these changes as well as for the risks that they may entail.

Already in 1964, Nikolai Semenovich Kardashev, Russian astrophysicist and deputy director of the Russian Space Research Institute of the Russian Academy of Sciences in Moscow, created and proposed a scale, known as the Kardashev scale, to classify civilizations (terrestrial or extraterrestrial) measuring their level of technological advancement, based on the amount of energy a civilization is able to utilize (Kardashev, 1964). The scale has three main categories, namely Type I, Type II and Type III. A Type I civilization harnesses the energy output of its home planet, Type II harnesses all the energy output of its star and Type III the energy output of its galaxy. Kardashev’s work is hypothetical and highly speculative as it attempts to rank other civilizations in the
universe which may be millions or billions of years ahead and away from us. However it does help us acquire a cosmic perspective in regard to the energy consumption of a civilization and it has inspired a number of other scientists to explore the possibilities that lay ahead of us regarding future technological growth and the energy problem of our time which may form a barrier to our progress (Dyson (1966); Sagan (1973); Borowski (1987); Barrow (1998); Kaku (2005)). Dr. Michio Kaku, theoretical physicist and co-creator of String Field Theory\(^6\), discusses the subject extensively and analyzes the methods of energy utilization of each Type (Kaku, 2010). For example Type I, which would be considered *planetary*, would make use of wind and hydroelectric power as well as fractions of solar power, and it would harness energy by manipulating powerful weather phenomena as it would be able to control the weather and other planetary energies such as hurricanes or volcanoes which can release the energy of hundreds of hydrogen bombs. Type II, which would be considered *stellar*, would utilize all the energy of its star including the harnessing of the energy of solar flares, and Type III, which would be characterized as *galactic*, would extract energy by hundreds of billions of stars. Type III civilization could also potentially harness the Planck energy, the energy at which space and time become unstable. Therefore, even though many scientists are doubtful, one cannot rule out the possibility of an advanced civilization attaining enough energy to go beyond Special Relativity to General Relativity and quantum theory, breaking the light barrier and destabilizing space and time achieving interstellar travel (Kaku, 2010).

For non-physicists, all this may sound like reading the cover of a good sci-fi book, but the truth is that most, if not all, of our current technological achievements were once viewed with skepticism, and considered to be nothing more than science fiction tales. Kardashev, Sagan, Kaku and other scientists have calculated based on energy consumption formulas that we are nowhere to be found on the scale described above, as we are still a *Type 0* civilization, since we still extract our energy mostly from dead plants (oil and coal). However, we are beginning to see the first signs of this major transition through the latest shift to renewable energy resources, such as wind, solar, geothermal and hydroelectric power harnessing, as well as the latest trends in Geoengineering.\(^7\) Furthermore, we are currently witnessing the first signs of harnessing and modifying weather phenomena, all of which is described in detail in the research paper “Weather as a Force Multiplier: Owning the Weather in 2025”, produced by the Department of Defense and presented to the U.S. Air Force already in 1996 (House et

\(^6\) A branch of String Theory

\(^7\) The field of study which focuses on climate engineering, or else, climate intervention. “The deliberate large-scale manipulation of an environmental process that affects the earth's climate, in an attempt to counteract the effects of global warming," As defined by the Oxford English Dictionary.
al., 1996). Kaku estimates that with an average growth rate of about 3% per year, our civilization may attain Type I status in about 100-200 years, Type II status in a few thousand years, and Type III status in about 100,000 to a million years. It may sound a lot to us now, but it’s quite minimal compared to the time-scale of the universe itself (Kaku, 2010).

Being so close to making the transition from Type 0 to Type 1 civilization and with such tremendous advancements within our reach, we need to take into account all aspects relevant to this shift as well as the problems and difficulties that go alongside. As Kaku underlines, a common apprehension is that this transition is the most dangerous one, as we already hold in our hands enormous capabilities ranging from creating life anew to obliterating life altogether using weapons of mass destruction. As humans, we may have matured in regard to our technological advancements but we are still quite juvenile when it comes to our collective thinking, we can therefore be compared to a child playing with a supersonic weapon. Kaku, who has written and discussed extensively on the subject, supports in his book Physics of the Future (2011) as well as in a number of interviews that,

*The generations that are alive today are the most important generations ever to walk the surface of the Earth because we are the ones who will determine whether we make the transition to a planetary civilization or whether we destroy ourselves because of our arrogance and our weapons.*

As Kaku further explains, scientists fear that if we are not seeing any signs of other advanced civilizations, it may well be because they didn’t manage to make it through this transition. This is a problem that we are facing now for the first time as a global community since it’s the first time that we have been given so many capabilities to consciously shape the course of the future. However, it is still unknown whether we are able to use them for our collective benefit and not for our self-destruction. Theoretical physicist Stephen W. Hawking talked about this in one of his lectures when he said “It is not clear that intelligence has any long-term survival value” (Hawking, Life in the Universe, 1996).

The consequences of the aforementioned technological transitions and changes have not only been restricted to our societies as humans and dominant species of our planet. The side-effects of human progress have had a major impact on a global scale on the environment and all living beings. Problems have included:

- The somewhat recent shift from coal and steam engines to oil and fuel has had a tremendous impact on the population increase and on the production growth but has also inflicted a considerable burden on the atmosphere (Meetham, (1956); Candelone et. al (1995)).
• The shift to oil has involved several environmental disasters due to oil spills (Toscano, 2010), such as in the Gulf of Mexico in April, 2010, one of the largest ones ever recorded and with still unknown current and future environmental implications (Kinver, 2011).

• The effects of air pollution, such as vitamin D deficiency (Agarwal, 2002), coming from megacities and industrialized areas are seriously affecting people (Molinaa M. J. & Molinaa L. T., 2004), as well as causing climate changes on an urban, regional and global level (Wellburn (1994); Qun Xu (2001); Ramanathan & Feng (2009)).

• Increase in population and consumption have also had an effect on the animal consumption rhythm, which, combined with economical reasons such as profit maximization, has in some cases led to unhealthy methods of animal production, causing severe illnesses such as the dioxin poisoning of animals in Germany in 2011 which caused many deaths and health disorders, as well as the famous Bovine Spongiform Encephalopathy (BSE), commonly known as the mad cow disease, which had many human casualties and led to the slaughtering of 4.4 million cattle during the eradication process (Brown, 2001).

• Population growth and increase of demand in animal products has caused many species to be on the verge of extinction, and has been detrimental to fish population dynamics worldwide (Beyer, 1981). This has also caused problems regarding waste disposal, including toxic waste which is highly hazardous to all life forms. In several cases, toxic waste has been associated with birth defects, leukemia and other forms of cancer, and other extensive adverse health effects, both physical and mental, as we read in No Safe Place: Toxic Waste, Leukemia, and Community Action (Brown & Mikkelsen, 1990) and other literature (Vrijheid, 2000).

• The creation of the atom-bomb, which was thought to be salutary after WWII, followed by extensive nuclear testing around the world affected the health of the atmosphere, the ocean, the soil and the underground water supply. This, along with the creation and use of weapons of mass destruction (since the bombing of Hiroshima and Nagasaki in 1945), led to global concerns from scientists, politicians and environmentalists.

• The discovery of nuclear energy might have provided solutions to the energy problem in several areas through the construction of power plants, but it has also included the risks of nuclear disasters due to occasional accidents, Chernobyl and Fukushima being only 2 out of a long list of nuclear and radiation accidents recorded (BBC World News, September 12, 2011). An associated
problem is that of radioactive waste disposal (Withersoon (1991), Ahearne (1997)).

Considering all these cases, it becomes clear that though technological advancements and progress may have inarguably benefited our societies and the population, they have also caused some serious concerns. Another important aspect of the problem is that the benefits of science and technology are visible mostly in certain areas affecting only a part of the global population, i.e. mostly in developed countries, while in many other parts of the world a large number of people including children, are dying daily from malnutrition or preventable illnesses due to lack of food, clean water and adequate medication. At the same time, even inside developed countries, access to scientific and technological advancements seems to be largely based on economic factors, often excluding a part of the population from sharing the benefits. Yet, the consequences of environmental pollution as well as the potential threat of a nuclear war, affect every person and living being on the planet as well as the future generations.

It must be noted, that concerned scientists have raised their voices in an attempt to educate the public regarding the dangers that some of our achievements entail, as they considered it their moral obligation to share their concerns which arise from their unique understanding of the potential consequences. For example, Albert Einstein wrote a telegram to the American public in 1946 which was published under the headline Atomic Education Urged by Einstein (The New York Times, May 25, 1946). In his telegram, Einstein pleaded for contributions to a fund of $200,000 to carry on a nationwide campaign in order to “promote new type of essential thinking” and he urged people to understand that “a new type of thinking is essential if mankind is to survive and move toward higher levels”.

*Often in evolutionary processes a species must adapt to new conditions in order to survive. Today the atomic bomb has altered profoundly the nature of the world as we know it, and the human race consequently finds itself in a new habitat to which it must adapt its thinking [...] Today we must abandon competition and secure cooperation. This must be the central fact in all our considerations of international affairs; otherwise we face certain disaster. Past thinking and methods did not prevent world wars. Future thinking must prevent wars.*

Einstein realized that acknowledging the danger is only a part of the solution. The key lies in transforming the way humanity perceives the world and consequentially, the way it handles interpersonal and international affairs, replacing competition with cooperation and replacing nationalistic chauvinism with a more global perspective. Or as Fromm (1947) would have it, we still need to learn “how the tremendous energies within man can be released and used productively” instead for our self-destruction. Other scientists have also taken action based on their concerns. To illustrate the latter,
the Pugwash conference and the Russell-Einstein Manifesto (July 9, 1955) was a collective attempt by scientists of the time to educate the public and governments around the world about the risks humanity is facing if we persist on the development and use of weapons of mass destruction.

These scientists considered it their moral responsibility to take action and begin a campaign in order to inform people regarding all these new technological capabilities and the need for a new way of thinking that seemed imperative. Furthermore, some scientists, like Joseph Rotblat, winner of the Nobel Peace Prize in 1995, completely abandoned their highly admirable and respected work, which was related to the development of nuclear weapons, to join the campaign against the creation and use of weapons of mass destruction. Therefore, while many may support that ethics is foreign to and inapplicable to science (e.g. David Hume (1711-1776), Hall (1999), Donnelly (2002)), Einstein, Rotblat and others, portray a different perspective regarding the moral and social responsibility of science. Through the process of scientific and technological evolution, the notion of “morality in science” seems to become more relevant and perhaps in some cases vital to our discussion.


> As our own species is in the process of proving, one cannot have superior science and inferior morals. The combination is unstable and self-destroying.

### 3.2 Scientific Ethics

It’s almost 60 years since the Russell-Einstein Manifesto was written and signed and neither the achievements nor the dangers have stopped. The old problems of air, water and ground pollution, climate change, waste disposal, and animal population dynamics as well as the immediate or long term effects on humans, remain. Science has made tremendous progress in many fields such as biology, genetics, chemistry as well as computer science. Unfortunately, some research has found solutions that could also be used as chemical or biological weapons which could affect major parts of a nation’s population or even cause a pandemic if used for bio-warfare or bioterrorism. Such research is referred to as dual-use. For many scientists, creations emanating from dual-use...
use research are a cause of ethical concern which should not be neglected (Ebright, Wheelis and Keim, in Enserink 2011).

One such case of dual-use research concerns H5N1, an avian flu virus which was genetically altered a couple of years ago by Ron Fouchier, virologist of Erasmus Medical Center in Rotterdam, in order to be easily transmissible to mammals including humans. This has triggered a long and serious debate regarding scientific freedom, since, as Martin Enserink maintains, “if it emerged in nature or were released, it would trigger an influenza pandemic, quite possibly with many millions of deaths [...] it could change world history if it were ever set free” (Science Insider, 2011). Some, like biodefense and flu expert Michael Osterholm, support that these studies are very important because they provide the scientific community with valuable knowledge, while others, like Richard Ebright, molecular biologist at Rutgers University who has a strong interest in biosecurity issues, openly stated: "This work should never have been done". The virus could escape from the lab, or fall into the hands of bioterrorists and/or rogue nations who could use the published results to manufacture a new weapon of mass destruction. The study was reviewed by the U.S. National Science Advisory Board for Biosecurity (NSABB), in order to decide whether results should be published or whether certain key details should be omitted. "We don't want to give bad guys a road map on how to make bad bugs really bad" Osterholm said. Retired arms control Mark Wheelis of the University of California, Davis, wrote to Science Insider, “This is a good example of the need for a robust and independent system of PRIOR review and approval of potentially dangerous experiments [...] Blocking publication may provide some small increment of safety, but it will be very modest compared to the benefits of not doing the work in the first place.” Some scientists go even further, claiming there should be an international review system in order to pre-approve such research of extreme concern which could have global consequences. NSABB chairman Paul Keim agrees.

The process of identifying dual-use of concern is something that should start at the very first glimmer of an experiment. You shouldn't wait until you have submitted a paper before you decide it's dangerous. Scientists and institutions and funding agencies should be looking at this. The journals and the journals' reviewers should be the last resort. (Enserink, 2011).

When we begin to discuss about international prior-review systems and scientific freedom we are clearly entering the extremely interesting, however highly debatable, field of scientific ethics.

Scientific ethics, defined as the standards of conduct for scientists in their professional endeavors, covers a broad swath of activities from issues handled by White House advisory groups on topics such as the use of human subjects in research, [...] to one-on-one mentoring in individual laboratories [...]
whether or not to use fetal tissue in research to the appropriate role of private sector sponsorship of academic research.

Patricia A. Bolton (Chapter 16: Scientific Ethics, 2002)

Though the concept of “ethics in science” may be debatable, however, there is a wide range of issues that the scientific community faces every day, and a large part of scientific progress, but also social evolution, depends on the ethical decisions that are being made in connection to these issues.

Bolton recognizes two types of ethics related to science that will play a key role in our discussion:

- Ethics of the method and process (integrity): This addresses the process of conducting and reporting science and it describes the nature of the design, the experimental procedures, and the reporting of the research effort. Integrity is crucial because trust among scientists and between scientists and society is vital, while the reporting of the process is important so other scientists can replicate the experiment and evaluate the research.

- Ethics of the topics and findings (morality): This deals with the question of whether science is good or bad in specific areas, for instance when animal or human subjects are involved, or it may raise ethical dilemmas to scientists if there is a high potential of harm related to their research (e.g. dual-use research).

Scientific integrity is considered vital and necessary in science and is commonly accepted by the scientific community, and it has been the core of interest and discussion among scientists and philosophers of science for many centuries, even millennia (as far back as classical antiquity). The interest in scientific integrity is also reflected within our educational system, as most (if not all) science-based courses at secondary level and perhaps even at primary level, make use of lab experiments and written projects in a way as to teach students the process of proper scientific conduct. Especially at university level, science students receive more formal training regarding research integrity and acceptable scientific conduct. Yet, there seems to be a lack of interest in issues of morality reflected in our current educational system, where there seems to be no real encouragement of any philosophical discussion regarding morality in science. The expectation is that all students learn the rules of integrity through lab experiments, written reports or some form of practical training involving the scientific method before they graduate. We would expect that if society considered it important, students would also receive a formal ethical education regarding the moral aspects of science and the ethical dilemmas that many disciplines raise. Unfortunately, only few
schools and universities give their students the opportunity to consider the importance of ethical values and moral reasoning (e.g. universities such as Harvard, Stanford, and others), but these appear to be only in the form of specialized, optional courses. Consequently, some share the fear that “morality is reduced to secondary consideration without serious debate” and that perhaps the main reason is that more than often “ethical issues appear to be at odds with scientific agendas” (Andrew & Robottom, 2001).

Regarding a general ethical code for science, the National Academy of Sciences (On Being a Scientist, 2009) states, “Research is based on the same ethical values that apply in everyday life, including honesty, fairness, objectivity, openness, trustworthiness, and respect for others.” According to the guide, researchers have three sets of ethical obligations that motivate their adherence to professional standards:

- “First, researchers have an obligation to honor the trust that their colleagues place in them. Science is a cumulative enterprise in which new research builds on previous results. If research results are inaccurate, other researchers will waste time and resources trying to replicate or extend those results. Irresponsible actions can impede an entire field of research or send it in a wrong direction, and progress in that field may slow. Imbedded in this trust is a responsibility of researchers to mentor the next generation who will build their work on the current research discoveries.”

- “Second, researchers have an obligation to themselves. Irresponsible conduct in research can make it impossible to achieve a goal, whether that goal is earning a degree, renewing a grant, achieving tenure, or maintaining a reputation as a productive and honest researcher. Adhering to professional standards builds personal integrity in a research career.”

- “Third, because scientific results greatly influence society, researchers have an obligation to act in ways that serve the public. Some scientific results directly affect the health and well-being of individuals, as in the case of clinical trials or toxicological studies. Science also is used by policy makers and voters to make informed decisions on such pressing issues as climate change, stem cell research, and the mitigation of natural hazards. Taxpayer dollars fund the grants that support much research. And even when scientific results have no immediate applications—as when research reveals new information about the universe or the fundamental constituents of matter—new knowledge speaks to our sense of wonder and paves the way for future advances.”

Such codes of ethics that describe the members’ responsibilities can be found in several groups such as the medical society (referring to the Hippocratic Oath), the Forest Service
Research & Development Code of Scientific Ethics (USDA, 2002), or the chemists’ society which uses the Chemists’ Code of Conduct (American Chemical Society, 1994), which is presented below:

Chemists Acknowledge Responsibilities To:

• The Public

Chemists have a professional responsibly to serve the public interest and welfare and to further knowledge of science. Chemists should actively be concerned with the health and welfare of co-workers, consumer and the community. Public comments on scientific matters should be made with care and precision, without unsubstantiated, exaggerated, or premature statements.

• The Science of Chemistry

Chemists should seek to advance chemical science, understand the limitations of their knowledge, and respect the truth. Chemists should ensure that their scientific contributions, and those of the collaborators, are thorough, accurate, and unbiased in design, implementation, and presentation.

• The Profession

Chemists should remain current with developments in their field, share ideas and information, keep accurate and complete laboratory records, maintain integrity in all conduct and publications, and give due credit to the contributions of others. Conflicts of interest and scientific misconduct, such as fabrication, falsification, and plagiarism, are incompatible with this Code.

• The Employer

Chemists should promote and protect the legitimate interests of their employers, perform work honestly and competently, fulfill obligations, and safeguard proprietary information.

• Employees

Chemists, as employers, should treat subordinates with respect for their professionalism and concern for their well-being, and provide them with a safe, congenial working environment, fair compensation, and proper acknowledgment of their scientific contributions.

• Students

Chemists should regard the tutelage of students as a trust conferred by society for the promotion of the student's learning and professional development. Each student should be treated respectfully and without exploitation.

• Associates
Chemists should treat associates with respect, regardless of the level of their formal education, encourage them, learn with them, share ideas honestly, and give credit for their contributions.

- Clients

Chemists should serve clients faithfully and incorruptibly, respect confidentiality, advise honestly, and charge fairly.

- The Environment

Chemists should understand and anticipate the environmental consequences of their work. Chemists have responsibility to avoid pollution and to protect the environment.

It is perhaps notable that chemists’ responsibility towards the public goes first on the Code list. However, responsibility towards the environment goes last and that may reflect a lack of understanding of the true level of humans’ dependence upon the environment, however, it is very important that it has been included. Perhaps some might advocate that a clear cut code such as the above is unnecessary, firstly because moral obligations are a matter of personal taste and should not be included, and secondly because integrity is somehow embedded in all scientists. It is what David Goodstein, Physicist and former Vice-provost of the California Institute of Technology, calls the Myth of the Noble Scientist (section 1.1), which arises from the view that all scientists are innately honest and objective and not prone to human errors such as pride, prejudice or career pressure and antagonism (Academe, 2002). This is also the view which dominates the largely erroneous idea that scientific fraud and misconduct is very uncommon. However, as we can see in Figure 3.1, scientific misconduct seems to be “on the rise”. Here underline that the chart is only indicative as these are only the cases that have actually been reported to the Office of Research Integrity (ORI), it is therefore impossible to know the total amount of scientific fraud. It should also be noted that allegations are like claims in being not proven.
At this point, it becomes evident that scientific misconduct is an issue that requires our immediate attention as the above bar chart portrays a steady increase in the total number of cases of scientific fraud. In order to address this problem, it is important to understand its source and origins and consider the serious effects it may have on scientific progress and in some cases the public.

### 3.2.1 Scientific Misconduct

The U.S. Government, as quoted by the National Academy of Sciences (On Being A Scientist, 2009), defines misconduct as “fabrication, falsification, or plagiarism (FFP) in proposing, performing, or reviewing research, or in reporting research results.”

Anderson, Ronning, De Vries and Martinson (2007) in their study analyze group discussions with 51 mid- and early-career scientists, which reveal a dark side of competition in science. “According to these scientists, competition contributes to strategic game-playing in science, a decline in free and open sharing of information and methods, sabotage of others’ ability to use one’s work, interference with peer-review processes, deformation of relationships, and careless or questionable research conduct.”
Another type of scientific misconduct is scientific negligence. In such cases scientists provided erroneous information but did not have the intention of deceiving, they themselves were “fooled” as well.

The journal *Nature* published a study in which 3,247 scientists who had been funded by NIH (National Institutes of Health) responded to questions regarding all kinds of ethical misconduct in which they might have engaged while conducting scientific research. The results are rather disturbing (Figure 3.2).

![Figure 3.2. Percentage of NIH funded Scientists Who Say They Have Engaged in Ethical Misconduct (from Nature, 435, June 2005: p. 737)](image)

Despite the fact that if a scientist is caught he/she, his/her career and his/her institution, organization, or firm might suffer from severe sanctions, still, we can see that many researchers engage in wrongful scientific conduct. David Goodstein (Academe, 2002) mentioned several potential motivations of scientific misconduct which are summarized below with some additional ones:

- **Pressure**: Most if not all scientists have a lot of pressure in their careers, either because they are trying to build a strong reputation and publish prestigious papers to be in a position to request support and funding for their research, or because they are competing against time to get results before another scientific team conducting the same experiment somewhere else. In general the scientific community is a highly competitive one, where scientists often either publish or
perish. Interestingly enough, examining Figure 3.2 further, it becomes apparent that scientists are often under a great deal of pressure from their funding sources, which is rather disturbing, especially when it comes to studies related to the pharmaceutical and medical industry, the food industry, the oil industry or telecommunications.

- **Knowing the answer/Laziness:** Usually laziness can make scientists falsify data not because they want to harm the scientific body of knowledge, but because they believe a fact to be true and they do not want to go to the trouble to prove it. They honestly believe they knew the answer.

- **The ability to get away with it:** Falsifying and fabricating data is not that common in sciences like physics, astronomy or geology, but mostly in the biomedical sciences. Goodstein (Academe, 2002) discussed a study by Princeton sociologist Patricia Woolf of twenty-six cases of alleged misconduct that surfaced between 1980 and 1986. That study revealed that twenty-one came from the biomedical sciences, two from chemistry and biochemistry, one from physiology, and two from psychology. According to Goodstein, the reason is mainly because in the biomedical sciences results are rarely precisely reproducible, and due to biological variability the same procedure, performed on two organisms as nearly identical as possible, is not expected to give exactly the same results. That of course can be perceived as a window of opportunity for those who want to cheat.

- **Money:** Monetary gain can also be the reason for falsifying or fabricating data, even though Goodstein supports that simple monetary gain is seldom the reason. However, it does remain a potential motive.

- **Ideology:** Finally, scientists might choose to be dishonest because of a specific ideology they hold. For example, a scientist might be tempted to sabotage research on human embryonic stem cells due to personal beliefs.

From this we can see that scientists can have several motivations for going against their professional ethics; these can be very hard to fight against, for instance when there is a conflict between their professional and personal ethics, e.g. the case of stem cell research. The internal moral conflicts between scientific principles and religious or other personal values can be extremely difficult to deal with, especially if scientists never learned to anticipate them. Young researchers should be made aware that possible emotional or psychological barriers might be encountered along the career path of any scientist. Moral dilemmas arise when there is no clear answer as to the moral priority of a person. For example, a moral dilemma might arise between the first two obligations of scientists as described by the NAS, which are clearly related to integrity (1. Scientists’
obligation towards their colleagues, and 2. Obligation towards themselves), and the third obligation (3. Obligation to act in ways that serve the public) which leaves room for a lot of discussion as it is rather vague. As an extreme hypothetical example, if a scientist were to discover that a specific gene which may cause extreme violent behavior is found in all Asian people, should he/she publish his/her results leaving room for another global wave of social racism? Or should the results be concealed? Or should this scientist have never begun such research in the first place? Even though there is still a strong debate regarding the role of ethics in science and what it should entail, the third obligation (NAS) seems to be directly related to morality as defined by Bolton. There is a problem therefore when scientists do not receive the encouragement or necessary formal training they need in order to consider it as their professional obligation to ponder moral issues when making important decisions. And the ones that do, based on personal beliefs, might lack the confidence to make decisions regarding what is best for the public as they have not been prepared for it. Perhaps a formal ethical education combined with high level of critical thinking and a clear cut code of ethics describing the priorities and obligations of scientists (including both issues of integrity and morality) is missing.

3.3 Teaching Students about Ethics in Science

*It is vital that when educating our children’s brains that we do not neglect to educate their hearts.*

The Dalai Lama

It has been argued for quite some time now, that the science curriculum should include more issues related to science. According to Reiss (1999: p.122), some proposed aims for science education so far have included: education for economic productivity (National Academy of Sciences, 1995), education for scientific literacy (American Association for the Advancement of Science, 1993; Power, 1994; National Academy of Sciences, 1995; Gräber and Bolte, 1997; Hodson, 1998), education for the public understanding of science (Solomon & Thomas, 1999), education for democracy (Millar, 1997; Longbottom & Butler, 1999), education to enable students to grow as persons (Reiss, 1999a), education for citizenship (Layton et al., 1993; Irwin & Wynne, 1996; Hurd, 1997), education to better the world (Roth & Lee, 2002) and education for resistance against injustice (Barton, 1998).

According to Solomon (1993), the whole science and technology in society movement (STS\textsuperscript{10}) has greatly affected the school science curriculum and science is now more likely

\footnotesize{10 STS focuses on how social, cultural and political values affect scientific research and technological progress, and how these, later on, affect society, culture and politics. STS scholars are interested in a}
to be taught within a social context (Campbell et al., 1994). At the same time, many suggest that students should be taught something about the nature of science (Millar & Osborne, 1998; Eflin, Glennan & Reisch, 1999, in Reiss, 1999). These arguments stem from the fact that there seem to be considerable limitations in students’ understanding of the purpose and conduct of science. “The Development of Pupils' Understanding of the Nature of Science”, a research study which was conducted in England and focused on young students’ understanding of science, concluded the following (Driver et al.,1996, in Reiss 1999: p.116):

- “Pupils tend to see the purpose of science as providing solutions to technical problems rather than providing more powerful explanations.”
- “Pupils rarely appreciate that scientific explanations can involve postulating models. Even when they do, models are presumed to map onto events in the world in an unproblematic manner.”
- “Pupils rarely see science as a social enterprise. Scientists are seen as individuals working in isolation.”
- “Pupils have little awareness of the ways that society influences decisions about research agendas. The most common view is that scientists, through their personal altruism, choose to work in particular problems of concern to society.”

Many are the proponents of ethics, too, being added to science education, and specifically the aspects that fall under the term morality as was defined earlier (section 3.1.1), since most aspects of integrity are widely acceptable and promoted already through our educational system (e.g. Maxwell, 1984; Newton, 1988; Wakeford & Walters, 1995; Reiser & Bulger, 1997; Toulouse, 1999; in Reiss, 1999), while many well known scientists have made tremendous efforts to raise awareness regarding the importance of scientists’ personal ethics and their social responsibility, or the focus of their work has simply reflected their personal beliefs (e.g. Andrei Sakharov, Nikola Tesla, Joseph Rotblat, Albert Einstein and others). The Einstein-Russell Manifesto (section 3.1) is a good example of scientists collectively raising their voice against the misuse of scientific knowledge and the dangers such misuse might entail, (nuclear power in this case), urging people and their governments to end their quarrels without the use of destructive force. Such mobilization can be motivated only by strong humanitarian ideals and a deep ethical consideration regarding the potential effects of science on humanity and the planet.
There lies before us, if we choose, continual progress in happiness, knowledge, and wisdom. Shall we, instead, choose death, because we cannot forget our quarrels? We appeal as human beings to human beings: Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise; if you cannot, there lies before you the risk of universal death.

(Russell-Einstein Manifesto, July 9th, 1955):

While some might claim that ethical considerations are more relevant today due to the tremendous capabilities science has provided us with, the truth is that the moral aspects of science, since its very early steps, have intrigued some of the greatest minds in recorded history. Indeed, it was Plato (424/423 – 348/347 BC) who said already in classic antiquity that all forms of science are turned into cunningness, not wisdom, when they are separated from justice and other virtue (Plato, Menexenus, 247a).

However, not everyone acknowledges the relation between science and ethics (again our focus is on morality) and many are those who would protest against the inclusion of ethics in science education. Whether ethics is embedded in science and whether students should be educated about it is the next subject of debate, where we present and discuss in short the main arguments in favor and against such inclusion. First however, if we were to implement issues of ethics within the science curriculum, one would have to analyze and evaluate the possible aims of such inclusion.

Below is a description of the goals science educators should aim at when teaching students at school level (but also university) about ethics in science, followed by a discussion of the main arguments for and against.

3.3.1 Teaching Aims

In teaching students about ethics in science, the primary aim for most science educators would be students’ understanding of the scientific method, as it requires in itself the fulfillment of certain ethical obligations, i.e. to be objective, honest and truthful, to give proper acknowledgment to contributors and make good use of references. In addition, as Bertrand Russell and Karl Popper would stress, one of the most important ethical responsibilities of intellectuals in regard to integrity, is to express oneself as simply and clearly as possible, for simplicity allows for better understanding and gives room for constructive criticism (Koertge, 2008). The ethical norms surrounding the conduct and reporting of research are of great importance and that is why many journals dedicate a great deal of space to issues such as scientific fraud, cases of fabrication or falsification, as well as acknowledgment of the contributions of co-authors and the appropriate citation of others’ work (e.g. the Journal of Science and Engineering Ethics). However, it
seems that there is little here that is specific to science, and by itself vital to someone still in compulsory education.

The ethical obligations of scientists, regarding how they conduct and report their research, in other words their integrity regarding the scientific method, are important, but then so are those of social scientists, such as sociologists, psychologists, historians and others. So the focus should not be solely placed on issues of integrity, but should include aspects of morality as well that are directly related to science. Inspired by Davis (1999) and Reiss (1999), at least eleven teaching aims can be suggested:

1. Teaching ethics in science should help increase the ethical knowledge of students. Students would become familiar with different ethical schools and ideologies, as they would get to hear about different types of moral philosophies and their important contributors, ranging from Plato and Aristotle, to Immanuel Kant and David Hume. The argument supporting this aim is the same as in learning any new knowledge that can be judged as useful or valuable.

2. Teaching ethics in science should help students improve their moral judgment. As Davis (1999) explains when writing about an ethics course at university:

   *The course might, that is, try to increase the likelihood that students who apply what they know about ethics to a decision they recognize as ethical will get the right answer. All university courses teach judgment of one sort of another. Most find that discussing how to apply general principles helps students to apply those principles better; many also find that giving students practice in applying them helps too. Cases are an opportunity to exercise judgment. The student who has had to decide how to resolve an ethics case is better equipped to decide a case of that kind than one who has never thought about the subject.* (p. 164-5)

3. Teaching ethics in science should aim to heighten the moral sensitivity of participants. The example that Davis (1999) chose is that of a chemistry teacher that urges students to consider what would happen to heavy metal ions, such as those of lead, if they were poured down school laboratory sinks.

4. Discussions on the positive and negative effects of science and technology should encourage students to contemplate on the overall purpose of science and consider the level of social responsibility arising from scientist’ work. Students should focus on questions regarding science’s priorities. For example, is the purpose of science to serve and help people and therefore give priority to humanitarian goals, or is our purpose as people to serve science and be ready to sacrifice our humanitarian values in the pursuit of knowledge?
5. A consequent aim should be to help students understand and appreciate the dependence of humans on other species and on the environment.

6. The fifth aim is in conjunction with the aim to create a holistic view (the understanding that a system may have properties over and above those of its parts and its organization) towards Earth.

7. Aims 5 and 6 would help students learn how to better evaluate the consequences of science’s impact on a global scale.

8. In line with aims 1-7, an overall aim should be to implement strong humanitarian as well as environmental values. Discussions on ethics in science could be a good way to implement such values by presenting and analyzing cases where those values are absent. Students should also be presented with cases where the importance of scientific contribution for the betterment of humanity is clear and be used as an inspiration. There are many examples of scientists who recognize and advocate the importance of humanitarian values in science, but the remark of Nikola Tesla, physicist, inventor, futurist and one of the world’s most notable scientific contributors, is considered a most suitable one:

   Science is but a perversion of itself unless it has as its ultimate goal the betterment of humanity. (Tesla, 1919)

9. A further aim should be to help students learn to associate the process of scientific conduct with the democratic process, encouraging them to appreciate the process of debate with respect towards each other’s opinions and constructive criticism.

   The values of science and the values of democracy are concordant, in many cases indistinguishable. Science and democracy began - in their civilized incarnations - in the same time and place, Greece in the seventh and sixth centuries B.C. . . . Science thrives on, indeed requires, the free exchange of ideas; its values are antithetical to secrecy. Science holds to no special vantage points or privileged positions. Both science and democracy encourage unconventional opinions and vigorous debate. Both demand adequate reason, coherent argument, rigorous standards of evidence and honesty.


10. Teaching ethics in science might “make students better people in the sense of making them more virtuous or otherwise more likely to implement normatively right choices” (Reiss, 1999; p. 124). For example, a unit on the consequences of contaminated lakes, rivers or oceans, might prevent students from causing unnecessary pollution. Similarly, a unit on non-renewable natural recourses might help students understand
better the problems of over-consumption and waste disposal, and the purpose and importance of preserving methods and recycling habits, leading them to save more energy, re-use or recycle materials more.

Of course, in any attempt to teach students about a subjective matter such as ethics, one must be careful to recognize the difference between ethical education and ethical indoctrination, the former leading to the expansion of students’ worldview and open-mindedness, while the latter, which can be compared to brainwashing, could lead to narrow-mindedness and dogmatism. Thus we add a final and very important aim:

11. Teaching ethics in science should aim to promote ethical education in conjunction with critical thinking.

Moral principles do not apply themselves, they require a thinking mind to assess facts and interpret situations. (Paul, 1988)

Below is a list containing the main arguments found in literature supporting or opposing the inclusion of ethics in science education. The arguments are presented in brief and not discussed in depth; however, they serve as a necessary basis for the main dialogue.

3.3.2 Arguments in Support of Inclusion of Ethics in Science Teaching

Those with the privilege to know, have a duty to act.

Albert Einstein

According to Reiss (1999), there are two main families of arguments in favor of teaching students about ethics in science (again we take ethics to be equivalent to morality in this chapter as defined by Bolton); first has to do with the nature of science (its source and its purpose), while the other one has to do with the potential consequences of teaching about ethics in science.

Arguments 1-3 concern the nature of science:

1. All science is conducted and applied within particular social contexts.

The first argument that revolves around the nature of science, arises from the understanding that even if we consider science as “disinterested, universalist, open-minded and communal” (Merton, 1973; in Reiss, 1999; p.120), we still need to consider that the great majority of the projects being researched have been funded with the aim that certain ends will be met (e.g. production of a new medicine, or the creation of a new defense system), and therefore most if not all science is conducted and applied within specified social contexts (Fuller, 1997). These ends (purposes) reflect the
interests, the motives and the expectations of scientists, firms, organizations, governments and all funding sources, which could be criticized as good or bad, right or wrong, egoistic or altruistic. At the same time, the ends themselves can be criticized as good or bad based on their usefulness and their impact, for example, the production of a new medicine could potentially save lives, presumed to be a good thing; the design of a new defense system could help protect civilians from an invasion, presumed to be a good thing; the creation of a new kind of fabric could increase production and employment, presumed to be a good thing.

Indeed, just beginning to spell out some of the intended or presumed goods (health improvement, increased military security, etc.) alerts us to the fact that perhaps there are other ways of meeting these ends or, indeed, perhaps these ends are not unquestionably the goods that may have been assumed.

Reiss (1999: p.120)

Either way, the argument supports that moral judgment is embedded in the purpose or use of a scientific discovery or application and should not be separated, for the process of moral criticism and questioning may lead to better alternatives and better results.

2. Moral considerations in science are everyone’s concern.

Moral considerations in science are everyone’s concern, not only scientists’. Scientific dilemmas or dangers arising from scientific progress affect us all, and therefore we should not rely on and be assured by the fact that a few students subscribe to university ethics courses, especially considering that the majority of these courses are optional and not everyone chooses to subscribe to them.

3. Science topics should be more relevant to students.

A lot of what students learn does not seem to be relevant, while a lot that do seem relevant, are excluded from their education. Here is an interesting remark from Vicky, a student involved in a research study by Osborn & Collins (1999: p.6):

But still like this morning we were talking about genetic engineering, and Miss told us about this article, and how they’re going to make clones of each baby that gets born. They’re going to make a clone of it, so say if it needs a transplant, kidney transplant, or whatever, he could get it from his clone, and she didn't want to hear that it's wrong. She didn't want to know our opinions and I don't reckon that the curriculum lets them, lets us discuss it further. I mean, science is okay you can accept the facts, but is it right, are we allowed to do this to human beings?
Perhaps it is not surprising that, in our time, with the tremendous scientific breakthroughs that are taking place, it is the ethical aspects that seem to be lacking in students’ science education; yet, they are both of interest and of valid concern to them.

Arguments 4-8 concern the potential consequences of teaching about ethics in science:

4. *Discussions about ethics will raise the level of critical and reflective thinking in students.*

Such interventions as teaching about ethics in science will raise the level of critical and reflective thinking in students. Critical thinking is crucial for it allows students to recognize issues that do not seem to fit in their existing schema and to find ways to modify it in order to assimilate the new information or reject the information using a reasoning process (Selwyn & Maher 2003: p. 42). To achieve this however, researchers note that students need to be introduced to the vocabulary of critical thinking i.e. arguments, assumptions, cause and effect, compare and contrast (Wright 2002: p. 257), which is very similar to that of the scientific reasoning process. Reflective thinking, even though is often used as a synonym, is actually a part of the critical thinking process, and it focuses on analyzing and making judgments about what has already happened.

5. *Students will increase their ability to think about their thoughts.*

Similarly, students will increase their ability to think about their own thoughts, meaning increase their ability to consider the content and reflect on it, a process that Piaget (1971) called “reflective abstraction”. According to Louw (1998: p. 81):

> Reflective abstraction results in the creation of new ideas, knowledge and insights through the rearrangement of existing knowledge and thoughts. Reflective abstraction is the result of hypothetico-deduction and scientific reasoning.\(^\text{11}\)

Reflective abstraction would increase students’ ability to self-reflect and raise their level of self-consciousness and meta-cognition. Being aware of one’s own thoughts and conscious about his/her thinking process as well as his/her personal limitations and biases, gives the ability to alter his/her state of mind when he/she judges it to be false. William James (1842 – 1910), American psychologist and philosopher with many influential publications in psychology, educational psychology as well as other fields, highlighted in his lectures:

\(^\text{11}\) Scientific reasoning is the foundation supporting the entire structure of logic underpinning scientific research. It combines observation, creation, testing and modification of theories and hypothesis, making predictions, and the ability to analyze data.
The greatest discovery of my generation is that a human being can alter his life by altering his attitudes of mind. (1902: p. 95)

6. Students would exercise the use of logic, practice the skill of argumentation and learn about the diversity of opinions.

Students in exercising the use of logic (a central element both in science and philosophy), would also practice the skill of argumentation, and learn about the diversity of opinions. This may help students learn how to disagree while maintaining patience and respect towards each-other’s views, an important element for meaningful and constructive communication.

7. Expansion of students’ world-view.

Discussions and exchange of opinions would expand students’ world-view as it would provide them with new perspectives and new points of view and will allow them to see the world in ways they have never seen before.

8. Students would have a protected space within which they could decide what constitutes as “the truth”.

Finally, a course dedicated to ethics in science would be the only protected space within the school curriculum where students would be allowed to decide by themselves what constitutes “truth”, instead of being forced to accept and replicate, without questioning, the truth of others (e.g. scientific knowledge, historic knowledge etc.). This could be truly meaningful and very useful as it teaches students to take responsibility regarding the way they view the world and themselves in it.

3.3.3 Arguments Against Inclusion of Ethics in Science Teaching

The main arguments against the teaching of ethics in science either have to do with the nature of science and the nature of ethics, or with the potential consequences of such implementation.

Arguments 1-4 concern the nature of science, or the nature of ethics:

1. Ethics and Science deal with different forms of knowledge.

This first argument stemming from the consideration of the nature of ethics and the nature of science, arises from a distinction between different forms of knowledge. As David Hume (1711-1776) advocated, there is a big difference between what he called matters of fact and relations of ideas. Ethics deals with ideas while science deals with facts, and therefore, these two realms of knowledge have their ‘truth claims’ investigated in different ways and by different means. At the same time, Hume also
supported that there is no relation between what is and what ought to be; a contradiction that was later known as the naturalistic fallacy. Therefore, ethics has no place in science, as the two domains deal with different forms of knowledge; science deals with what is, while ethics deals with what ought to be. Similarly, in a protest against the inclusion of moral issues in science, Hall (1999) states:

Science is a discipline concerned exclusively with the reliability that can be attributed to factual ('is') statements as a result of empirical investigation. It is widely recognized that 'is' statements in science cannot be turned into the 'ought' statements of moral discourse. For example, science can fairly accurately judge the consequences of bringing together a number of sub-critical masses of U235 above a densely populated geographical area. It can say absolutely nothing, however, about whether such an action would be right or wrong. The answer to the latter question lies outside the domain of science, but within the remit of moral discourse. The domains of scientific and moral discourse are fundamentally different; they have different core concepts (space, time, energy and good, right, ought), difference procedural ground rules and different tests for truth. (p. 15)

2. Ethics in science can limit the research.

At the same time, some argue that when ethics is involved in science, it can limit the research as well as the achieved results. For example, Donnelly (2002) claims:

Where ethics impinges on the research practices of science, by requiring the scientist to attribute ethical status to objects of study, this attribution limits what can be known, or perhaps, more circumspectly, redirects the process, with possible impacts on the knowledge which can be achieved. [...] The claim is rather that, as scientists, they can acknowledge no intrinsic ethical status in the beings (qua scientific objects) they study, or allow any ethical status they do attribute to play a part in the reasoning processes, qua scientific, in which they engage.

(p. 139)

3. The capacity to reason morally does not guarantee a moral behavior.

An argument, that has to do more with the nature of ethics rather than with the nature of science, is that “the capacity to reason morally is no guarantee of moral behavior” (Chapman, J. (2002): p.73), a problem known also as the attitude-behavior discrepancy issue. In other words, even if we did provide students with some form of ethical education, there would be no guarantee that it would have any meaningful impact on their future behavior.
4. **Scientists will be influenced by the culture and expectations of the people within the organizations that employ them.**

Similarly, there is the belief that teaching ethics in science won’t make scientists ‘good’ (in the moral sense) because their future behavior will ultimately be influenced by the culture and expectations of the people within the firms or organizations that employ them.

Arguments 5-8 concern the potential consequences of teaching about ethics in science:

5. **Ethical education will lead to ethical indoctrination.**

A potential consequence of teaching students about ethics in science, is the danger of teachers indoctrinating students with their own particular values, as students often seek to imitate and impress their teachers.

6. **Science teachers are not educated in moral philosophy.**

Science teachers are generally educated in science, not in moral philosophy. According to Reiss (1999: p.119), trying to implement ethical issues in their curriculum might:

(a) “reduce the time they have available to teach science

(b) lead to lower quality teaching, since science teachers will be teaching outside their sphere of knowledge

(c) lead to lower levels of professional satisfaction amongst existing science teachers

(d) result in fewer science graduates wanting to enter teaching, thus increasing the shortage of science teachers that exists in many (e.g. the UK) but not all (e.g. Germany) countries.”

7. **Students will learn to argue excessively with the teachers.**

At the same time, some teachers have the fear that students will learn to argue excessively with them not only on ethical matters, but also on fact-based issues concerning science. As one science teacher commented:

> When we talk about the ethics of anything you’re going to give an opinion rather than something that’s fact based. Once you start giving an opinion then you express disagreement. Then they treat the whole of the subject in the same way that they treat your opinion in that they disagree with it personally. So they might end up treating your fact based stuff in the same manner. (Levinson et al., 1999: p. 4)

8. **Critical thinking threatens the calm of assumed amiability**
Finally, it has been argued that critical thinking “threatens the calm of assumed amiability that governs much of our interactions with one another” (Brown & Freeman, 2000), and discussions on ethics and exercises of debate within the classroom *would* aim at raising the level of critical and reflective thinking as mentioned earlier. At the same time, it’s not very common that someone wants his/her opinion or reasoning to be criticized or proven wrong.

Next, we will contrast and comment on some of the arguments for and against.

### 3.3.4 An Overview of the Arguments For/Against Teaching Ethics in Science

In this section we first explore the contrasting arguments through an overview position; we then discuss a few arguments in some detail.

The main argument concerns the differences between the nature of science and the nature of ethics, or philosophy in general. In considering this, one has to acknowledge that the aims of these two domains and their sphere of knowledge differ, at least ostensibly, because they also share some strong similarities as well. Both science and philosophy, of which ethics is a part, are attempts to make sense of the world. In the Greek origins of science and philosophy the two were often indistinguishable, and even today, the most interesting scientific questions are often philosophical or border on philosophical questions. However, even if we accept that the forms of knowledge used are different, it does not automatically mean that the two are incompatible and contradictory.

Though Hume and others claim that matters of fact arise from pure, fundamental science and not from applied science, this should not be confused with relations of ideas. Others, like Karl Popper, support that while in the past scientists were limited in their responsibility of seeking the truth with little concern for how that truth might be applied, today “this happy situation belongs in the past. Today not only all pure science may become applied science, but even all pure scholarship” (Popper 1994o: p. 121, in Koertge, 2008). According to Popper, today’s scientists should be responsible to foresee any unwanted dangerous consequences and try to counteract them. Popper called this ‘*sagesse oblige*’: anyone who is in a privileged knowledge position has extra moral obligations to warn other people of possible damage that can result from the applications or misapplications of his findings. Additionally, Popper claims that

*Ethical principles form the basis of science. The idea of truth as the fundamental regulative principle... can be regarded as an ethical principle.*
Similarly, others as in the “Agenda for Ethics Research in ‘Horizon 2020’” clearly state:  

*The research themes are not ends in themselves, but means to realising European commitments to human rights and values. These rights and values presuppose normative claims about how humans should treat one another, what makes for good society, and how responsible governments and businesses should behave.*


In other words, there appears to be an increased understanding of an inherent relationship between research agendas and ethics within science, especially in our time and age.

In Figure 3.3, we can see a representation of the different areas of science separated between fundamental (top of vertical axis) and applied science (bottom of vertical axis), and further separated based on whether ethics is applied or not, according to the arguments of David Hume and Karl Popper. Animal testing is used only as an example of cases that belong to applied science, however it stands right on the border of fundamental and applied science, since in some cases it might provide researchers with answers regardless of their potential use (pure science) while it can raise different levels of ethical considerations. The center of the diagram is called the “secure” passage, which is within specific boarders, based on Donnelly’s (2002) claim that ethics limits the research. Donnelly’s limit is depicting the size of the “secure” passage and indeed, one can say that it will slow down the development of science. But, if it the secure passage were not present it could lead to licentious developments that disregarded accepted rules and/or conventions. If the passage widens, it will cut through the misuse-area.

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12Horizon2020 is a huge combination of research and innovation programs within Europe, with nearly €80 billion of funding available, with an emphasis on excellent science, industrial leadership and tackling societal challenges within the time frame of 2014-2020. (Retrieved from http://ec.europa.eu/programmes/horizon2020).
Even though an agreement may not be reached between the two main arguments, perhaps a different approach might help people move past their basic differences.

Let us agree that science, as a theoretical entity, does not have an interest in addressing or solving ethical dilemmas in itself, as this is not its purpose. Ethical issues (as discussed here) simply arise from the potential risks and benefits that are created from the use or misuse of scientific knowledge and its (potential) applications. Once those issues are recognized, they should be analyzed and discussed in a rational manner that includes ethical considerations, so as to address the problems raised. It therefore seems important to try to cultivate ethical reasoning to help humans evolve and progress further in harmony with each other and the environment. This can be started through education. It is notable regarding the latter, that the European Union shares a similar understanding, by strongly promoting the idea of ethics being included within their biggest EU Research and Innovation program, Horizon2020. More specifically, a detailed statement has been compiled by LERU (League of European Research Universities), titled “Agenda for Ethics Research in ‘Horizon 2020’”, which highlights ethics as an essential element in the success and scientific quality of Horizon 2020. According to the statement:

Figure 3.3. The different areas of science based on the level of ethical applicability according to the arguments discussed above presented through Hume and Popper (van Inge, 2012).
Ethics offers the theoretical and practical tools to deal with the role of values in scientific and societal challenges. In this way ethics plays a crucial role in fostering responsible research and innovation.

(Retrieved from www.leru.org)

We turn to discussing a few arguments in more detail.

Ethics in science can limit the research: Donnelly’s (2002) claim that when ethics is involved in science it can limit both research and results may be true in some cases, for example, due to ethical considerations human cloning has not been sufficiently studied (a case where scientific freedom is an issue). Similarly, it is not acceptable to conduct medical (or psychological) research on human beings without their consent. In cases where this has occurred, it has raised a number of ethical issues on whether other scientists should make use of results that were obtained through “inappropriate” conduct. The infamous cases of Joseph Mengele\(^{13}\), and Shiro Ishii\(^{14}\), portray clear examples of scientists who clearly disregarded any moral considerations or humanitarian values related to science. Eventually, both scientists were prosecuted as war criminals after the end of WWII\(^{15}\), showing that the world community does not accept scientific progress at such high “cost”. Looking at the potential consequences of scientific conduct without ethical considerations, it becomes apparent, that science does need to make use of some moral boundaries even if that stands in the way of scientific progress. It all boils down to whether society considers the protection of human rights and dignity its priority, against an endless quest for the truth. Eventually, this is the core of the question of whether science’s purpose is to serve people or whether people’s purpose is to serve science.

Attitude-behavior discrepancy: “The capacity to reason morally is no guarantee of moral behavior” (Chapman, 2002). This is known as the attitude-behavior discrepancy.

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13 Joseph Mengele (1911-1979), also known as the Angel of Death, was a German SS officer and a physician in the Nazi concentration camp Auschwitz. He became mostly famous for his human experiments on camp inmates, with a particular interest in heredity. He practiced many of his experiments on twin children while most of his patients died during the procedure, as there was no anesthetic used, or from infections afterwards (Miklos, 1993).

14 Lieutenant Shiro Ishii (1892-1959) was a famous Japanese microbiologist at the Unit 731 who worked on developing biological weapons. Historical records show that Unit 731 experimented on more than 10,000 prisoners of war and civilians from China, the Korean Peninsula, Mongolia and the former Soviet Union (Xinhua, The China Daily, 2003).

15 However, Mengele fled to South America to escape, and Ishii was given immunity by the United States in exchange for his work results which they regarded “absolutely invaluable” considering that “the information was obtained fairly cheaply” (BBC Horizon, 1984).
problem. No training or schooling can guarantee an ethical behavior by an individual, not even on behalf of those who strongly advocate strict ethical rules (e.g. deontologists\textsuperscript{16}). Much in the same way, the capacity to reason mathematically does not guarantee a successful solution to a mathematical problem, but, it greatly increases the possibility. Society values mathematical reasoning in itself, even though many students will hardly ever make use of difficult mathematics in their career, if any at all. However, all people do come across ethical dilemmas and make use of moral judgment daily throughout their lives, so it seems important to value ethical reasoning enough to invest time and energy in educating people. Maya Angelou, author named by the \textit{Ladies’ Home Journal} as one of the 30 most powerful women in America because of her important role in the American Civil Rights Movement (Lupton, 1998), strongly supported that

\textit{When you know better, you do better}

Chapman (2002) was specifically interested in the teaching of ethics in undergraduate legal education, however, some of her arguments seem quite appropriate for scientists as well as lawyers. Chapman underlines that an ‘ethical sense’ is necessary for lawyers because of their power, their specialized knowledge and their role in the justice system, and for lawyers’ own job satisfaction. Similarly one may argue, an ethical sense is necessary for scientists for they also carry a great deal of specialized knowledge and a great number of ways and possibilities to use it. At the same time, the effects of such knowledge and its use can vary from local to global (e.g. air or water pollution) and from immediate and temporary, to slow and long-term effects (e.g. climate change). Furthermore, it is also quite reasonable that an ethical framework is important for one’s job satisfaction. The late Stephen R. Covey (1932 – 2012), educator, author, and businessman with ten honorary doctorates, emphasized in his best seller “The 7 Habits of Highly Effective People” that a long, healthy, and happy life is the result of making contributions, of having meaningful projects that are personally exciting and contribute to and bless the lives of others.

\textit{Only a life lived for others is a life worthwhile.}

(Albert Einstein, \textit{The New York Times}, June 20, 1932)

In further addressing the argument that an ethical education would be meaningless as scientists’ behavior will ultimately be influenced by the culture and expectations of the firms or organizations that employ them, a counterargument could be that, if society focused on providing an ethical education revolving around the respect towards human values and the environment, then \textit{that} would be the culture and the expectations of

\textsuperscript{16} Deontology is an ethical position within normative ethics that judges the morality of an action based on the action’s adherence to rules/moral duties.
people, which would further shape the culture and expectations of the firms and the organizations that employ them. Nelson Mandela had a strong faith in the changes that education can bring to the people and the world:

*Education is the most powerful weapon which you can use to change the world.*

(1993, *Nobel Peace Prize laureate*)

Nelson Mandela was not the only one who understood the power of education in affecting future generations and shaping the future of society and the whole world. As was read in section 1.1, Adolf Hitler focused greatly on bringing about an ideological shift within the younger generations through the German educational system of the time in order to ensure the successful implementation of the new ethical and social norms on which Nazi Germany would be built.

The European Council is currently showing an increasing level of interest in educational reform with an emphasis on education for democracy and human rights, as we read in the following statement:

*Education plays an essential role in the promotion of the core values of the Council of Europe: democracy, human rights and the rule of law, as well as in the prevention of human rights violations. More generally, education is increasingly seen as a defense against the rise of violence, racism, extremism, xenophobia, discrimination and intolerance.*

(Retrieved from: http://www.coe.int)

*Critical thinking threatens the calm of assumed amiability:* As it was argued in section 3.3.3, critical thinking might “threaten the classroom balance and the calm of assumed amiability that governs much of our interactions with one another”. We address this point by considering the Delphi Report, a study conducted by a group of 30 experts in 1990, who determined that critical thinking is a process divided into the following skills and dispositions (Facione, 2002):

- Interpretation: The ability to understand information.
- Analysis: The ability to identify the main arguments.
- Evaluation: The ability to judge whether this argument is credible and valid based on the logic and evidence given.
- Inference: The ability to decide what to believe based on solid logic, and to understand the consequences of this decision.
• Explanation: The ability to communicate the process of reasoning to others.

• Self-Regulation: The ability to monitor one’s own thinking and correct flaws in logic.

Furthermore, seven dispositional elements were also identified and include:

• Inquisitiveness: Concern to become and remain well-informed.

• Truth-seeking: Willingness to face one’s own biases and reconsider views.

• Critical thinking self-confidence: Trust in one’s ability to reason.

• Open-mindedness: Flexibility in considering alternative viewpoints.

• Systematicity: Systematic thinking that follows a linear process.

• Analyticity: The willingness to pick apart your own and others’ logic.

• Cognitive Maturity: Being persistent in seeking the truth.

Critical thinking increases the capability of identifying central issues and assumptions, making correct inferences from data, deducing conclusions from data provided, interpreting whether conclusions are warranted, and evaluating evidence or authority (Renaud & Murray, 2008). All these skills and dispositions are crucial for the continuous development of human cognition and character, and are of high importance when it comes to both scientific reasoning and moral judgment. At the same time, the development of critical thinking in students would serve as a necessary tool against the possibility of ethical indoctrination, which was another argument against the teaching of ethics in science.

The Delphi study has been criticized as it ignores the role of ethics in decision making. This criticism has been highlighted as a need for a moral element to be included in critical thinking (Martin, 1992; Fox, 2002). It should be noted that critical thinking cannot guarantee moral behavior, however it’s an important prerequisite.

*Science teachers are not educated in moral philosophy:* Another argument and serious issue that needs to be addressed is who would undertake the task of educating students and in what form. It could be regular science teachers in their regular science class. Such skills and dispositions as enumerated in the Delphi Report could be built into a classroom by science teachers with the requisite knowledge and background which could come through teacher education programs and other professional activities. As an alternative, specialized teachers in philosophy of science, capable of transmitting such
difficult content in the best possible way could teach a separate line of courses within the curriculum.

Before deciding who might teach students about ethics, we should first find out what would really be the best way to have a successful implementation of ethics within the school syllabus with an emphasis on ethics in science (section 3.4). One main aim of the research reported in this thesis was to address this point.

The final section of this chapter is about creating a conscious ethical ideology through our educational system which would serve as a necessary basis for moral reasoning, a central element of human cognition in everyday life, and for the re-evaluation of the current social norms with the purpose of improving social patterns, as well as interpersonal relations.

3.4 Creating a Conscious Ethical Ideology

We’ve bought into the idea that education is about training and ‘success’, defined monetarily, rather than learning to think critically and to challenge. We should not forget that the true purpose of education is to make minds, not careers. A culture that does not grasp the vital interplay between morality and power, which mistakes management techniques for wisdom, which fails to understand that the measure of a civilization is its compassion, not its speed or ability to consume, condemns itself to death.

Chris Hedges, Empire of Illusion (2009)

The problem that was discussed in the previous chapters regarding the dangers of our technological advancements and the moral aspects of science mainly boils down to the question: “What man ought to do and not to do when it comes to the conduct and use of science and technology and what skills and knowledge ought young people to have when it comes to making personal decisions about the results of technological and scientific research?” Of course that question is directly related to the purest of all social questions: “How man ought to live? What ought man do and not do in relation to himself and his fellow men?” Such questions have troubled many great minds through the millennia and have honored them with the title of philosopher for daring to contemplate such issues, and for using, according to Aristotle, man’s highest virtue, reason, to form their arguments and support their theories, in an attempt to cast some light in the yet uncharted abyss that is human nature and the purpose of human function and existence. We begin with a short discussion about the reasons why society should attempt to cultivate moral reasoning in students and help create a conscious ethical ideology. This is followed by a discussion as to how we might be able to do that.
3.4.1 Reasons for Cultivating Moral Reasoning in Students

The most important endeavor is thestriving for morality in our actions. Our inner balance and even our very existence depend on it. Only morality in our actions can give beauty and dignity for life.

Albert Einstein to Reverend C. Greenway, (November 20, 1950)

The ways we conduct and use science are strongly affected by our social ethical norms, which in turn are greatly influenced by our own personal ethics and vice versa (ethics and morality are taken to be equivalent in this chapter). We focus her on the importance of people being encouraged to contemplate and theorize about their lives, their goals, their morals and their behavior.

Philosophical questions often appear completely rhetorical at first glance, and surely, people’s answers might differ greatly, but it is those answers, or non-answers (meaning the lack of conscious decisions regarding these issues), that silently and subconsciously guide one’s daily actions and construct one’s world perspective. It is those answers (or again our non-answers) that give subjective and unique meaning to our lives, create our expectations from ourselves and others, and help define a basis for moral judgment; for they are the core values that formulate our morality and produce the ethical and social norms within which we live. (This is apart from the law, which is externally defined by others and more than often not ethical at all). As Martin Luther King pointed out:

Never forget that everything Hitler did in Germany was legal.

(Letter from a Birmingham Jail, 1963)

Personal morality stands as the only barrier between us and social chaos. It is a subtle inner voice which tunes our behavior and can potentially become a strong motivation urging us to renounce crime, injustice, racial, sexual or religious discrimination, oppression, and all kinds of physical and psychological violence, and make this world truly a better place. It is therefore important that society impel people to consider ethical issues, encourage them to question, doubt, argue reasonably and not based on unexplored subconsciously driven emotions, and to make deeply conscious choices regarding their behavior and their actions. When people are not conscious of their own behavior or the norms that guide their lives (including their origin as well as their purpose), they can be more easily managed and manipulated into false value systems since they are in no position to question the purpose and the deep social effects of these norms.

Erich Fromm in his book Man for Himself describes his concerns about the lack of ethical consciousness and man’s erroneous belief in irrational value systems, due to the lack of proper guidance (Fromm, 1947: p.2):
The contemporary human crisis has led to a retreat from the hopes and ideas of the Enlightenment under the auspices of which our political and economic progress had begun. [...] The ideas of Enlightenment taught man that he could trust his own reason as a guide to establishing valid ethical norms and that he could rely on himself, needing neither revelation nor the authority of the church in order to know good and evil. The motto of the Enlightenment ‘dare to know’, implying ‘trust your knowledge’, became the incentive for the efforts and achievements of modern man. The growing doubt of human autonomy and reason has created a state of moral confusion where man is left without guidance of either revelation or reason. The result is the acceptance of a relativistic position which proposes that value judgments and ethical norms are exclusively matters of taste or arbitrary preference and that no objectively valid statement can be made in this realm. But since man cannot live without values and norms, this relativism makes him an easy prey for irrational value systems. He reverts to a position which the Greek Enlightenment, Christianity, the Renaissance, and the eighteenth-century Enlightenment had already overcome. The demands of the State, the enthusiasm for magic qualities of powerful leaders, powerful machines, and material success become the sources for his norms and value judgments. (Fromm, 1947: p.2)

If we do not posses good ethical values to improve consciously the norms of our lives ourselves, then we will continuously need more and more laws to either allow or forbid all kinds of behavior in order to maintain social balance -if we actually agree that what we experience today is in fact, social balance. The only rules society will adhere to will be in the form of psychological extortion and coercion, such as fear of punishment.

Apart from Erich Fromm who was quoted several times earlier condemning man’s obedience to external power structures such as the State or religion, Albert Einstein also comments:

A man’s ethical behavior should be based effectually on sympathy, education, and social ties and needs; no religious basis is necessary. Man would indeed be in a poor way if he had to be restrained by fear of punishment and hope of reward after death.

(New York Times Magazine, November 9, 1930)

Especially today, with new international treaties being negotiated (such as ACTA\textsuperscript{17}), which affect fundamental rights such as freedom of expression and privacy, combined with the increased development in interception technology through covert surveillance of phone calls, emails, even credit card purchases, the ideas of security, freedom, and

\textsuperscript{17} The Anti-Counterfeiting Trade Agreement (ACTA) is a multinational treaty for establishing international standards for intellectual property rights enforcement over the Internet. Opponents say the agreement adversely affects fundamental rights such as freedom of expression and privacy. At the same time the secret nature of negotiations which excluded the general public has provoked heavy criticism and it has been described as policy laundering by critics such as the Entertainment Consumers Association and the Electronic Frontier Foundation.
privacy seem to have conflicting interests. Freedom, privacy and other human and civil rights often seem to be taking a serious hit in the name of safety and security especially ever since the world-wide rise of the “War against terrorism”. However, all these issues raise the serious question of whether we should be willing to sacrifice more and more parts of our freedom, without first attempting other alternatives for motivating human behavior -such as a meaningful and well-grounded ethical education based on moral reasoning and self-realization and not fear or impulsive emotions. Could we create peaceful and happy communities if we gave up our freedom rights and allow all our actions to be directed and controlled by a higher power? Or is it true that good, ethical people don’t need laws to tell them to act responsibly while bad people will almost always find a way around the laws? The U.S. Citizen’s Rule Book\textsuperscript{18} states:

“Control’s real name is bondage. The logical conclusion would be, if giving up some rights produces a better society, then by giving up all rights we could produce a perfect society. We could chain everybody to a tree, for lack of trust. This may prevent crime, but it would destroy privacy, which is the heartbeat of freedom. It would also destroy trust which is the foundation for dignity. Rather than giving up rights, we should be giving up wrongs. The opposite of control is not chaos. More laws do not make less criminals. We must give up wrongs, not rights, for a better society. William Pitt of the House of Commons once proclaimed, ‘Necessity is the plea for every infringement of human liberty; it is the argument of tyrants; it is the creed of slaves.’”

Considering our discussion so far, many would recognize a social need to invest more time and creative energy in educating people morally, raising critical awareness and the ability to question and challenge the norms established by the state, science or religion, while cultivating benevolent character traits and emotions through the transmission of charitable values. A positive change in the moral perspective of people would not only have an effect on science and its use and therefore motivate a different approach to the problems it has created which was our original concern in this paper, it would have an effect on the whole population and it would transform the culture, the priorities and the long-term goals of our society which is a far more important aim. At the same time, it would most probably be less costly than manufacturing, purchasing and installing cameras on every street corner and inside every house in order to minimize criminality. Perhaps what our culture is lacking is a respect and appreciation for moral philosophy and philosophy in general. As Plato strongly supported:

\textit{There will be no end to the troubles of states, or of humanity itself, until philosophers become kings in this world, or until those we now call kings and

\textsuperscript{18} The Citizens Rule Book is a handbook written by Charles R. Olsen to educate American citizens regarding their rights and responsibilities. It is a compilation of quotes from the founding fathers of the United States and it contains select government documents, including the Constitution, Bill of Rights, Declaration of Independence, and a handbook for jurors.
rulers really and truly become philosophers, and political power and philosophy thus come into the same hands.


However, in a time of a democratic regime it is people who have the power to affect political decisions and it is therefore people who are in need of a philosophical education, not only politicians.

In other words, before stripping people bare from their fundamental rights such as the right of freedom and privacy in order to secure more peaceful, safe and fair communities, we should first provide people with the cognitive, and most importantly, moral tools to be able to regulate their own behavior, as well as to reexamine to the core what truly constitutes a peaceful and fair community.

### 3.4.2 A General Approach to Cultivating Moral Reasoning in Students

Here we will begin a discussion of a more general approach as to the means by which moral reasoning can be cultivated, and a conscious ethical ideology created with an emphasis on humanitarian and environmental values. This way we hope to sidestep the dangers of ethical indoctrination, regardless of the students’ age. In other words we do not discuss here exact content of a hypothetical specialized course on moral philosophy which could be implemented within our basic educational system, as such content would greatly vary from place to place. Furthermore, the content would depend on the age of the students, for example there would certainly be different content at primary and secondary levels.

Creating a moral consciousness demands a well-trained critical mind and wide exposure to different opinions and ethical ideologies through extensive reading and discussion, thus avoiding ethical indoctrination. This requires an ability to entertain a thought or an idea without automatically assimilating it. It is obvious that when exposed to several conflicting ideas one cannot accept them all, so it is important to encourage a more complex thinking process in an attempt to evaluate the different ideas and critically assess which seem right and which seem wrong based on the individual’s pre-established beliefs. As the Delphi Report concluded (section 3.3.4), critical thinking plays a key part as it requires and cultivates several cognitive skills such as interpretation, analysis, inference, self-regulation, open-mindedness, cognitive maturity and others. Repetition of such cognitive engagement that is driven by logic, reason and valid argumentation can raise one’s critical abilities to the point where one might begin to reevaluate personal views as one continuously encounters ideas that might conflict with pre-existing ones. Especially in primary and secondary level when students’ views are
not so absolute and rigid, it would be easier to begin practicing such cognitive activities than wait until university.

**The Three Branches of Ethics**

It would be valuable to be familiar with a selection of the existing moral theories in order to understand their basic differences. Additionally, it would be useful for students to understand, discuss, and be able to distinguish between the three branches of ethics in order to have a more spherical approach towards ethical issues:

- **Normative ethics**: Is the branch of philosophical ethics that examines the set of questions/issues that arise when we think about questions such as “how ought one act?” For example, the question of whether killing is always wrong belongs in this category of ethical investigation.

- **Meta-ethics**: Is the branch of philosophical ethics that enquires into the nature of ethics and moral reasoning. For example, discussions about whether ethics is objective or relative and whether people always act from self-interest are meta-ethical discussions.

- **Applied ethics**: Applied ethics deals with specific cases where moral judgment can be applied. For example animal testing or abortion, are specific cases where controversial moral issues arise.

Below is a short description of the most popular philosophical disagreements and the ethical schools and moral philosophies that have been built around them, especially regarding the source of ethical values, a central element of philosophical discussions which has been the cause of hundreds of ethical schools being created through the millennia.

**Moral Philosophies and Ethical Schools**

Regarding the nature of ethics (meta-ethics), one important disagreement arises from the fact that many place the origin of ethical values in an internal source (subjective opinion) while others place it in an external source (e.g. God). Consequently, one important category is formed by those who believe that ethical values are eternal and changeless truths independent of opinion. The moral philosophy that supports this idea is **Moral Objectivism**, and there are several versions of moral objectivism.

- **Moral objectivism**: Is the meta-ethical position that moral truths exist independently from opinion.
**Moral universalism:** Is the position that some moral values can be applied universally to everyone.

**Moral realism:** Is the position that ethical sentences express propositions which they can be evaluated and used to draw conclusions by means of logic in the way that other propositions can. According to moral realism, this can lead to certain and unambiguous conclusions about ethical decisions.

**Moral absolutism:** Is the position that some forms of human conduct are right or wrong in any context. Even in an attempt to do good, bad actions are always bad and cannot be justified. For example killing someone, even in self defense, is always bad.

Others believe that ethical values are simply human conventions and therefore not universally objective truths. The moral philosophy that supports this idea is *Moral relativism*, which also has different subcategories.

- **Moral relativism:** Is the meta-ethical position that morality is not universal, but that moral truths can be determined by factors relative to one's society or culture.

**Moral subjectivism:** Is the position that ethical values depend on personal opinion.

**Moral situationism:** Is the position that ethical values depend on specific situations/context.

Another important division arises not regarding the source of ethical values, but regarding moral judgment and the specific criteria of what is right and what is wrong (normative ethics).

- **Deontology:** Is the normative ethical position that judges the morality of an action based on the action's adherence to a set of moral rules, implying the existence of moral duty behind our actions (e.g. Immanuel Kant and *Kantian ethics*).

- **Consequentialism:** Is the position in normative ethics which states that right or good action is that which produces the most favorable outcome/consequence.

  **Utilitarianism:** Is the best known version of consequentialism, which supports that happiness is the basic goal of ethics, and that right actions are those which produce the most amount of happiness (or minimize unhappiness).

Finally, another interesting division within normative ethics lies between those who advocate ethical egoism and those who advocate ethical altruism.

- **Ethical egoism:** Is the philosophical position which supports that moral agents ought to do what is in their own self-interest.
Ethical altruism: Is the philosophical position which supports that individuals have a moral obligation to help, serve, or benefit others apart from themselves.

The ethical ideologies we described above are but a selection from a very wide spectrum of moral philosophies. Our aim is simply to call attention to the most popular philosophical disagreements as well as to the fact that we often make daily decisions and judgments completely unaware of our own personal beliefs regarding these issues.

Concerning the third branch, applied ethics, we couldn’t expect to find a richer subject than science and technology to inspire discussions of ethical issues and dilemmas, although of course it should not be the only source of discussion. Together with American psychologist Lawrence Kohlberg, who specialized in research on moral education and reasoning and was best known for his theory of stages of moral development, we would argue in favor of children needing to be in an environment that allows for open and public discussion of day-to-day conflicts and problems (another important source of discussion for applied ethics) in order to develop moral reasoning abilities, especially in their early education (Kohlberg et al, 1975), Kohlberg (1985), Kohlberg et al. (1989)).

In general, an ethical education discussing all these different ethical schools and daily ethical dilemmas would be valuable, but perhaps not enough (or for some, too much). If our overall aim is to cultivate moral reasoning in students but also create a conscious ethical ideology and try to instill humanitarian and environmental values in order for future generations to be able to address some of today’s pressing issues, our educational system could take a different approach, that of Plato, and more particularly, Aristotle. Both philosophers focused on virtues and the importance of cultivating fine character traits in the youth of the time: courage, temperance, generosity, greatness of soul, friendliness, truthfulness, justice, modesty, benevolence and others, instead of focusing on defining a clear set of moral rules. Within the field of philosophy of education, James Page, Australian educationist and anthropologist, advocates that virtue ethics can provide a good rationale and a necessary basis for peace education19. Furthermore, Thomas Alured Faunce, consultant to UNESCO Bioethics and Health Law, has argued that whistleblowing in the medical world would be more valued and better supported within clinical governance pathways if it had a stronger academic foundation in virtue ethics (Faunce & Jefferys, 2007).

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19 Peace education aims at helping students acquire the values, knowledge, as well as the attitudes, skills, and behaviors to live in harmony with oneself, with each others, and with the natural environment.
3.4.3 Alternative Educational Approaches: Virtue Ethics, Values Education and Peace Education

Virtue ethics, one of the three dominant approaches to normative theories (the other two being deontology and consequentialism), emphasizes the importance of moral education since virtuous character traits are developed in one’s youth, and advocates that adults are therefore responsible for instilling virtues in the young. Virtues are not considered to be superficial habits such as being a non-smoker, instead they “go all the way down”.

A similar more recent approach adopted by some schools in Europe (Taylor, 1993) and around the world is the notion of Values education (Cross, 1995; Cheng et al., 2006; Kriengsak, 2006). Unlike Aristotle’s virtue ethics which focuses on cultivating specific character traits, values education focuses on specific values being transmitted to pupils by teachers and other adults (Powney et al., 1995), such as happiness, peace, unity, equality, justice, humility, hope, simplicity, honesty, trust, freedom, co-operation, courage, love. Values education can be compared to a type of Socratic dialogue, where pupils slowly and progressively are brought to their own understanding of what constitutes good behavior for individuals and society (Minnis, 1991). We would strongly advocate this kind of educational approach to give students the opportunity to gradually realize themselves why certain values are important.

Similarly, in the past century, there has been an increasing advocacy of peace education. Harris and Synott (2002: p.4) have described peace education as “a series of teaching encounters that draw from people:

- their desire for peace,
- non-violent alternatives for managing conflict, and
- skills for critical analysis of structural arrangements that produce and legitimize injustice and inequality.”

In general, peace education programs around the world represent “a wide spectrum of focal themes, including anti-nuclearism\(^{20}\), international understanding, environmental responsibility, communication skills, non-violence, conflict resolution techniques, democracy, human rights awareness, tolerance of diversity, coexistence and gender equality” (Groff and Smoker, 1996; Harris, 1999; Johnson, 1998; Swee-Hin, 1997; in Agarwal, 2014), while Koichiro Matsuura, past Director-General of UNESCO, has described peace education as being of ”fundamental importance to the mission of UNESCO and the United Nations” (Page, 2008: p.xix). According to H.B. Danesh,

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\(^{20}\) Opposition to nuclear weapons.
physician, psychiatrist, founder and president of the International Education for Peace Institute, education must focus on the healthy development and maturation of human consciousness through assisting people to analyze and transform their worldviews (Danesh, 2006). Danesh supports that the majority of people and societies express conflict-based worldviews (the survival-based worldview and the identity-based worldview), which then are expressed in conflicted interpersonal and international relationships. According to Danesh, these worldviews are correlated to phases of human development and it is only through the acquisition of a Unity-Based Worldview that humans have the capacity to alleviate conflict, accept diversity, and establish a truly sustainable culture of peace.

Recently there has been a meshing of peace education, education for democracy and human rights education, with a main focus around conflict resolution training. Conflict resolution is a central theme in peace education, and as we read in Jeffries (2000: p.21)

*Conflict is very natural and normal, but you can’t go through your entire life beating everybody up—you have to learn different ways to resolve conflict.*

According to the Council of Europe Charter on Education

*Member states should include education for democratic citizenship and human rights education in the curricula for formal education at pre-primary, primary and secondary school level as well as in general and vocational training.*

Retrieved from: www.coe.int

We would therefore advocate a similar approach; a long and gradual process throughout all years of schooling in our attempt to implement ethics within our education.

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21 “Education for democratic citizenship means education, training, awareness-raising, information, practices and activities which aim, by equipping learners with knowledge, skills and understanding and developing their attitudes and behavior, to empower them to exercise and defend their democratic rights and responsibilities in society, to value diversity and to play an active part in democratic life, with a view to the promotion and protection of democracy and the rule of law.” (Council of Europe Charter on Education for Democratic Citizenship and Human Rights Education)

22 “Human rights education means education, training, awareness-raising, information, practices and activities which aim, by equipping learners with knowledge, skills and understanding and developing their attitudes and behavior, to empower learners to contribute to the building and defense of a universal culture of human rights in society, with a view to the promotion and protection of human rights and fundamental freedoms.” (Council of Europe Charter on Education for Democratic Citizenship and Human Rights Education)
Beliefs, Attitudes and Values Theory

All the aforementioned educational approaches, including values education, peace education, human rights education and education for democracy, share the same central theme; that certain values need to be instilled in students. However, in order to successfully implement such humanitarian as well as environmental values in people (students in this case), which means persuade them regarding their importance and bring about a change in their beliefs, we need to review the Beliefs, Attitudes and Values theory, a cognitive consistency theory that was developed, thoroughly researched and published by Milton Rokeach in 1968. According to Rokeach, a person’s beliefs, attitudes, and values are interconnected and must be in harmony with each other. In order for persuasion to take place the focus must be in changing a person’s values, which according to Rokeach are the most important variable in the theory. Furthermore, through his theory, Rokeach proposes a solution to the attitude-behavior discrepancy problem. But first we should take a look and understand each variable separately before we are able to understand their interconnectedness.

- **Beliefs**, are general perceptions whether something exists and is true. A person can have thousands of different beliefs, which are generally divided into two main categories: peripheral beliefs, which are easier to change because they are of less importance to the individual, and central beliefs which are harder to change because they are crucial to the individual’s existence (Sereno, 2012).

- **Values**, are beliefs that are particularly important to a person because they help guide their lives, and while an individual may have hundreds of thousands of beliefs, he/she usually has generally few values by which his/her life is lived. Values are also divided in two categories; instrumental values, which are the beliefs a person decides to live his/her life by, (e.g. being honest or being just), and terminal values, which are by themselves ends that a person deeply wishes to achieve (e.g. getting a university diploma) (Sereno, 2012).

- Finally, **attitudes** are the feelings (positive, negative or neutral) that a person has towards people, things, situations or ideas. Although attitudes appear to be closely connected to behavior, current research has almost consistently shown that attitudes are poor predictors of behavior (Sereno, 2012).

According to Rokeach, true persuasion occurs by affecting a person’s values, because these are the beliefs by which a person wishes to live. By changing a person’s values, all beliefs related to these values change, and immediately all attitudes displayed as a result of these beliefs also change. The three variables involved, beliefs, attitudes and values, form a functionally integrated system where a change in one part will affect all the other parts. Rokeach compares this system to the model of the atom, where a
person’s values would constitute the nucleus of the atom, while the rest of the beliefs would be the surrounding electrons. In other words, affecting a person’s values is key to persuasion. Furthermore and most importantly in order for the attitude-behavior discrepancy problem to be avoided, the individual must be persuaded that the new set of values are relevant to their own self-concept and their self-image, meaning the way they would actually like to perceive themselves (Sereno, 2012). If a change occurs at the value level, the individual will want to live by a different set of values which will further affect his/her general beliefs, attitudes, and most likely his/her behavior. Only then, true persuasion has occurred.

Therefore, concerning our particular issue of successfully instilling humanitarian values in students, such as values of peace, justice, honesty, empathy, courage, benevolence and cooperation, as well as environmental values, we should aim to bring a change not only in students’ core beliefs (values) regarding the meaning and importance of these qualities, but also in the way they view themselves within society (self-concept).

Generally speaking, most children are raised praising many of these values, which are the main characteristics of most childhood role-models, the so-called ‘heroes’, which young children are so eager to identify with. According to Fromm, (1947: p.9)

...it is one of the characteristics of human nature that man finds his fulfillment and happiness only in relatedness to and solidarity with his fellow men. However, to love one’s neighbor is not a phenomenon transcending man; it is something inherent in and radiating from him. Love is not a higher power which descends upon man nor a duty which is imposed upon him; it is his own power by which he relates himself to the world and makes it truly his.

However, as they grow older, children are naturally further influenced by other role-models which promote different sets of values, such as being ‘cool’ or popular, which more than often have nothing to do with the aforementioned characteristics. If we were to instill fine character traits based on these values, we would have to try to prolong this inherent admiration towards the qualities of a ‘hero’ and help students realize the importance of these noble qualities throughout their whole lives, as something more than in a childhood phase. In order to do that, we would have to begin in primary or pre-primary education and help children realize early on, in their own unique way, the dangers humanity and the planet are currently facing, transmit a strong sense of responsibility towards each-other, the environment and future generations, highlight their self-importance and boost their self-concept by motivating them to view themselves as ‘heroes’ in the never-ending battle against the dire problems the previous generations have created and towards creating fair and peaceful communities.
In sum, virtue ethics as well as values and peace education, which in a way complement each other, can be transmitted through our basic educational system in a way that supports the exposure of pupils to many different ethical ideologies and encourages the cultivation of critical thinking through the use of extensive discussion and debate within the frame of a specifically and carefully designed line of courses, rather than a one-year single course. This line of courses could begin early on in pre-primary education where children should first learn to value and respect each other and become sensitized towards people and the environment, help create situations where they can actually practice good character traits, and then slowly be introduced to the vocabulary of ethics as well as to the main ethical disagreements and the different moral philosophies that exist, while learn to distinguish between the three branches of ethics; meta-ethics, normative, and applied ethics. And since we live in “the age of science” (Piel, 2001), the source of examples and issues discussed and debated within the realm of applied ethics could be, and most importantly, should be, inspired in a great part by past, present and future moral dilemmas raised by science and technology. This way, we could deliver multiple aims such as:

- Increase the level of critical thinking in students.
- Assist them to create themselves a conscious and meaningful ethical ideology and a basis for moral judgment that helps them define their purpose and place in society.
- Aid them to acquire good character traits through self-realization such as trustworthiness, empathy, bravery, humility, benevolence, fairness and cooperation.
- Aid them to assimilate meaningful values such as happiness, peace, freedom, courage, justice, unity, equality, simplicity, honesty and love.
- Aid them to acquire a genuine appreciation for science and technology and their effects on social development.
- Aid them to acquire a deep consideration regarding potential world-wide consequences (either positive or negative) from scientific and technological advancements.
- Aid them to raise their sensitivity and level of personal responsibility towards their “neighbor”, the global population, the environment as well as the future generations.
- Aid their worldview transformation into a more “unity-based worldview”.

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We are already witnessing a major shift towards educational approaches with a focus on cultivating important values in students in order to ensure the protection of human rights, democracy and peace. What this paper additionally proposes is that students should assimilate the aforementioned values by raising their ethical sensitivity and awareness and increase their level of critical thinking within the context of an ethical/philosophical course which will provide them with the necessary cognitive tools to not only accept a new set of “rules” of conduct, but to learn to re-evaluate the ethical and social norms that guide their lives and society as a life-long process.
4. RESEARCH DESIGN

In this chapter I present the participants, the school and cohort, the structure and timeline of the research, as well as the content of the lectures and the teaching strategies used during the intervention. Afterwards, I describe the data collection instruments and techniques used for the acquisition of quantitative and qualitative information. In the following chapters, I present the methods used for a) the statistical analysis of the quantitative data and b) the analysis of the qualitative data, and finally, the conclusions of the research followed by a short discussion.

4.1 School, Subjects and Cohort
The research was conducted in the Netherlands, at Bredero College in Amsterdam Noord, and all parts of the research took place during the course of Informatica (Informatics) in 5VWO\textsuperscript{23}. The total number of students of this course was 30; however, only 16 students were selected to participate in the research. Specifically, the research made use of 4 groups, with 4 students in each group (16 students in total). Bredero College is considered to be an average Amsterdam school with a great diversity of ethnicity among students.

4.1.1 Selection of Subjects
Groups were divided together with the help of the teacher, Mr. V, in such a way so that we would avoid potential conflicts among students that don’t get along, but also in a way that would help avoid students being influenced by each other due to strong friendship bonds. The reason why we chose to make use of groups was to promote group discussions and assignments, while 4 was considered a suitable number of group members because it would make every member’s opinion significant, while giving him/her the time and space to contribute with his/her arguments. If we had 8 or 10 members in each group perhaps some wouldn’t have the time or opportunity to share their opinion or they would remain silent leaving others do the talking. At the same time if it were only 2 or 3 people in a group their opinion would be important but perhaps we wouldn’t have sufficient variety of opinions. Therefore we considered the number 4 as the most appropriate for our needs.

\textsuperscript{23} The Dutch school system divides high-school in 3 categories; VMBO which last 4 years (from the age of 12 till 16), HAVO which lasts 5 years (from the age of 12 till 17), and VWO which lasts 6 years (from the age of 12 till 18) and offers the possibility to access university unlike the other categories.
The reason why a small number of groups was selected (again 4), was to be able to handle the students’ homework assignments and their scheduled in-class presentations time-wise. Having 5, 6 or more groups would have demanded more of Mr. V’s lecturing time and consequentially that would have also increased the knowledge gap between research group and non-research group within the course of Informatica. The teacher, Mr. V, was kind enough to grant us 6 hours of his lecture time for our research and he was extremely helpful and supportive. Of course, for the purposes of this study, we would have preferred considerably more time in order to engage students as much as possible in classroom discussions and have them exposed to many different topics and arguments. However, that was impossible since the intervention took place within the time frame of another course.

The selection of the students which would participate in the research was made by Mr. V alone, who took into account a) keeping a fair gender ratio in the research group and b) the students’ performance in Informatics. Since the participating students would miss approximately 6 hours of their scheduled lectures, their level in Informatics should be such that would allow them to lose such valuable learning time. Finally, another criterion was c) the students’ level of English. Since the research took place in a Dutch high-school and English is not the students’ native language, it was important that the participating students were comfortable to talk, read and write in English.

The 16 subjects that were selected eventually for the research were 10 boys and 6 girls, approximately 16 years old, and they were concluding their pre-final year in high-school. However, 3 male students had to be excluded from the analysis, 1 due to illness and the other 2 because they didn’t fill out all the questionnaires. Excluding 3 students while having such a small number of participants was unfortunate, however, it did help keeping a better gender ratio among students.

Therefore, the total number of subjects was $N=13$, with males $M=7$ and females $F=6$.

4.2 Description of Intervention

The intervention was comprised of 4 meetings with the students and with a total amount of 6 hours, 3 of which were dedicated to the lectures, 1 hour was dedicated to the students’ presentations and the rest was required for the administration and filling of the questionnaires.

In the beginning of the first meeting, two questionnaires were administrated to the students in order to record their pre-defined views a) on general matters of ethics (Ethics Position Questionnaire - EPQ) and b) on specific topics regarding ethics in science (Ethics in Science Questionnaire - ESQ). Afterwards, we had planned 3 sets of interactive lectures including classroom debates and homework assignments which were to be
presented in class by the groups. At the end of the lectures, after our 3rd meeting, students were given the same two questionnaires again to record any changes in their ethical beliefs and their opinion about ethics in science. At that point students were also asked to write some final comments individually about the lectures and the assignments and about their overall impressions.

Finally, the EPQ and ESQ questionnaires were administrated one last time 6 months after the end of the lectures (4th and final meeting), to see whether students preserved their last recorded opinion or if they returned to their original views prior to the intervention.

### 4.2.1. Timetable

Below I present the intervention timetable (Table 4.1), followed by a discussion of the content of the lectures and the reasons behind the decisions made regarding the content (section 4.2.2), as well as the data collection methods; questionnaires (section 4.3.1), debate questions (section 4.3.2.1), homework assignments (section 4.3.2.2), and students’ final comments about the content of the lectures (section 4.3.2.3).

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Date</th>
<th>Hours</th>
<th>Questionnaires (EPQ + ESQ)</th>
<th>Lectures</th>
<th>Debates</th>
<th>Students’ Homework</th>
<th>Students’ final comments</th>
</tr>
</thead>
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<td>12/12/2011</td>
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**Table 4.1: Timetable of the intervention and the organized activities**

### 4.2.2 Lectures on Ethics

The lectures were scheduled in three meetings with the students, with a total of four hours. One hour during the first meeting (one hour was also used for the administration of the questionnaires prior to the lecture), two hours during the second meeting (out of which one hour was used for students’ presentations of their homework assignments), and one hour during our final meeting.
1st Meeting

During the first meeting, the students were immediately given the first round of the two questionnaires, the EPQ and the ESQ, which took up about one hour of the two hours we had available for our first contact. Afterwards, there was a 45 minute presentation on ethics given by the researcher which was split between two categories: a) Introduction to ethics, and b) Ethics in science and technology. The specific topics discussed were:

a) Introduction to Ethics:
- Definition of the word “ethics”
- Different types of ethical schools and the ideologies they represent; examples and criticism (the main schools that were discussed were deontology and consequentialism, and there was also a comparison between ethical egoism vs. ethical altruism)
- Aristotle’s views on “eudaimonia” (=happiness) and the highest virtue: reasoning
- Plato’s views on the human function (purpose)
- Comparison of Plato and Aristotle regarding their views on human function
- Aristotle’s Virtue Ethics
- Plato’s “Allegory of the Cave”

The reason why these specific topics were selected was to introduce to the students the branch of philosophy that studies ethics, and to present the essence and criticism of the two major ethical schools of normative ethics: deontology and consequentialism (section 3.3.2.1). This seemed important as a basis for further ethical analysis but also relevant since we were interested in measuring the level of idealism (which is related to deontology) and the level of relativism (which is related to consequentialism) in the students using the EPQ instrument.

The second main focus was to discuss ethical egoism and ethical altruism, in an attempt to “expose” the personal choice all humans make regarding our moral priorities and the way we view our place in society. That is, do we consider our only priority to serve ourselves or do we consider it as a conscious moral obligation to serve others as well? (The example that was given in regard to selfless altruism was that of Jesus Christ). To explain the contradiction, the two great philosophers, Plato and Aristotle, were selected to compare their views on human beings’ purpose. In his Nicomachean Ethics (350 BC), Aristotle, defines the human function as expressing the highest form of reason possible with the purpose of attaining personal happiness or “eudaimonia”. On the other hand for Plato, the human function is defined as deliberation, ruling, living and taking care of things. These two definitions differ greatly and they emphasize the chasm between the views of each philosopher regarding human purpose. Plato thinks of it in terms of the
person’s relation with others and his/her place in society. His ideas of ruling, deliberating, and taking care of things are related to the community in which one lives. Aristotle approaches the issue from a more individualistic perspective. Expressing reason with the sole purpose of attaining happiness does not have anything to do with a relation to a community or others, it relates mostly to the individual. The long term goal was that students would consider the relation between scientists’ own personal ethical codes and the reflection of those through their work, while considering the importance of how one relates him/herself to society. Also, we wanted to present a different approach to normative ethics on behalf of Aristotle, one that doesn’t deal with moral rules or codes, but one that focuses on cultivating good traits of character, virtue ethics, and allow students to consider the importance of these virtues (section 3.3.2.2). Finally, we discussed with the students Plato’s “Allegory of the Cave” to explain that more than often people are prisoners of their own limited views and understanding.

The second part of the presentation was specifically dedicated to ethics in science.

b) Ethics in Science and Technology:

- Definition and explanation of the two types of ethics in science: Integrity and Morality
- Introduction to the scientific method and its relation to professional integrity in science
- The interrelation of science and commerce and the danger of undermining issues of morality
- The 3 sets of ethical obligations of researchers according to the National Academy of Sciences
- Discussion of the global effects of science and technology (both positive and negative) and why (according to the National Academy of Science) scientists should “act in ways that serve the public”

With this part of the lecture, we wanted to present to the students the two categories of scientific ethics, integrity and morality. The aim was for the students to become more familiar with and be able to separate the two sides of the coin “ethics” when it comes to science. We also wanted students to understand how integrity relates to the scientific method and why it is unquestionably accepted by the international scientific community. At the same time, we wanted to stress the role of morality in science, especially today since it is so closely related to practical applications and commerce, and the fact that the technological side-effects such as pollution are visible on a global level. Also, we wanted to discuss with the students that morality, compared to integrity, is not
acceptable by all scientists, however, the National Academy of Science does include as an ethical obligation for scientists their responsibility towards the public and we wanted to motivate students think about what that may mean.

At the end of the first meeting, students were divided in 4 groups and were given detailed instructions about the homework assignment which required them to do group research about a famous scientist (different for each group), discuss, write their personal comments and prepare a classroom presentation for the second meeting which was scheduled two weeks later (more details about the homework assignments are presented in section 4.3.2.2 Homework assignments). Groups were also given the researcher’s contact information in order to communicate in case they needed further clarification and help with the assignments.

Finally, a little before students were let out for their school break, they were shown an excerpt from the movie “The Great Dictator” (1940), starring Charlie Chaplin. In the selected fragment, a speech is given by Chaplin himself who impersonates a dictator similar to the figure of Adolf Hitler. The specific fragment is a monologue which is designed to appeal to people’s highest moral standards, such as brotherhood, unity, democracy and peace. The dictator addresses soldiers specifically, urging them to reunite with those highest moral values and virtues and abandon conflict and violence. We considered the fragment relevant, since the highest ethical standards highlighted in the passage are appealing to all men and women regardless of culture, profession, sex or age (the fragment can be found in Appendix A).

2nd Meeting

During the second meeting, two weeks after the first one, each group had to present their homework assignment to the rest of the class. During the presentations, students were asked to think about the similarities and differences between the ethical positions of the scientists presented and to consider the moral responsibility of scientists whose work can have dramatic effects on individuals, the population or the environment.

After the presentations were finished, there was another 45 min presentation on scientific ethics given by the researcher. The topics that were discussed were:

- Main forms of scientific misconduct regarding integrity and description of the peer review process
- Main reasons for scientific misconduct
- Issues of morality in science (variety of scientific dilemmas and scientists’ social
During this part of the lectures we wanted to focus on and inform students about the different forms of scientific misconduct. Types of scientific misconduct that were discussed were: fabrication, falsification, obfuscation, bare assertions, and plagiarism. Afterwards, the peer review process was presented to the students to explain its purpose and its importance, as it serves as a review mechanism to assure the credibility and the validity of a research before it is published (for example in scientific conferences or magazines). The aim was for students to understand the importance of debate and criticism in science.

Further on, we discussed the potential sources of scientific misconduct (mostly inspired David Goodstein, 2002); career pressure, laziness, ease of fabrication and monetary gain. Finally, we considered and added a last source of scientific misconduct, even though it was not included in Goodstein’s list: personal ideology, where scientists might choose to be dishonest because of a specific ideology they hold. The aim was that students would consider the importance of scientists’ personal ideology and how that may affect their work.

Later on, we pointed out that while integrity is vital for all scientists and is similar within all kinds of research (i.e. we expect all researchers to be objective, honest, and to report their aims, methods and results clearly, etc.), issues of morality and dilemmas within disciplines can vary greatly. The aim was to motivate students to ponder on the diversity of ethical dilemmas and the level of social responsibility among scientists in a variety of disciplines. We discussed that some types of research might affect only a small experimental group (of animals or humans), while other types of research could have global effects on the population or the planet (for example the experiments taking place at the LHC at CERN and the possibility of creating microscopic black holes (MBHs) (O’Neill, (2009); Boyle, (2010)).

After that we discussed some specific examples of disciplines that have raised ethical dilemmas in the past, present and potentially the future. The examples that were discussed are:

Biotechnology: Specifically, we focused on Red Biotechnology which involves human genetic manipulation and modification, such as cloning or biological

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24 Definition from the Merriam-Webster dictionary: “The manipulation (as through genetic engineering) of living organisms or their components to produce useful usually commercial products.”
improvement of humans, Green Biotechnology which involves agricultural applications in the form of genetically modified organisms (GMOs), Blue Biotechnology which involves marine and aquatic applications, and Bioinformatics which collects and organizes tremendous amounts of genetic information which can be used diversely. As all these disciplines are at their peak of evolution and are progressing rapidly, it seemed important to give students the opportunity to consider by themselves the moral complications. (Let it be noted that we did not present or comment on the progress of any of those fields in any negative way; it was merely an introduction to the field of Biotechnology and its cutting-edge applications. We only hoped that students would keep a critical view regarding ethics during the presentation and decide themselves what constitutes a moral dilemma and what not.)

Eugenics: The reason we wanted to discuss the history of Eugenics with the students was not only because it is a discipline regaining a lot of popularity and attention under a different name, Human Genetics\(^{25}\), (recent example are the famous “designer babies”, whose genetic makeup can be artificially selected by genetic engineering to ensure the presence or absence of particular genes or characteristics (Agar, 2006)), but also because its major impact in the historic evolution of our world. It was also a good opportunity to present the case of Karl Pearson and Margaret Moul and their controversial research (1925) which seemed to be greatly influenced and driven by the researchers’ personal biases (section 1.1). We considered it important for students to think about the potential consequences when science is affected by scientists’ personal ethics, views, and biased prejudices. At the same time it was a good case to show how even political developments can be strongly affected by the scientific “trends” of the time, and how the latter can affect our general moral perspective and our social norms, including legal euthanization, sterilization, and abortion without first obtaining the individual’s consent.

Data mining: The next subject we discussed is a young field of computer science, which is defined as the process of extracting patterns from large data sets by combining methods from statistics, artificial intelligence and database management. It is used in a wide range of “profiling” practices, such as marketing, surveillance, fraud detection, scientific discovery and so forth. Data mining techniques are an extremely powerful tool increasingly used in the private and

\(^{25}\) According to Edwin Black and his book ‘War Against the Weak: Eugenics and America’s Campaign to Create a Master Race’ the study of Eugenics changed its name to Human Genetics due to the negative publicity it gained after WWII.
governmental sector for advertising and surveillance purposes (e.g. collecting Internet browsing history). In a report created by the Markle Foundation (December, 2003) regarding information sharing and analysis to address the challenges of homeland security, it was pointed out that agencies at all levels of government are now highly interested in collecting and mining large amounts of data from a number of commercial sources. We considered it highly relevant to discuss with the students the new capacities provided by technological advancements, such as finding, storing and managing huge amounts of personal data at very high speeds, and how these have raised serious moral dilemmas and legal issues such as issues of privacy, “profiling” and anonymity. The students were presented with the case of the Information Awareness Office (IOA) of the Defense Advanced Research Projects Agency (DARPA), an agency of the United States Department of Defense, which was created in January 2002, with the sole purpose of achieving TIA – Total Information Awareness. This would be accomplished by designing huge computer databases to collect and store everyone’s personal information within the United States, such as phone calls, e-mails and other forms of on-line communication, credit card records, and medical records through social networks and other sources, all without a search warrant. The world-wide-web phenomenon “Facebook”, which functions as a global social network with more than 800 million active users, is one of the projects that many internet conspiracy theorists consider to be one of IAO’s projects, especially because many of its private funders were associated with the Central Intelligence Agency (CIA) and the U.S. Department of Defense (Matt Greenop, Facebook - the CIA conspiracy, (Aug 8, 2007), The New Zealand Herald).

The purpose of this discussion was that students would consider the conflicting issues of “safety” and “privacy” and the possibilities that may arise from the manipulation of sensitive personal data. Facebook was specifically mentioned due to its vast popularity nowadays among the new generations and because it was thought that students could

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26 The aim of the IAO, which had on its office seal the phrase “scientia est potentia” = knowledge is power, as well as the “eye of providence” - a.k.a. the “all-seeing eye” on the pyramid, also found on the American dollar, was to “counter asymmetric threats by achieving total information awareness useful for preemption, national security warning, and national security decision making” (U.S. Department of Defense, Report to Congress Regarding the Terrorism Information Awareness Program, (May 20, 2003)).

27 Because of strong public concern that the deployment of such technologies and methods could potentially lead to a mass surveillance system, the IAO was defunded by Congress in 2003 but not stopped. Meanwhile, Shane Harris (winner of the New York Public Library’s Helen Bernstein Book Award for Excellence in Journalism) supports in his article “TIA Lives On”, (Feb. 23, 2006, National Journal) that several IAO projects continue to be funded, and that they simply run under different names.
relate to the moral issues and the dangers arising, being themselves amongst those who share a lot of personal information online.

We decided to close the discussion with a hypothetical scenario concerning the use of sensitive data through data mining techniques. Students were asked to consider what the possible effects on society would be, if we were to discover (and chose to make use of such knowledge), the genetic information which would helps us to accurately predict who and at what age someone would develop cancer, Alzheimer’s or cardiovascular diseases. Possible complications that were discussed were the effects on people’s health insurance, life insurance, workers’ contracts, or even marriage patterns creating a whole list of different forms of social exclusion, since it’s highly possible that many would rather not marry or procreate with someone who has 85% chances of developing cancer after the age of 35.

The meeting ended with the first classroom debate which unfortunately was interrupted by the school bell and did not turn out to be very insightful or useful for qualitative data as only one student got the chance to express an argument. However, raising the question and urging them to form an opinion was hopefully meaningful for the students. Details about the classroom debates can be found later in section 4.3.2.1 Classroom Debates.

3\textsuperscript{rd} Meeting

The 3\textsuperscript{rd} encounter with the students begun with a summary of the topics that were covered in the second meeting, after which, the students were shown a short video-clip regarding nuclear testing. In general, the topics we wanted to focus on in our last meeting with the students were:

- The morality of creating science and technology for the purpose of dominating or inflicting harm (e.g. nuclear weapons, biological weapons or chemical weapons, etc.)
- The Russell-Einstein Manifesto
- Einstein’s and Nobel’s views on war, competition, and scientists’ responsibility

The video was an illustration of the global map, indicating the number, the year and the geographical locations of all officially recorded nuclear bomb testings throughout the years 1945-1998, and the countries which were involved in the testings. The online source of the video can be found at the end of the References section.
Discussions about nuclear testing, as well as the possibility of nuclear factory accidents inspired by the latest tragedy in Japan after the major earthquake on March 11th, 2011, were specifically chosen as examples of the ethical considerations that so often arise within science regarding its social but also environmental responsibility, and they were also related to some of the homework assignments. What we wanted to point out, was that even though many respected scientists began and joined a long campaign against the use of nuclear weapons and the creation of weapons of mass destruction (the example that students were presented with was the Russell-Einstein Manifesto (1955)), nations continued to test their strength and power often at the expense of other nations and the environment, reaching a total of 2,053 officially recorded nuclear tests through the years 1945-1998.

After the video, students were presented with the second debate question and again they had to pick sides and defend their opinion with use of argumentation.

Afterwards, the discussion was directed towards how much science and technology, especially “war technology”, have advanced through the ages under the threat of an imminent danger, either that being wild animals, barbarians, witches, political enemies, terrorists and so forth, and how that which begun as a pure survival instinct turned into a conflict over land, religious, or political faith. Indisputably, through the process of continuous conflict and warfare, the advancements and developments of scientific research often turned out to be useful for commercial purposes as well, so we made sure not to be negative towards military research. However, we considered it appropriate to present students with a rhetorical question to ponder:

What if all the intelligence, originality and creativity of humans were directed towards solving current global issues such as scarcity problems, energy problems, and new occurring health and environmental problems, instead of discovering new ways to inflict harm?

Afterwards, students were presented with a famous quotation from Alfred Nobel, inventor of dynamite and founder of the Nobel Prize. In 1891, he said to Austrian peace partisan and authoress of the anti-war novel Lay down Your Arms, Bertha von Suttner:

Perhaps my factories will put an end to war sooner than your congresses; on the day that two army corps can mutually annihilate each other in a second, all civilized nations will surely recoil with horror and disband their troops.

(Retrieved from: www.nobelprize.org)

What we cared to discuss with the students was that, while Alfred Nobel’s thoughts seemed reasonable, history proved him wrong, as nations have possessed the knowledge and capabilities to annihilate each other and the entire planet for a long time.
now, and yet, they continue to constantly fund new research, expand the amount of military force, and engage in warfare.

We also mentioned to the students, that in a speech on the problems of being a scientist and managing social responsibility for others, made just after the atomic bomb had been dropped on Japan in 1945, Einstein compared their (physicists) problems to that of Nobel.

*Alfred Nobel invented an explosive more powerful than any then known, an exceedingly effective means of destruction. To atone for this 'accomplishment' and to relieve his conscience, he instituted his award for the promotion of peace.*

(Retrieved from: www.nobelprize.org)

The aim was to inform students that some scientists, such as Albert Einstein, have recognized and openly discussed the moral dilemmas of science. Finally, students were presented with the third debate question, and subsequently engaged in a debate. This also marked the end of our meetings. Afterwards, the students were asked to go home and reflect on the lessons, the debates and their assignments, and write a paragraph with their final comments and impressions of the lectures. Details on the students’ final comments can be found in section 4.3.2.3 Students’ Final Comments.

Before the students left, they were also given some extra printed presentation slides to take home with them, which were labeled “Food for Thought”. The slides included some famous quotations of Albert Einstein who was a known supporter and promoter of peace, which were compared to some of the views of Aristotle and Plato presented earlier, as well as some rhetorical questions for students to ponder. Students were also given all the previous PowerPoint presentations that had been used for the lectures, in case they wanted to review the material before they wrote their final comments. All the presentation slides can be found in Appendix B.

### 4.3 Data Collection Methods
The aim of the investigation was to collect both quantitative and qualitative data; therefore, a variety of instruments and methods were used.

#### 4.3.1 Quantitative
Two questionnaires, the Ethics Position Questionnaire (EPQ), and the Ethics in Science Questionnaire (ESQ), were administrated before the beginning and after the end of the lectures, while they were also given out one last time 6 months after the end of the intervention, to record any final changes. Since English was not the native language of
the students, both questionnaires were translated into Dutch with the help of a Dutch language teacher, to make sure students were able to clearly understand the questions asked. Both versions of the questionnaires (English and Dutch) can be found in Appendix C.

4.3.1.1 The Ethics Position Questionnaire

Our aim was to inquire into the moral judgment of students regarding issues of ethics in science, therefore, we had to take into consideration the individual variations that exist among students regarding their personal ethical position. There has been quite some research and several approaches describing the differences in peoples’ moral reasoning (e.g. Hogan, (1970); Hogan, (1973); Kelman & Lawrence, (1972); Kohlberg, (1968); Kohlberg, (1976); Rest, Cooper, Coder, Masanz, & Anderson, (1974)), however, Schlenker and Forsyth (1977) offer an approach which suggests that moral thought can be described most parsimoniously by taking into consideration two main factors:

A) A person’s level of idealism, meaning the extent to which someone believes that desirable consequences can always be achieved with the “right action”, and
B) The level of relativism, meaning the extent to which a person rejects the idea of universal moral rules and absolutes when making use of moral judgment.

According to Forsyth (1980), when these two dimensions are crossed and dichotomized, they produce a 2x2 taxonomy table which classifies 4 ethical ideologies based on the levels of these two dimensions, idealism and relativism (Table 4.2: The two dimensions of EPQ, Idealism and Relativism, and the four ethical ideologies). The ethical position of a person within the table is determined by whether he/she espouses idealistic or non-idealistic values and by whether he rejects universal moral rules in favor of relativism. High score on the idealism scale and high score on the relativism scale describes situationism, while high score on idealism and low relativism describes absolutism. High score on the relativism scale and low idealism describes subjectivism and low relativism score with low idealism describes exceptionism.

The 4 ethical ideologies yielded by the crossing of the two dimensions are described more analytically below (Forsyth, 1980):

(a) Situationism: advocates a contextual analysis of morally questionable actions; rejects moral rules; advocates individualistic analysis of each act in each situation; relativistic
(b) Absolutism: uses inviolate, universal moral principles to formulate moral judgments; assumes that the best possible outcome can always be achieved by following universal moral rules.

(c) Subjectivism: argues that moral judgments should depend primarily on one's own personal values; appraisals based on personal values and perspective rather than universal moral principles; relativistic.

(d) Exceptionism: admits that exceptions must sometimes be made to moral absolutes; moral absolutes guide judgments but pragmatically open to exceptions to these standards; utilitarian.

<table>
<thead>
<tr>
<th>A Taxonomy of Ethical Ideologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Idealism / Relativism</strong></td>
</tr>
<tr>
<td><strong>Low</strong></td>
</tr>
<tr>
<td><strong>High</strong></td>
</tr>
<tr>
<td><strong>Absolutists</strong></td>
</tr>
<tr>
<td>Assumes that the best possible outcome can always be achieved by following universal moral rules.</td>
</tr>
<tr>
<td><strong>Situationists</strong></td>
</tr>
<tr>
<td>Rejects moral rules; advocates individualistic analysis of each act in each situation; relativistic.</td>
</tr>
<tr>
<td><strong>Low</strong></td>
</tr>
<tr>
<td><strong>Exceptionists</strong></td>
</tr>
<tr>
<td>Moral absolutes guide judgments but pragmatically open to exceptions to these standards; utilitarian.</td>
</tr>
<tr>
<td><strong>Subjectivists</strong></td>
</tr>
<tr>
<td>Appraisals based on personal values and perspective rather than universal moral principles; relativistic.</td>
</tr>
</tbody>
</table>

Table 4.2: The two dimensions of EPQ, Idealism and Relativism, and the four ethical ideologies

In order to measure the level of idealism and relativism, Forsyth designed and published the Ethics Position Questionnaire (EPQ) in his paper *A Taxonomy of Ethical Ideologies* (1980). Forsyth supports that the instrument has the following characteristics: (a) two scales, one, to measure idealism and a second scale to measure relativism; (b) high inter-item consistency on each scale but broad representativeness of the desired constructs; (c) stability across time; and (d) orthogonality between the two scales. Also, Forsyth tested and validated the questionnaire regarding its internal consistency and reliability. Cronbach’s alpha was found .80 for Idealism and .73 for Relativism, while test-retest reliability was found .67 for Idealism and .66 for Relativism.

The EPQ is comprised of 20 attitude statements, 10 that measure the level of idealism and 10 that measure the level of relativism in a subject. The idealism score in the
original EPQ is obtained by taking the mean of first 10 items, while the relativism score is obtained by taking the mean of the last 10 items. Each person’s results are taken to be the two EPQ scores which are then crossed and show the ethical position of the subject. However in our research, we decided to mix the statements to avoid “guiding” the students by keeping a certain “direction” for a long time, so the idealism score was obtained by all odd-numbered items and the relativism score was obtained by all even-numbered items.

Furthermore, the original EPQ used a 9-point Likert scale for the statements, but it was decided to use a 7-point scale in our research instead, ranging from 1 (Completely disagree) to 7 (Completely agree). The reason behind this was that the subjects were young students and we felt they might have more difficulty to handle the extra options given by the 9-point scale used by Forsyth, i.e. “Completely disagree, Largely disagree, Moderately disagree, Slightly disagree, Neither agree not disagree, Slightly agree, Moderately agree, Largely agree, Completely agree”. Therefore, the options we decided to keep were: “Completely disagree, Disagree, Partly disagree, Neutral, Partly agree, Agree, Completely agree”. It was not possible to validate the Dutch version of the EPQ due to time constraints.

4.3.1.2 Ethics in Science Questionnaire

The Ethics in Science Questionnaire (ESQ) was designed by us for the purposes of this study after careful consideration, and it contains 29 attitude statements using a 7-point Likert scale ranging from 1 (Completely disagree) to 7 (Completely agree) just like the EPQ. The questionnaire focuses on 5 different dimensions in which we were interested regarding ethics in science:

A. Understanding and acknowledgement of Integrity (Do students acknowledge the importance of integrity in science?) This dimension comprised of 5 attitude statements:

1. Integrity is important in science and everyone should share the same rules of scientific conduct (regarding observation, data collection, reporting, etc.).

2. Scientists don’t need to share the same rules on how research is done and reported, every case is different.

3. Integrity is important to keep some basic levels of trust among scientists.

4. We live in a free world, therefore everyone has the right to conduct and report research as he/she likes and it should be considered equally valid.

5. Rules about integrity in science should form an ethical code for scientists.
B. Understanding and acknowledgement of Morality (Do students acknowledge the importance of morality in science?) This dimension comprised of 5 attitude statements:

1. Moral values are irrelevant to the scientific world.
2. Morality in science is critical to the survival of our world and the global population.
3. As long as the evidence is recorded and reported correctly (integrity), the morality of the topic being researched is not important.
4. Morality is important in science to keep the public's trust (in science).
5. Morality should be included in the ethical code of scientists.

C. Personal career vs. Social responsibility (Should either integrity or morality be sacrificed for the promotion of scientists’ personal career?) This dimension comprised of 7 attitude statements:

1. In order to compete in a global environment over funds, reputation and success, scientists can disregard integrity.
2. In order to compete in a global environment over funds, reputation and success, scientists can disregard morality.
3. If you are a scientist and your employer asks you to participate in scientific misconduct, you have a moral obligation to “blow the whistle”.
4. Like other employees, scientists have to do what they are told without moral questioning.
5. Scientists have no social responsibility for the harmful creations and applications of their science.
6. The moral aspects of a research project is also the employee's responsibility, not only the employer's.
7. Scientists should have a greater allegiance to society than their employer.

D. People vs. Science (Is science’s purpose to serve humanity or humanity’s purpose to serve science?) This dimension comprised of 6 attitude statements:

1. Science is more about discovering interesting truths, not about serving people.
2. Science has a social responsibility beyond providing new knowledge.
3. We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare.
4. It’s okay for some people to be harmed or sacrificed in order for science to advance.

5. The overall effectiveness of science can be determined by the amount of interesting knowledge that it has given us.

6. The overall effectiveness of science can be determined by the degree to which it improves people's lives.

E. Scientists’ ethical education (Should scientists be educated about matters of ethics in science and should both morality and integrity be included in that education?)

1. Morality is different for everyone so young scientists don’t need to be educated about it.

2. Morality can be (positively and/or negatively) influenced, so young scientists need a formal education on scientific ethics with a positive (moral) influence.

3. Young scientists can learn about integrity by observing older scientists, they don’t need a formal education.

4. Not all young scientists have good role models (older scientists), therefore they need a formal education to learn about the code of ethics of the world-wide scientific community.

5. Ethics (both integrity and morality) is important in science and young scientists should be educated about it.

6. There are no ethical principles in science that are so important that they should be part of any code of ethics.

Several statements were chosen to have a different direction than the rest in order to avoid guiding the students. Also, all the statements were mixed in the questionnaire so that students wouldn’t notice the similarities between some of them, hoping that they would answer impulsively and more honestly. Unfortunately however, due to time constraints the ESQ was not validated regarding its test-retest reliability and its internal consistency.

Finally, the questionnaires were not given anonymously because we wanted to follow individuals. Therefore, it was important to know the names of the students so we could see whether their classroom opinion and their written comments supported their answers in the questionnaires.
4.3.2 Qualitative

For the acquisition of qualitative information a number of methods and instruments were used. First of all, all meetings with the students were audio and video-recorded. Furthermore, we made use of a) classroom debates to actively engage students in dialogue, b) homework assignments to promote research and group discussions, and c) written comments and impressions of the students.

4.3.2.1 Classroom Debates

In order to gain insight into students’ views regarding ethics in science, we orchestrated a few debates (3 in total) within the classroom during our 2nd and our 3rd meeting.

The aim was to capture students’ attention and engage them in an active way, so when each debate question appeared on the board, students were asked to stand up and walk to the left side of the classroom if they were in favor of the statement presented, or walk to the right side if they were against.

The first debate question was presented on the board at the end of the 2nd meeting after we had discussed issues of profiling and anonymity:

1. Should data-miners be allowed to make use of any kind of data in order to maximize their company’s profit / serve their organization’s purpose?

This question was selected because we had already talked about the possibilities and the dilemmas arising from the field of data mining during the lectures, and also because we thought the students would be intrigued since they were all voluntarily following the course of Informatics. At the same time, we would get a first glimpse of students’ opinion regarding placing moral boundaries in research when it comes to sensitive personal data. Also, it answers indirectly to the question:

“Do scientists have a higher moral obligation towards their employer or the public?”

which is related to one of the dimensions in the ESQ, Personal career vs. Social Responsibility (section 4.3.1.2 Ethics in Science Questionnaire) which focuses on whether scientists should give priority to their personal career or the public’s benefit, and it was a good opportunity to acquire some qualitative information around this topic.

The second and third debate questions were presented during our 3rd meeting. The second debate question was:
2. Should there be boundaries on the kinds of research that are being conducted or do we consider science’s purpose to provide us with knowledge at any cost?

Again, the debate was over placing moral boundaries in general within science or not, something that would hopefully clarify the students’ position regarding the underlying purpose of science. Meaning, do they consider science’s purpose to serve humanity, or humanity’s purpose to serve science at all costs (when the two conflict each other), a question that was also related to one of the dimensions of the ESQ, People vs. Science. Furthermore, this question was directly related to issues of morality rather than integrity, we would therefore see whether they acknowledge the importance of morality in science and therefore the need for moral boundaries.

Finally, the last debate question was:

3. Is it moral for scientists to work on projects that support warfare?

During the last lecture, we had mentioned how science has often advanced through warfare, so the final question was solely focused on warfare related research; a part of science that also raises ethical dilemmas often, although again, not for everybody. We were interested to see the students’ views on the matter, as we expected they could greatly vary considering it’s an issue with many arguments in favor and many arguments against. This question was also directly related to one of the items in the ESQ.

Overall, apart from recording their arguments for our research, what we considered to be most valuable for the students during the debates, was the opportunity to listen to each other, practice their skills of argumentation and engage in critical thinking, while allowing for the possibility that students might change some of their views.

4.3.2.2 Homework assignments

As mentioned earlier, at the end of the first meeting, students were divided in 4 groups of 4 and were given a homework assignment to prepare for the second meeting.

Each group was assigned one famous historic scientific figure which they had to research and present to the classroom. The students were asked to research information about the scientist’s life and work, and discuss as a group with the purpose of exchanging views based on their understanding of his personal position regarding morality and the social responsibility of science. What we considered important was for students to recognize how the scientists’ personal ideology and beliefs can be reflected though their work, but also for them to exchange opinions about what may be ethical and what not.
The groups were asked to prepare a classroom presentation of 15 minutes, and give to the rest of the class a summary of the scientist’s work and their understanding regarding his ethical ideology. Furthermore, each student was asked to write a paragraph with his/her individual thoughts about the scientist s/he had been assigned with, including comments and criticism. That was important in order to collect individual views apart from the group presentations regarding the scientists.

The figures that were assigned were:

A) Group 1 - Albert Einstein, German theoretical-physicist  
B) Group 2 - Joseph Mengele, German physician  
C) Group 3 - Józef Rotblat, Polish physicist  
D) Group 4 - Shiro Ishii, Japanese microbiologist

Two figures (Albert Einstein and Joseph Rotblat) were chosen as examples of scientists with a deep moral consideration regarding science’s social responsibility and with a sensitized view towards humanity and the environment. Both scientists participated in campaigns against nuclear testing and weapons of mass destruction and they both signed the Russell-Einstein Manifesto in 1955. Albert Einstein was selected because he raised some controversial issues having participated in the creation of the atomic bomb, under the fear that Hitler was going to win WWII. However, through his anti-war campaigns and through several of his famous quotes and his non-scientific work, one can recognize his views on peace and unity. Similarly, Joseph Rotblat was selected as a remarkable personality, who, even though Jewish and personally affected by the political developments of the time, quit the Manhattan Project based on moral considerations and began a life-long campaign against the creation and use of weapons of mass destruction.

The other two figures, Joseph Mengele and Shiro Ishii, were chosen as examples of scientists whose work reflects an opposing ideology to those assigned to the other two teams. These two examples, Mengele and Ishii, were meant to contradict in a clear way the personal ethics and the views of Einstein and Rotblat, and therefore bring into students’ attention the importance of personal ethics in scientists. Meanwhile, we asked students to take into consideration the political situation of the time when researching the work of each scientist, as all of their work was affected by the war conditions of the time.

Groups were given hand-outs with all the details about the homework assignment, including an abstract and some interesting quotes about science from famous historic personalities such as Nikola Tesla, Julius Robert Oppenheimer, Martin Luther King, Jr.,
Mahatma Gandhi, and of course Albert Einstein. All hand-outs can be found in Appendix D.

4.3.2.3 Students’ Final Comments
After the end of the lectures (3rd meeting), students were asked to write an individual paragraph with their overall impressions of the lectures. The aim was to collect some information on their views after the whole intervention (lectures, debates and assignment) and see which parts drew their attention and made an impression on them. We also wanted to gain insight regarding their thoughts on scientists’ ethical education and whether they consider it important.

Specifically, they were asked:

   a) whether they found the topic of scientific ethics interesting,
   b) what stood out as important to them, and
   c) whether they believe an ethical education would be valuable and useful to future scientists

Conclusions based on the qualitative information gained through the debates, the assignments and students’ final comments are presented in chapter 7.

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5. QUANTITATIVE ANALYSIS

In this chapter I present all the statistical methods that were used in order to analyze the results of the two quantitative tools that were employed in the research, the Ethics Position Questionnaire (EPQ) and the Ethics in Science Questionnaire (ESQ). First, I discuss how the two questionnaires relate to the research questions, then I present the research hypotheses, and finally, I present all the statistical tests that were applied to data from the two questionnaires. Details regarding the results and how these relate to the relevant research questions are presented in

The relevant research questions are:

R.Q.1 Can students’ personal ethical ideology be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

R.Q.1.b What kind of effect might the intervention cause on students’ ethical ideology?

R.Q.2 Can students’ views regarding ethics in science be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

R.Q.2.b What kind of effect might the intervention cause on students’ views regarding ethics in science?

R.Q.3 Is there a correlation between students’ personal ethical ideology and their views about ethics in science?

R.Q.3.b What kind of effect might the intervention have on the correlation between students’ personal ethical ideology and their views about ethics in science?

5.1. Statistical Aims

As mentioned in chapter 2, the focus of this research is manifold. More specifically, the questionnaires and statistical methods that were used aim on measuring:

A) Whether there was an impact on students’ general ethical ideology due to the intervention (R.Q.1) and the direction of the effect (R.Q.1.b)
B) Whether there was an impact on students’ views about ethics in science due to the intervention (R.Q.2) and the direction of the effect (R.Q.2.b)

C) The correlation between students’ personal ethical ideology and their views about ethics in science (R.Q.3) and whether there was an impact on that correlation due to the intervention (R.Q.3.b)

In order to examine these issues, we used both the EPQ and the ESQ (described in section 4.3.1 Quantitative).

As mentioned in 4.2 Description of Intervention, both questionnaires were distributed to 13 respondents who were asked to indicate their level of agreement or disagreement regarding the attitude statements presented, ranging from 1 - 7 (1 meaning “Completely disagree” and 7 meaning “Completely agree”), in three different time periods. The first measurement took place right before the intervention (first interview), the second one was immediately after the intervention (second interview), and the last one was six months after the intervention (third interview).

5.2. Hypotheses

While the null Hypothesis (H₀) states that there will be no effect due to the intervention observed, the alternate hypothesis of the research was that the intervention in the form of interactive lectures, classroom discussions, debates, and group assignments would have an effect on students’ ethical ideology and on their views about ethics in science. However, we did not state a hypothesis regarding the direction of the changes. Instead, we only stated a hypothesis regarding the degree of the change observed in the three time periods.

More specifically, our hypothesis was that the differences between the scores of the first and second rounds of results would be greater than the difference between the first and third rounds, meaning that some of the changes would be partly undone within the 6 month-period, although not completely. In other words, we expected that right after the intervention students’ views would be found to be influenced by the intervention, and that only part of this effect would fade away after the 6 months, signifying a lasting effect.

Therefore, our detailed hypotheses for this study are:
In the second stage of the analysis, we examined the possibility of a correlation between the two instruments (the EPQ and the ESQ). First, we calculated the correlation based on the average scores of the questionnaires from all 3 interviews, and then we recalculated these correlations for each stage of our research, that is before, right after, and 6 months after the intervention, in order to see if any notable changes occurred due to the intervention.

Therefore, our hypothesis regarding the correlation between the EPQ and the ESQ is:

\[ \text{H}_3: \text{There will be an effect on the relationship between the EPQ and the ESQ due to the intervention.} \]

Further on, I present the statistical tests that were applied on each questionnaire:

### 5.3. Ethics Position Questionnaire (EPQ)

The EPQ questionnaire (section 4.3.1.1) consists of 20 attitude statements, 10 concerning Idealism and 10 concerning Relativism. For each respondent we calculated two scores, which are the mean values of the relevant items. Table 5.1 below summarizes the characteristics of the two scales of the EPQ questionnaire in the three stages of the research (before, right after, and 6 months after the intervention).
### Descriptive Statistics

<table>
<thead>
<tr>
<th>Interview index</th>
<th>Scale</th>
<th>Scale mean</th>
<th>Scale SD</th>
<th>Inter-scale correlations</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Idealism</td>
<td></td>
</tr>
<tr>
<td>First interview</td>
<td>Idealism</td>
<td>5.47</td>
<td>0.80</td>
<td>1.0</td>
<td>-0.209</td>
</tr>
<tr>
<td></td>
<td>Relativism</td>
<td>5.05</td>
<td>0.60</td>
<td>-0.209</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
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<td>13</td>
<td>13</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Second interview</td>
<td>Idealism</td>
<td>5.22</td>
<td>0.76</td>
<td>1.0</td>
<td>0.186</td>
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<tr>
<td></td>
<td>Relativism</td>
<td>4.55</td>
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<td>0.186</td>
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<td></td>
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<td>13</td>
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<td>13</td>
</tr>
<tr>
<td>Third interview</td>
<td>Idealism</td>
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<td>-0.201</td>
</tr>
<tr>
<td></td>
<td>Relativism</td>
<td>4.71</td>
<td>0.48</td>
<td></td>
<td>-0.201</td>
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<tr>
<td></td>
<td>N</td>
<td>13</td>
<td>13</td>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

Table 5.1: Characteristics of the EPQ in the three time periods

The first column presents the mean value of Idealism and Relativism in each time period and the second column gives the corresponding standard deviation. Columns three and four show the correlation between the two scales. According to the inter-scale correlations, a positive correlation between the two scales is observed only during the second interview while in the first and the last interview, the corresponding correlations are negative. None of these correlations is statistically significant at the level of 0.01 or 0.05. Finally, column five presents the level of Cronbach’s alpha for each scale in each time period. The Cronbach’s alpha index, that is a measure of internal consistency, is satisfactory for the Idealism scale, but not for the Relativism scale, especially in the third interview. However, Cronbach’s alpha is only indicative in our case, as our number of respondents was too small.

**Analysis of Variance (ANOVA)** with repeated measures was used to compare the means of the Idealism and Relativism scale in the three stages of the intervention (Table 5.2: Idealism Mean and SD for each interview and Table 5.3: Relativism Mean and SD for each interview). The mean and the standard deviation of Idealism is almost equal to those of Relativism, although there are slightly higher values in the scale of Idealism. Specifically, the respondents had a slightly greater mean score in Idealism than in Relativism in all three time periods.

**Idealism (ANOVA)**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEALISM1</td>
<td>5.47</td>
<td>0.80</td>
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<tr>
<td>IDEALISM2</td>
<td>5.22</td>
<td>0.76</td>
</tr>
<tr>
<td>IDEALISM3</td>
<td>5.27</td>
<td>0.76</td>
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</table>

**Relativism (ANOVA)**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELATIVISM1</td>
<td>5.05</td>
<td>0.60</td>
</tr>
<tr>
<td>RELATIVISM2</td>
<td>4.55</td>
<td>0.56</td>
</tr>
<tr>
<td>RELATIVISM3</td>
<td>4.71</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Table 5.2: Idealism Mean and SD for each interview

Table 5.3: Relativism Mean and SD for each interview
We also conducted Multivariate Tests for the main effect of the factors Idealism and Relativism in order to discover any statistically significant difference among the three stages of intervention for either factor (Table 5.4: Multivariate tests for Idealism and Table 5.5: Multivariate tests for Relativism).

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
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<tbody>
<tr>
<td>IDEALISM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai's Trace</td>
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<td>0.874&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.444</td>
<td>0.137</td>
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<td>2.000</td>
<td>11.000</td>
<td>0.444</td>
<td>0.137</td>
</tr>
<tr>
<td>Hotelling's Trace</td>
<td>0.159</td>
<td>0.874&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.444</td>
<td>0.137</td>
</tr>
<tr>
<td>Roy's Largest Root</td>
<td>0.159</td>
<td>0.874&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.444</td>
<td>0.137</td>
</tr>
</tbody>
</table>

a. Exact statistic  
b. Design: Intercept  
Within Subjects Design: IDEALISM  

Table 5.4: Multivariate tests for Idealism

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELATIVISM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai's Trace</td>
<td>0.375</td>
<td>3.298&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.075</td>
<td>0.375</td>
</tr>
<tr>
<td>Wilks' Lambda</td>
<td>0.625</td>
<td>3.298&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.075</td>
<td>0.375</td>
</tr>
<tr>
<td>Hotelling's Trace</td>
<td>0.600</td>
<td>3.298&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.075</td>
<td>0.375</td>
</tr>
<tr>
<td>Roy's Largest Root</td>
<td>0.600</td>
<td>3.298&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.000</td>
<td>11.000</td>
<td>0.075</td>
<td>0.375</td>
</tr>
</tbody>
</table>

a. Exact statistic  
b. Design: Intercept  
Within Subjects Design: RELATIVISM  

Table 5.5: Multivariate tests for Relativism

No statistically significant effect was found based on the ANOVA tests, disproving our $H_1a$ hypothesis (There will be a significant difference in students’ ethical ideology as a result of the intervention). However, due to the small number of participants, the ANOVA results are not 100% reliable and need careful interpretation. For that reason, further tests were applied.

In order to test the assumption of sphericity due to the repeated measures ANOVA that we used, we conducted the Mauchly’s Test of Sphericity for both Idealism and Relativism. This tests the null hypothesis that the error covariance matrix of the
orthonormalized transformed dependent variables is proportional to an identity matrix (Table 5.6: Maychly’s Test for the assumption of sphericity for Idealism and Table 5.7).

### Mauchly’s Test of Sphericity (Idealism)

<table>
<thead>
<tr>
<th>Within Subjects Effect</th>
<th>Mauchly’s W</th>
<th>Approx. Chi-Square</th>
<th>df</th>
<th>Sig.</th>
<th>Epsilon a</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEALISM</td>
<td>0.772</td>
<td>2.843</td>
<td>2</td>
<td>0.241</td>
<td>0.814</td>
</tr>
</tbody>
</table>

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects (Table 5.8)

b. Design: Intercept
Within Subjects Design: IDEALISM

Table 5.6: Maychly’s Test for the assumption of sphericity for Idealism

### Mauchly’s Test of Sphericity (Relativism)

<table>
<thead>
<tr>
<th>Within Subjects Effect</th>
<th>Mauchly’s W</th>
<th>Approx. Chi-Square</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELATIVISM</td>
<td>0.689</td>
<td>4.097</td>
<td>2</td>
<td>0.129</td>
</tr>
</tbody>
</table>

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects (Table 5.9)

b. Design: Intercept
Within Subjects Design: relativism

Table 5.7: Maychly’s Test for the assumption of sphericity for relativism

The significance value was 0.241 (>0.001) for Idealism, and 0.129 (>0.005) for Relativism which means that the assumption of sphericity has not been violated.

We also conducted Tests of Within-Subject Effect first for Idealism (Table 5.8: Test of Within-Subject Effect for Idealism.) and then for Relativism (Table 5.9) in order to measure how much an individual in our sample tends to change over time.
### Tests of Within-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEALISM</td>
<td>0.445</td>
<td>2</td>
<td>0.223</td>
<td>1.020</td>
<td>0.376</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>Sphericity Assumed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greenhouse-Geisser</td>
<td>0.445</td>
<td>1.629</td>
<td>0.273</td>
<td>1.020</td>
<td>0.364</td>
</tr>
<tr>
<td></td>
<td>Huynh-Feldt</td>
<td>0.445</td>
<td>1.849</td>
<td>0.241</td>
<td>1.020</td>
<td>0.371</td>
</tr>
<tr>
<td></td>
<td>Lower-bound</td>
<td>0.445</td>
<td>1.000</td>
<td>0.445</td>
<td>1.020</td>
<td>0.332</td>
</tr>
<tr>
<td>Error(IDEALISM)</td>
<td>Sphericity Assumed</td>
<td>5.235</td>
<td>24</td>
<td>0.218</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greenhouse-Geisser</td>
<td>5.235</td>
<td>19.548</td>
<td>0.268</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Huynh-Feldt</td>
<td>5.235</td>
<td>22.189</td>
<td>0.236</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower-bound</td>
<td>5.235</td>
<td>12.000</td>
<td>0.436</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8: Test of Within-Subject Effect for Idealism.

Looking at the values in the sphericity assumed row, the F value was 1.020 and the significance value was 0.376>0.005 for Idealism. Thus, there was no significant effect of time of measurement on the values of Idealism.

### Tests of Within-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELATIVISM</td>
<td>1.705</td>
<td>2</td>
<td>0.853</td>
<td>5.479</td>
<td>0.011</td>
<td>0.313</td>
</tr>
<tr>
<td></td>
<td>Sphericity Assumed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greenhouse-Geisser</td>
<td>1.705</td>
<td>1.526</td>
<td>1.118</td>
<td>5.479</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>Huynh-Feldt</td>
<td>1.705</td>
<td>1.702</td>
<td>1.002</td>
<td>5.479</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>Lower-bound</td>
<td>1.705</td>
<td>1.000</td>
<td>1.705</td>
<td>5.479</td>
<td>0.037</td>
</tr>
<tr>
<td>Error(RELATIVISM)</td>
<td>Sphericity Assumed</td>
<td>3.735</td>
<td>24</td>
<td>0.156</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greenhouse-Geisser</td>
<td>3.735</td>
<td>18.307</td>
<td>0.204</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Huynh-Feldt</td>
<td>3.735</td>
<td>20.430</td>
<td>0.183</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower-bound</td>
<td>3.735</td>
<td>12.000</td>
<td>0.311</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.9: Test of Within-Subject Effect for Relativism.
For Relativism, the F value was 5.479 and the significance value was 0.011>0.005 (Table 5.9: Test of Within-Subject Effect for Relativism). Thus, there was no significant effect of time of measurement on the values of Relativism either.

Even though no statistically significant effect was found based on the ANOVA, we were interested in investigating the direction of the changes regarding individual subjects, so next we conducted Wilcoxon Signed-Rank Test for paired samples for both scales since the number of participants was small and the population could not be assumed to be normally-distributed. Here we focused on the differences between the first and second interviews, and between the second and third interviews in each subject. The Wilcoxon test is presented in Table 5.10: Wilcoxon signed-rank test for Idealism and Relativism. and Table 5.11: Wilcoxon Results.

<table>
<thead>
<tr>
<th>Wilcoxon Signed-Rank Test</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IDEALISM2 - IDEALISM1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>9</td>
<td>5.67</td>
<td>51.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>2</td>
<td>7.50</td>
<td>15.00</td>
</tr>
<tr>
<td>Ties</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IDEALISM3 - IDEALISM2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>6</td>
<td>4.58</td>
<td>27.50</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>4</td>
<td>6.88</td>
<td>27.50</td>
</tr>
<tr>
<td>Ties</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RELATIVISM2 - RELATIVISM1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>9</td>
<td>6.44</td>
<td>58.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>2</td>
<td>4.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Ties</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RELATIVISM3 - RELATIVISM2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>5</td>
<td>4.30</td>
<td>21.50</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>7</td>
<td>8.07</td>
<td>56.50</td>
</tr>
<tr>
<td>Ties</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. IDEALISM2 < IDEALISM1
b. IDEALISM2 > IDEALISM1
c. IDEALISM2 = IDEALISM1
d. IDEALISM3 < IDEALISM2
e. IDEALISM3 > IDEALISM2
f. IDEALISM3 = IDEALISM2
g. RELATIVISM2 < RELATIVISM1
h. RELATIVISM2 > RELATIVISM1
i. RELATIVISM2 = RELATIVISM1
j. RELATIVISM3 < RELATIVISM2
k. RELATIVISM3 > RELATIVISM2
l. RELATIVISM3 = RELATIVISM2

Table 5.10: Wilcoxon signed-rank test for Idealism and Relativism.
Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>IDEALISM2 - IDEALISM1</th>
<th>IDEALISM3 - IDEALISM2</th>
<th>RELATIVISM2 - RELATIVISM1</th>
<th>RELATIVISM3 - RELATIVISM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-1.604&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-2.224&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-1.380&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0.109</td>
<td>1.000</td>
<td>0.026</td>
<td>0.168</td>
</tr>
</tbody>
</table>

a. Based on positive ranks.
b. The sum of negative ranks equals the sum of positive ranks.
c. Based on negative ranks.
d. Wilcoxon Signed Ranks Test

Table 5.11: Wilcoxon Results

The results of Wilcoxon signed ranks test [p-value = ½ Asymp.Sig (2-tailed)>0.05] showed that the intervention did not elicit a statistically significant change in the ranks of Idealism right after and six months after the intervention. However, the rank difference between Idealism1 and Idealism2 came very close to a statistically significant measure [p-value = ½ Asymp.Sig (2-tailed)=0.0545>0.05]. Also, Relativism between the second and third interview did not change significantly [p-value = ½ Asymp.Sig (2-tailed)= 0.084 >0.05], whereas the ranks of Relativism were significantly higher in the first interview than they were in the second [p-value = ½ Asymp.Sig (2-tailed) = 0.013 <0.05]. The results regarding individual subjects are analyzed more in detail in chapter 5.4.

5.4. Ethics in Science Questionnaire (ESQ)
As far as the ESQ is concerned, we used 29 attitude statements to investigate students’ views about ethics in science. These items are clustered in 5 new dimensions (scales) which compress all the information and give us the opportunity to continue our analysis using a smaller database. We did not do a Factor Analysis for the clustering of the items, since our sample was very small and the results would not be reliable. The structure of these five scales (Integrity, Morality, Scientists’ Social Responsibility, People vs. Science, and Scientists’ Ethical Education) has been analytically presented in section 4.3.1.2 Ethics in Science Questionnaire According to this clustering, we calculate five mean scores out of the items that compose each scale. Since some statements have positive and others negative phrasing, the items that have different orientation are reversed in the analysis to point to the same direction as the rest.

Table 5.12 presents the statistical characteristics of the ESQ including the mean values, the standard deviations and the level of internal consistency (Cronbach’s alpha). The last five columns present the correlations among the 5 scales of the questionnaire. The symbol * which marks some of the correlations means that the correlation is significant
at the level of 0.01, while the symbol ** means that the correlation is significant at the level of 0.05. The correlations which do not have any * symbols are not statistically significant.

In Table 5.12 below we observe the following correlations:

- between People vs. Science and Scientists’ Ethical Education during the first interview,
- between Personal Career vs. Scientists’ Social Responsibility and Scientists’ Ethical Education during the second interview,
- between Personal Career vs. Scientists’ Social Responsibility and People vs. Science in the third interview, and
- between Personal Career vs. Scientists’ Social Responsibility and Scientists’ Ethical Education during the third interview.

We would expect a correlation to appear between Morality and the following three dimensions (Personal Career vs. Scientists’ Social Responsibility, People vs. Science, and Scientists’ Ethical Education), however such correlations were not observed during any stage of the research.
### Descriptive Statistics

<table>
<thead>
<tr>
<th>Interview index</th>
<th>Scale</th>
<th>N</th>
<th>Scale mean</th>
<th>Scale SD</th>
<th>Cronbach’s Alpha</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Integrity</td>
</tr>
<tr>
<td><strong>First</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.Integrity</td>
<td>13</td>
<td>4.78</td>
<td>0.55</td>
<td>0.38</td>
<td>1</td>
<td>-0.208</td>
</tr>
<tr>
<td>2.Morality</td>
<td>13</td>
<td>4.32</td>
<td>0.51</td>
<td>0.47</td>
<td>-0.208</td>
<td>1</td>
</tr>
<tr>
<td>3.Scientists’ Social Responsibility</td>
<td>13</td>
<td>3.75</td>
<td>0.70</td>
<td>0.51</td>
<td>-0.233</td>
<td>-0.259</td>
</tr>
<tr>
<td>4.People vs. Science</td>
<td>13</td>
<td>4.83</td>
<td>0.79</td>
<td>0.44</td>
<td>0.070</td>
<td>0.230</td>
</tr>
<tr>
<td>5.Ethical Education</td>
<td>13</td>
<td>4.31</td>
<td>0.67</td>
<td>0.52</td>
<td>-0.114</td>
<td>0.157</td>
</tr>
<tr>
<td><strong>Second</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.Integrity</td>
<td>13</td>
<td>4.17</td>
<td>0.66</td>
<td>0.45</td>
<td>1</td>
<td>-0.037</td>
</tr>
<tr>
<td>2.Morality</td>
<td>13</td>
<td>4.40</td>
<td>0.41</td>
<td>0.58</td>
<td>-0.037</td>
<td>1</td>
</tr>
<tr>
<td>3.Scientists’ Social Responsibility</td>
<td>13</td>
<td>3.91</td>
<td>0.46</td>
<td>0.52</td>
<td>0.068</td>
<td>0.176</td>
</tr>
<tr>
<td>4.People vs. Science</td>
<td>13</td>
<td>4.59</td>
<td>0.58</td>
<td>0.47</td>
<td>0.406</td>
<td>0.396</td>
</tr>
<tr>
<td>5.Ethical Education</td>
<td>13</td>
<td>4.33</td>
<td>0.68</td>
<td>0.64</td>
<td>0.546</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Third</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.Integrity</td>
<td>13</td>
<td>4.34</td>
<td>0.35</td>
<td>0.58</td>
<td>1</td>
<td>0.057</td>
</tr>
<tr>
<td>2.Morality</td>
<td>13</td>
<td>4.45</td>
<td>0.49</td>
<td>0.54</td>
<td>0.057</td>
<td>1</td>
</tr>
<tr>
<td>3.Scientists’ Social Responsibility</td>
<td>13</td>
<td>4.13</td>
<td>0.62</td>
<td>0.45</td>
<td>0.106</td>
<td>0.314</td>
</tr>
<tr>
<td>4.People vs. Science</td>
<td>13</td>
<td>4.58</td>
<td>0.58</td>
<td>0.63</td>
<td>0.122</td>
<td>0.330</td>
</tr>
<tr>
<td>5.Ethical Education</td>
<td>13</td>
<td>4.53</td>
<td>0.63</td>
<td>0.57</td>
<td>0.362</td>
<td>-0.230</td>
</tr>
</tbody>
</table>

Table 5.12: Characteristics of the ESQ
Next, we conducted **Analysis of Variance (ANOVA)** with repeated measures for each factor. Multivariate tests of the analysis is a way to look for the main effect of the factors of the ESQ that was used, in order to discover any statistically significant differences among the three stages of the intervention for the five dimensions (Table 5.13).

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai's Trace</td>
<td>0.422</td>
<td>4.013</td>
<td>2.000</td>
<td>11.000</td>
<td>0.049</td>
<td>0.422</td>
</tr>
<tr>
<td>Wilks' Lambda</td>
<td>0.578</td>
<td>4.013</td>
<td>2.000</td>
<td>11.000</td>
<td>0.049</td>
<td>0.422</td>
</tr>
<tr>
<td>Hotelling's Trace</td>
<td>0.730</td>
<td>4.013</td>
<td>2.000</td>
<td>11.000</td>
<td>0.049</td>
<td>0.422</td>
</tr>
<tr>
<td>Roy's Largest Root</td>
<td>0.730</td>
<td>4.013</td>
<td>2.000</td>
<td>11.000</td>
<td>0.049</td>
<td>0.422</td>
</tr>
<tr>
<td><strong>Morality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai's Trace</td>
<td>0.059</td>
<td>0.343</td>
<td>2.000</td>
<td>11.000</td>
<td>0.717</td>
<td>0.059</td>
</tr>
<tr>
<td>Wilks' Lambda</td>
<td>0.941</td>
<td>0.343</td>
<td>2.000</td>
<td>11.000</td>
<td>0.717</td>
<td>0.059</td>
</tr>
<tr>
<td>Hotelling's Trace</td>
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<td>2.000</td>
<td>11.000</td>
<td>0.439</td>
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</tr>
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</table>

a. Exact statistic

b. Design: Intercept

**Table 5.13: Multivariate test for each factor of the ESQ**
The significance values were greater than 0.005 for all of the dimensions indicating that there were no significant differences among the three measurements of these in the three stages of intervention.

Mauchly’s Test of Sphericity below was used to test the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix (Table 5.14).

<table>
<thead>
<tr>
<th>Within Subjects Effect</th>
<th>Mauchly's W</th>
<th>Approx. Chi-Square</th>
<th>df</th>
<th>Sig.</th>
<th>Greenhouse-Geisser</th>
<th>Huynh-Feldt</th>
<th>Epsilon a</th>
<th>Lower-bound</th>
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<td>Integrity</td>
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<td>2.973</td>
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<td>0.226</td>
<td>0.809</td>
<td>0.916</td>
<td>0.500</td>
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</tr>
<tr>
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<td>0.236</td>
<td>0.812</td>
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<td>Science serving people</td>
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<td>0.969</td>
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<td>1.094</td>
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<td>0.914</td>
<td>1.000</td>
<td>0.500</td>
<td></td>
</tr>
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</table>

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept

Table 5.14: Mauchly’s Test for the assumption of sphericity for all factors of the ESQ

The results of the Mauchly’s Test of Sphericity indicate that the assumption of sphericity has not been violated, as the significance value is greater than 0.005 for all 5 factors.

Again, we conducted Tests of Within-Subjects Effects. Looking at the values in the sphericity assumed row in Table 5.15: Tests of Within-Subjects Effects for all factors of the ESQ. (following), the significance value for all factors is higher than 0.005. Thus, there is no significant effect of time of measurement on the values of the ESQ factors.
## Tests of Within-Subjects Effects

<table>
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<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
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</tr>
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<td>24.000</td>
<td>.228</td>
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</tr>
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</table>

Table 5.15: Tests of Within-Subjects Effects for all factors of the ESQ.

Once again, even though no statistically significant effect was found based on the ANOVA, we are interested to investigate the direction of the changes regarding individual subjects, so next we conducted Wilcoxon Signed-Rank Test (Table 5.16 and Table 5.17: Wilcoxon results) for paired samples for all the dimensions of the ESQ, since the number of participants is small and the population cannot be assumed to be normally-distributed. Here we focused on the differences between the first and second interviews, and between the second and third interviews in each subject. The Wilcoxon tests are presented below while the results are discussed in detail in chapter
### Wilcoxon signed-rank test

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<th>Sum of Ranks</th>
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<td>6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.83</td>
<td>47.00</td>
</tr>
<tr>
<td>Ties</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social responsibility3 – social responsibility2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.25</td>
<td>29.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.89</td>
<td>62.00</td>
</tr>
<tr>
<td>Ties</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Science serving people2 – science serving people1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.81</td>
<td>62.50</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.70</td>
<td>28.50</td>
</tr>
<tr>
<td>Ties</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Science serving people3 – science serving people2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.67</td>
<td>34.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.40</td>
<td>32.00</td>
</tr>
<tr>
<td>Ties</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ethical education2 – ethical education1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.70</td>
<td>33.50</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.36</td>
<td>44.50</td>
</tr>
<tr>
<td>Ties</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ethical education3 – ethical education2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>5&lt;sup&gt;a&lt;/sup&gt;b</td>
<td>7.00</td>
<td>35.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>8&lt;sup&gt;a&lt;/sup&gt;c</td>
<td>7.00</td>
<td>56.00</td>
</tr>
<tr>
<td>Ties</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
a. integrity2 < integrity1  
b. integrity2 > integrity1  
c. integrity2 = integrity1  
d. integrity3 < integrity2  
e. integrity3 > integrity2  
f. integrity3 = integrity2  
g. morality2 < morality1  
h. morality2 > morality1  
i. morality2 = morality1  
j. morality3 < morality2  
k. morality3 > morality2  
l. morality3 = morality2  
m. social responsibility2 < social responsibility1  
n. social responsibility2 > social responsibility1  
o. social responsibility2 = social responsibility1  
p. social responsibility3 < social responsibility2  
q. social responsibility3 > social responsibility2  
r. social responsibility3 = social responsibility2  
s. science serving people2 < science serving people1  
t. science serving people2 > science serving people1  
u. science serving people2 = science serving people1  
v. science serving people3 < science serving people2  
w. scienceservingpeople3 > scienceservingpeople2  
x. science serving people3 = science serving people2  
y. ethical education2 < ethical education1  
z. ethical education2 > ethical education1  
aa. ethical education2 = ethical education1  
ab. Ethical education3 < ethical education2  
ac. Ethical education3 > ethical education2  
ad. Ethical education3 = ethical education2

Table 5.16: Wilcoxon signed-rank test for the ESQ.

<table>
<thead>
<tr>
<th></th>
<th>integrity2 - integrity1</th>
<th>integrity3 - integrity2</th>
<th>morality2 - morality1</th>
<th>morality3 - morality2</th>
<th>social responsibility2 - social responsibility1</th>
<th>social responsibility3 - social responsibility2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-2.169a</td>
<td>-0.512b</td>
<td>-0.417b</td>
<td>-0.448b</td>
<td>-0.105b</td>
<td>-1.157b</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0.030</td>
<td>0.609</td>
<td>0.677</td>
<td>0.654</td>
<td>0.916</td>
<td>0.247</td>
</tr>
</tbody>
</table>

a. Based on positive ranks.  
b. Based on negative ranks.  
c. Wilcoxon Signed Ranks Test
As we can see, none of the examined changes were statistically significant \[ p\text{-value} = \frac{1}{2} \text{Asymp.Sig (2-tailed)}>0.05 \] except the difference between integrity in the second interview and integrity in the initial interview \[ p\text{-value} = \frac{1}{2} \text{Asymp.Sig (2-tailed)} = 0.015 >0.05 \]. For this difference, the test showed that the index had a higher value in the second interview than the first interview.

5.5. Correlations
In the last part of our study, we examine the existence of a potential correlation between the two questionnaires using the Pearson correlation coefficient. The mean scores of the correlations among the factors from the EPQ and the ESQ questionnaire are given in Table 5.18: Correlations between the factors of EPQ and ESQ based on mean scores of the three interviews.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Morality</strong></td>
<td>0.17</td>
<td>-0.11</td>
</tr>
<tr>
<td><strong>Scientists’ social responsibility</strong></td>
<td>0.30</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>People vs. science</strong></td>
<td>0.67**</td>
<td>-0.06</td>
</tr>
<tr>
<td><strong>Ethical education</strong></td>
<td>0.42**</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

Table 5.18: Correlations between the factors of EPQ and ESQ based on mean scores of the three interviews.
Here we can see that, overall, there was a statistically significant correlation between Idealism and People vs. science, as well as Idealism and Scientists’ Ethical Education.

Again, we note that the symbol * means that this correlation is significant at level 0.01, while the symbol ** means that it is significant at level 0.05. The correlations which do not have any * symbols are not statistically significant.

The respective correlations were calculated again, taking into account the stage of the research. Table 5.19-Table 5.21 give the correlations before, after, and 6 months after the intervention.

<table>
<thead>
<tr>
<th>Pearson correlations</th>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Integrity</td>
<td>0.24</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Morality</td>
<td>-0.06</td>
<td>-0.30</td>
</tr>
<tr>
<td></td>
<td>Scientists’ social responsibility</td>
<td>-0.31</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>People vs. science</td>
<td>0.63*</td>
<td>-0.17</td>
</tr>
<tr>
<td></td>
<td>Ethical education</td>
<td>0.30</td>
<td>-0.22</td>
</tr>
</tbody>
</table>

Table 5.19: Correlations before the intervention.

Before the intervention, a correlation was observed only between Idealism and People vs. Science.

<table>
<thead>
<tr>
<th>Pearson correlations</th>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Integrity</td>
<td>0.07</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>Morality</td>
<td>0.38</td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>Scientists’ social responsibility</td>
<td>0.71**</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>People vs. science</td>
<td>0.75**</td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>Ethical education</td>
<td>0.48</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Table 5.20: Correlations right after the intervention.
Right after the intervention, a correlation was observed between Idealism and two dimensions of the ESQ; Scientists’ social responsibility and People vs. Science.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity</td>
<td>-0.03</td>
<td>0.57*</td>
</tr>
<tr>
<td>Morality</td>
<td>0.30</td>
<td>0.38</td>
</tr>
<tr>
<td>Scientists’ social responsibility</td>
<td>0.85**</td>
<td>-0.18</td>
</tr>
<tr>
<td>People vs. science</td>
<td>0.63*</td>
<td>0.10</td>
</tr>
<tr>
<td>Ethical education</td>
<td>0.54</td>
<td>-0.31</td>
</tr>
</tbody>
</table>

Table 5.21: Correlations 6 months after the intervention.

Finally, six months after the intervention, a correlation was observed between Idealism, Scientists’ social responsibility and People vs. Science, as well as between Relativism and Integrity.

Overall, one the one hand the statistical tests that were applied to our data are necessary to give us a few indications regarding the level of significance of the changes that were observed; however, the small number of participants constitutes a serious barrier to form any concrete conclusions. For that reason, in the Results chapter, there has been an effort to focus on and analyze deeper isolated questions and individual subjects to get a clearer view of the actual effects of the intervention.

More details and discussion are presented next, in chapter 6.
6. QUANTITATIVE RESULTS

In this chapter, the results of the quantitative aspects of the research are presented in three categories. First, I discuss the results that were obtained through the EPQ and how these answer to the relevant research questions (R.Q.1 and R.Q.1.b). Afterwards, I discuss the results that were obtained through the ESQ and how these answer to the relevant research questions (R.Q.2 and R.Q.2.b). Finally, I discuss how the results answer R.Q.3 and R.Q.3.b regarding the correlation between the two instruments.

6.1 Ethics Position Questionnaire (EPQ)

6.1.1 Idealism and Relativism

The results from the statistical tests that were applied on the EPQ, showed no statistically significant difference among the three stages of the intervention for either Idealism or Relativism (Multivariate Tests, Tables 6 and 7 in chapter 5). We did observe a slight change in the mean scores of the two factors, both of which showed a decrease after the intervention, with Idealism scoring a little bit higher than Relativism during all three phases of the research, even though they were not found to be statistically significant (Table 6.1).

<table>
<thead>
<tr>
<th></th>
<th>First Interview</th>
<th>Second Interview</th>
<th>Third Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEALISM</td>
<td>5.47</td>
<td>5.22</td>
<td>5.27</td>
</tr>
<tr>
<td>RELATIVISM</td>
<td>5.05</td>
<td>4.55</td>
<td>4.71</td>
</tr>
</tbody>
</table>

Table 6.1: Comparison of mean scores of Idealism and Relativism

Further on, we were interested to investigate the direction of the changes regarding individual students. Based on the Wilcoxon Signed-Rank Test for paired samples (Tables 5.10 and 5.11, section 5.3), we were able to compute two bar charts to represent the changes in individual students in each of the two dimensions. What we are interested in is recording any potential lasting effects on students’ views caused by the intervention. A lasting effect means that the student showed a change in his/her scores (which could be either an increase or a decrease), especially when comparing an individual’s scores between interviews 1 (before the intervention) and 3 (six months after). A student is not considered to have a lasting effect if his/her scores returned to their original position six months after the intervention, or very close to. As we can observe from the bar charts following, some effects are small while others are big, while some students show an
effect only six months after the intervention, which could mean that they needed more time before changing their views, even if the change is relatively small.

The vertical axis of the two bar charts represents the eventual score that each student attained in each dimension.

6.1.2 Changes in Individual Students

A. Idealism

Graph 6.1 portrays a bar chart showing in detail each student’s differences in his/her level of Idealism between the three interviews.

Overall, 9 individuals were found to have lower scores of Idealism in the second interview than the first one, 2 increased their score in the second interview in relation to the first one and 2 remained at the same level. Six students had lower scores in the third interview than in the second, 4 increased their Idealism score from the second to the third interview and 3 did not change.
Analytically, after the six-month-time-period and compared to their original responses, in 3 cases (23%) the level of Idealism increased (students 1, 4, 5), in 9 cases (69.2%) the level of Idealism decreased (students 2, 3, 6, 7, 8, 9, 10, 11, 13), while in one case the level of Idealism returned to the original level (student 12), after having gone through a large decrease during the second interview.

Interesting cases were those of students 2, 6 and 8 where the difference remained exactly the same between the second and third round of interviews. This disproves our hypothesis $H_{4,b}$ (a fraction of the change would be partly undone after the six-month period) but it could indicate a lasting effect, although for students 6 and 8 the change is very small. Students 3 and retained their original scores right after the intervention, but showed a change only after the six-month period. Other interesting cases were those of students 4 and 9, where the differences between the second and third round of interviews had a completely different direction of change compared to their original scores which could indicate either that they changed their mind very easily, or that they were not honest with their views in all three interviews. Another possibility, equally likely, is that some students may have been unsure of their views, and so changed after time because they had thought more about it. Student 12 had a big drop right after the intervention, which was completely reversed after the six-month period, which indicates that the intervention did not have a lasting effect, but rather a superficial one. Finally, students 7, 10 and 11 were also interesting cases, disproving our original hypothesis since the change in their views was not partly undone, but instead their idealism appeared to decrease even further after six months. Overall, only students 1 and 13 matched our $H_{4,b}$ hypothesis.

B. Relativism

Measurements of students’ Relativism show overall similar variations to those seen for Idealism (cf. Graph 6.1 and Graph 6.2). The bar chart below shows each student’s differences in his/her level of Relativism between the three interviews (Graph 6.2).
Graph 6.2: Changes in each student’s level of Relativism in the three time periods.

Here we see that after the six-month-time-period and compared to their original responses, in only two cases the level of Relativism increased (students 4 and 5), in nine cases the level of Relativism decreased (students 2, 3, 6, 7, 9, 10, 11, 12, 13) which explains the decrease in the mean scores of Relativism (Table 6.1), while in two cases the level of Relativism returned to its’ original level (students 1 and 8).

Students 2, 3, 6, and 11 matched our $H_{1b}$ hypothesis that the degree of change will be partly undone, however, in the case of student 3 the change was almost completely reversed which indicates that there was not lasting effect. Other interesting cases were those of students 9, 10 and 13 whose Relativism continued to decrease after the six-month period disproving our $H_{1b}$ hypothesis but indicating a lasting effect, while students 4 and 12 only showed a change after the six-month period which was rather small. Student 5 seemed to retain exactly the same level of Relativism between the second and third round of interviews also indicating a lasting effect. Finally, as we said above, in students 1 and 8 the change was completely reversed indicating that the effect of the intervention was rather superficial. Eventually, our $H_{1b}$ hypothesis holds only for a few students; subjects 2, 6 and 11.
Overall concerning *Idealism*, students 1, 2, 6, 7, 8, 10, 11 and 13 showed a lasting effect after the 6 month period, while students 3 and 5 which kept their original views right after the intervention showed a change only after the six-month period, which could mean they needed more time to assimilate and assess the information and change their views.

Concerning *Relativism*, students 2, 5, 6, 9, 10, 11 and 13 seemed to have a lasting effect on their level of *Relativism* due to the intervention, while students 4 and 12 seem to have needed more time before the intervention had an impact on their views, even though the change was rather small.

In sum, regarding both *Idealism* and *Relativism*, while our $H_1b$ (a fraction of the change would be partly undone after the six-month period) was true based on the mean scores of the students, it holds only for particular students, not for everyone.

### 6.1.3 Students’ Ethical Taxonomy

Regarding the overall direction of the effect, we can obtain an overview of each student’s ethical ideology by crisscrossing the two scores (*Idealism* and *Relativism*) of individual students. A comprehensive representation of the changes in students’ ethical ideology between the three time periods has been plotted (Graph 6.3 and Graph 6.4). It is noted that each subject is classified according to Forsyth’s ethical taxonomy (section 4.3.1.1) as:

- **Situationists** (high idealism and high relativism)
- **Absolutists** (high idealism and low relativism)
- **Subjectivists** (low idealism and high relativism)
- **Exceptionists** (low idealism and low relativism)

Details regarding the taxonomy of ethical ideologies are found in chapter 4 (section 4.3).
Graph 6.3: Students’ taxonomy of ethical ideologies in the three time periods (emphasis on *Idealism*)
In the above graphs we can see that nearly all students are classified as Situationists (high Idealism and high Relativism), with two exceptions:

- student 1 (dark blue), who was originally classified as a Subjectivist in the 1st interview and afterwards moved high into the Situationist zone; and

- student 5 (yellow), who was originally classified as an Absolutist (just on the left side of the Relativism limit), and then as a Situationist, although the change of his Relativism level was rather small.

Interestingly enough, some students moved towards Absolutism (high Idealism, low Relativism) during the second interview (students 2, 3 and 11). Particularly interesting was student 3 who showed a big change and moved relatively far into the Absolutist zone right after the intervention, however the change was almost completely reversed after the six months indicating there was no long term effect on his/her ethical ideology.
Similarly, student 12 had a big drop in his/her *Idealism* score right after the intervention, which moved him/her towards the center of the graph (between the four zones), however, he/she returned close to his/her original position after the six months also indicating a short term effect. Students 2 and 11 also crossed the border to *Absolutism* right after the intervention and only a small part of the change was undone after the six months which moved them back to *Situationism*. However, student 2 remained very close to the border between *Situationism* and *Absolutism* after the six months as well indicating a more long term effect. Also, student 8 (fuchsia) moved very close to the *Subjectivism* zone after the intervention and remained there during the six-month period as well.

In sum, we can observe some students being more affected by the intervention than others, while some appear to be almost completely unaffected (students 3 and 12) at least regarding only one dimension. What is perhaps interesting is the fact that in cases where there seemed to be a relatively big change (e.g. student 3 and student 12), it is almost completely reversed after the six month period, with the exception of student 6 who also had a relatively big drop in his *Relativism* score which remained. On the other hand, some more subtle changes in other students appear to remain after the six months as well (e.g. student 2, student 5, and student 11).

### 6.2 Ethics in Science Questionnaire (ESQ)

The ESQ focused on measuring the changes in students’ views regarding ethics in science, while some of its questions were either identical or closely related to some of the debate questions (section 7.1).

Here we discuss the five factors: *Integrity, Morality, Personal Career versus Social Responsibility, People versus Science,* and *Scientists’ Ethical Education,* first in terms of the means for all subjects using the ANOVA and then in subsequent subsections, changes in individuals across the three interviews for each factor.

#### 6.2.1 Comparison of the Five Factors of the ESQ

Regarding the Ethics in Science Questionnaire, in Table 6.2, we can see that there are no high variations between the mean values of the five factors among the three interviews. However, we can notice some interesting subtle changes. The mean score of Integrity seems to decrease right after the intervention but some of the change seems to be undone during the 6 month period, which goes along with our hypothesis (*H₂b*: *The effect on students’ views about ethics in science immediately after the intervention will be greater than the effect 6 months after the intervention*). However, the intervention
seems to have a different effect on all the other factors. More specifically, we can observe a small but constant increase in the mean values of Morality, Scientists’ Social Responsibility, and Ethical Education, while People vs. Science shows a decrease right after the intervention which remains after the 6 months as well.

<table>
<thead>
<tr>
<th>Comparison of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor/Interview Index</strong></td>
</tr>
<tr>
<td>Integrity</td>
</tr>
<tr>
<td>Morality</td>
</tr>
<tr>
<td>Personal Career vs. Social Responsibility</td>
</tr>
<tr>
<td>People vs. Science</td>
</tr>
<tr>
<td>Scientists’ Ethical Education</td>
</tr>
</tbody>
</table>

Table 6.2: Comparison of means for the five factors of the ESQ

Once again, even though no statistically significant effect was found based on the mean scores, we were interested to investigate the direction of the changes regarding individual students before we reach to any conclusions. Based on the Wilcoxon Signed-Rank Test for paired samples (Tables 5.16 and 5.17, section 5.4), we were able to compute five bar charts to represent the changes in individual students in each of the five scales.
6.2.2 Changes in Individual Students

Below is a detailed discussion of individual changes in each factor of the ESQ, illustrated by a bar chart which compares each student’s scores in all three interviews for each factor separately.

A. Integrity

The first dimension of the ESQ is ‘Understanding and acknowledgement of Integrity’ and aims to answer to the question: Do students acknowledge the importance of integrity in science? Graph 6.5 below shows the changes in students’ Integrity scores between the three interviews:

![Bar chart showing the changes in students' Integrity scores between the three interviews.](chart)

Graph 6.5: Students’ mean scores of Integrity in all three interviews.

Overall, 9 students (69.2%) showed a decrease on their Integrity scores six months after the intervention as compared to their original responses, while only one student showed an increase (student 6). Eight students (61.5%) indicated a possibility of a lasting effect (students 2, 4, 6, 7, 8, 9, 10 and 11) although for some students the change was rather small or it was almost completely reversed (e.g. students 7 and 8). Finally, only 4
students (30.7%) matched our $H_2b$ hypothesis which stated that the effect six-months after the intervention will be partly undone (students 4, 6, 7 and 8).

Below is a detailed discussion regarding particular items comprising the first dimension of the ESQ. The specific questions concerning Integrity are:

1. Integrity is important in science and everyone should share the same rules of scientific conduct (regarding observation, data collection, reporting, etc.).
2. Scientists don’t need to share the same rules on how research is done and reported, every case is different.
3. Integrity is important to keep some basic levels of trust among scientists.
4. We live in a free world, therefore everyone has the right to conduct and report research as he/she likes and it should be considered equally valid.
5. Rules about integrity in science should form an ethical code for scientists.

When looking at students’ responses to the particular five items in the ESQ that concern Integrity (Table 6.3), we observe that the mean dropped in all items except for one, item 4 (Q4. We live in a free world, therefore everyone has the right to conduct and report research as he/she likes and it should be considered equally valid). Overall, students still acknowledged the importance of integrity, as their level of agreement remained high despite the drop, however, they seem to become less “conservative” regarding the rules of conduct (observation, data collection, reporting). The questions can be found in section 4.3.1.2.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>5.15</td>
<td>5.30</td>
<td>4.61</td>
</tr>
<tr>
<td>Q2</td>
<td>5.61</td>
<td>4.23</td>
<td>4.23</td>
</tr>
<tr>
<td>Q3</td>
<td>5.46</td>
<td>4.76</td>
<td>5.23</td>
</tr>
<tr>
<td>Q4</td>
<td>4.30</td>
<td>4.61</td>
<td>4.69</td>
</tr>
<tr>
<td>Q5</td>
<td>5.84</td>
<td>5.38</td>
<td>5.30</td>
</tr>
</tbody>
</table>

Table 6.3: Mean scores of Integrity in all three interviews
B. Morality

The second dimension of the ESQ was ‘Understanding and acknowledgement of Morality’ which aimed to answer to the question: Do students acknowledge the importance of morality in science? Graph 6.6 below shows the changes in students’ Morality scores between the three interviews:

![Graph 6.6: Students’ mean scores of Morality in all three interviews](image)

Most of the students (61.5%) showed an overall increase in their Morality scores (students 3, 5, 6, 7, 8, 9, 10 and 13) which means they were more likely to acknowledge the importance of morality in science after the intervention than they were in the beginning, although for some students the change was rather small. Five students (38.4%) showed an overall decrease (students 1, 2, 4, 11 and 12) after the six-month period, while interestingly enough, two students moved to the opposite directions than they had in the second phase of the research (students 8 and 11), which means either that they changed their mind rather easily, or that they were not honest with their responses.

Overall, seven students (53.8%) indicated a lasting effect (students 1, 3, 4, 6, 7, 12, and 13) although for some the change was rather small, while four students showed an
change only after the six-month period (students 2, 5, 9, and 10) which could mean they needed more time to process the information before it had an impact on their views.

Overall, only students 1 and 3 matched our $H_2b$ hypothesis, although the differences between the first and last rounds of results were too small to be considered meaningful.

Below is a detailed discussion regarding particular items comprising the second dimension of the ESQ. The specific questions concerning *Morality* are:

1. Moral values are irrelevant to the scientific world.
2. Morality in science is critical to the survival of our world and the global population.
3. As long as the evidence is recorded and reported correctly (integrity), the morality of the topic being researched is not important.
4. Morality is important in science to keep the public’s trust (in science).
5. Morality should be included in the ethical code of scientists.

Reviewing the mean scores of each item concerning *Morality* in the three phases of the research (Table 6.4), we can see that for some questions the mean increased while for others it decreased.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
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</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3.38</td>
<td>4.15</td>
<td>3.15</td>
</tr>
<tr>
<td>Q2</td>
<td>4.92</td>
<td>5.30</td>
<td>5.23</td>
</tr>
<tr>
<td>Q3</td>
<td>4.23</td>
<td>3.76</td>
<td>3.53</td>
</tr>
<tr>
<td>Q4</td>
<td>5.38</td>
<td>5.30</td>
<td>5.38</td>
</tr>
<tr>
<td>Q5</td>
<td>5.07</td>
<td>5.07</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Table 6.4: Mean scores of *Morality* items.

Interesting were items 1 and 3. Four out of the thirteen students (30%) agreed with the first statement (*Q1. Moral values are irrelevant to the scientific world*) before the intervention while the rest all disagreed, however, right after the intervention four other students moved to the “neutral zone”, hence the increase in the mean during the second interview. After the six-month period however, only two students agreed with the statement (15%). Concerning the third item (*Q3. As long as the evidence is recorded and reported correctly (integrity), the morality of the topic being researched is not important.*), we can observe a continuous decrease in students’ level of agreement.
which is expected as the intervention might have raised their level of acknowledgement regarding morality in science.

C. Personal Career vs. Social Responsibility

The third dimension of the ESQ, *Personal career vs. Social responsibility*, aimed to answer to the question: *Should either integrity or morality be sacrificed for the promotion of scientists’ personal career?* Graph 6.7 shows the changes in students’ views regarding scientists’ social responsibility between the three interviews:

![Graph 6.7: Students’ mean scores of Personal Career vs. Social Responsibility in all three interviews.](image)

In most cases (61.5%), there was an increase in students’ scores on *Personal Career vs. Social Responsibility* after the six-month period (students 3, 4, 5, 6, 9, 10, 11 and 12) compared to their original scores, which means they were more likely to acknowledge scientists’ social responsibility and less willing to sacrifice aspects of integrity or morality in science for the promotion of personal career. On the other hand, 5 students (38.4%) showed an overall decrease during the third stage of the research (students 1, 2, 7, 8 and 13). Interesting cases were those of student 5, who showed a big increase right after the intervention which increased even further after the six-month period.
indicating a strong lasting effect, and student 13, who showed a large drop right after
the intervention which was however almost completely reversed after the six-month
period indicating no long term effect. Finally, 5 students had their change partly undone
after the six months and matched our $H_2b$ hypothesis (students 2, 8, 9, 10 and 13),
although for one student the change was almost completely reversed (student 13).
Similarly, student 3 had his change completely reversed, although it did not match our
$H_2b$ hypothesis, since his score six month after the intervention moved to the complete
opposite direction, and showed an increase even further than his original position.

Below is a detailed discussion regarding particular items comprising the third dimension
of the ESQ. The specific questions concerning Personal Career vs. Scientists’ Social
Responsibility are:

| 1. In order to compete in a global environment over funds, reputation and success, scientists can disregard integrity. |
| 2. In order to compete in a global environment over funds, reputation and success, scientists can disregard morality. |
| 3. If you are a scientist and your employer asks you to participate in scientific misconduct, you have a moral obligation to “blow the whistle”. |
| 4. Like other employees, scientists have to do what they are told without moral questioning. |
| 5. Scientists have no social responsibility for the harmful creations and applications of their science. |
| 6. The moral aspects of a research project is also the employee's responsibility, not only the employer's. |
| 7. Scientists should have a greater allegiance to society than their employer. |

When looking at the particular items that focused on Scientists’ social responsibility
(Table 6.5), we see that while for some items a part of the difference was reversed after
the six-month period, for others, the difference increased.
Table 6.5: Mean scores of Personal Career vs. Social Responsibility items.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>2.69</td>
<td>3.69</td>
<td>3.30</td>
</tr>
<tr>
<td>Q2</td>
<td>4.53</td>
<td>3.61</td>
<td>3.07</td>
</tr>
<tr>
<td>Q3</td>
<td>5.69</td>
<td>4.53</td>
<td>5.30</td>
</tr>
<tr>
<td>Q4</td>
<td>4.07</td>
<td>3.69</td>
<td>3.00</td>
</tr>
<tr>
<td>Q5</td>
<td>2.53</td>
<td>3.00</td>
<td>3.30</td>
</tr>
<tr>
<td>Q6</td>
<td>5.92</td>
<td>5.38</td>
<td>5.30</td>
</tr>
<tr>
<td>Q7</td>
<td>4.69</td>
<td>5.15</td>
<td>5.07</td>
</tr>
</tbody>
</table>

Interesting were items 1 (Q1. *In order to compete in a global environment over funds, reputation and success, scientists can disregard integrity*), and 2 (Q2. *In order to compete in a global environment over funds, reputation and success, scientists can disregard morality*). We can observe that before the intervention the level of agreement to the first statement (concerning integrity) was very low (2.69), while for the second (concerning morality) it was much higher (4.53), meaning students were more agreeable towards sacrificing aspects of morality for the promotion of scientists’ personal career. However, after the intervention, this difference decreased significantly, possibly because the level of importance of morality increased in students’ views after the intervention. This change goes along with the overall increase in the mean scores of *Morality* and the overall decrease in the mean scores of *Integrity* that were discussed previously. Similarly, item 4 (Q4. *Like other employees, scientists have to do what they are told without moral questioning*), showed a continuous decrease in students’ level of agreement during the three phases, which could also indicate an overall increase in students acknowledgement of morality due to the intervention.

Of particular interest was item 3 (Q3. *If you are a scientist and your employer asks you to participate in scientific misconduct, you have a moral obligation to “blow the whistle”*), which yielded some unexpected results. We see a high level of agreement before the intervention (5.69) which for some reason decreased right after the intervention (4.53), although a big part of the change was reversed after the six-month period (5.30).
D. People vs. Science

The fourth dimension of the ESQ is People vs. Science which aims to answer to the question: *Is science’s purpose to serve humanity or humanity’s purpose to serve science?* Graph 6.8 shows the changes in students' views regarding People vs. Science:

![Graph 6.8: Students' mean scores of People vs. Science in all three interviews.](image)

Most students (69.2%) showed a decrease in their scores right after and six months after the intervention (students 1, 2, 4, 5, 6, 7, 9, 11, and 13), which means they did not consider people’s purpose to serve science at any cost. Students 1, 2, 6 and 8 showed a change right after the intervention before they moved to the complete opposite direction six months later, although the changes compared to their original scores were very small, (except for student 8). Again, that could mean that they were unsure regarding their views, or they change their mind rather easily, or they were not honest with their responses, therefore, it is difficult to consider them as indications of a lasting effect of the intervention. Three students (23%) showed an overall increase (students 3, 8 and 12), while one student returned to his original scores (student 10). Finally, 9 students indicated a lasting effect (students 3, 4, 5, 7, 8, 9, 11, 12 and 13) but only three students matched our $H_2b$ hypothesis (students 4, 5 and 11). In the cases of students 3 and 12, where the change was small, we consider it meaningful because their scores
between the second interview and the third remained exactly the same, indicating a very small but steady effect.

Below is a detailed discussion regarding particular items comprising the fourth dimension of the ESQ. The specific questions concerning People vs. Science are:

1. *Science is more about discovering interesting truths, not about serving people.*
2. *Science has a social responsibility beyond providing new knowledge.*
3. *We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare.*
4. *It’s okay for some people to be harmed or sacrificed in order for science to advance.*
5. *The overall effectiveness of science can be determined by the amount of interesting knowledge that it has given us.*
6. *The overall effectiveness of science can be determined by the degree to which it improves people’s lives.*

Looking at the means of the specific items in Table 6.6, we see that all the means decreased from interview 1 to interview 3, except for item 3 (Q3. *We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare*), which was one of the debate questions as well, where the level of agreement increased in all 3 phases.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Interview</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Interview</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3.84</td>
<td>3.53</td>
<td>3.61</td>
</tr>
<tr>
<td>Q2</td>
<td>5.46</td>
<td>5.23</td>
<td>5.00</td>
</tr>
<tr>
<td>Q3</td>
<td>4.84</td>
<td>4.92</td>
<td>5.46</td>
</tr>
<tr>
<td>Q4</td>
<td>3.07</td>
<td>3.30</td>
<td>2.61</td>
</tr>
<tr>
<td>Q5</td>
<td>5.69</td>
<td>5.07</td>
<td>5.00</td>
</tr>
<tr>
<td>Q6</td>
<td>5.61</td>
<td>4.92</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Table 6.6: Mean scores of People vs. Science items.

We can see from the results that Q1 did not score very high, possibly because the statement excluded science’s responsibility towards people. On the other hand, Q2 scored quite high (much higher than Q1) before and after the intervention, which means more students acknowledged the social responsibility of science which stretches beyond simply providing us with new knowledge.
Interesting were the results on item 4 (Q4. *It's okay for some people to be harmed or sacrificed in order for science to advance*), which was also related to one of the debate questions (*Should there be boundaries on the kinds of research that are being conducted or do we consider science's purpose to provide us with knowledge at any cost?*), where while the level of agreement was already relatively low before the intervention (3.07), it dropped even further down after the six-month period (2.61).

Finally, items 5 and 6 were also interesting. Both statements (Q5. *The overall effectiveness of science can be determined by the amount of interesting knowledge that it has given us* and Q6. *The overall effectiveness of science can be determined by the degree to which it improves people's lives*) had almost equal level of agreement before the intervention with Q5 scoring a little bit higher than Q6, where after a small drop immediately after the intervention, their difference increased a little bit with Q6 scoring eventually higher, indicating a stronger level of agreement. This could mean that after the intervention science was seen as more related to actual social benefits. However, the difference between the two statements is very small to draw any strong conclusions.

**E. Scientists' Ethical Education**

The fifth and final dimension of the ESQ was *Scientists’ Ethical Education* which aimed to answer to the question: *Should scientists be educated about matters of ethics in science and should both morality and integrity be included in that education?*

Graph 6.9 shows the changes in students’ views regarding *Scientists Ethical Education* in all three interviews:
Most students (61.5%) showed an overall increase in Scientists’ Ethical Education (students 2, 4, 7, 8, 10, 11, 12 and 13), while 3 students showed a decrease (students 1, 5, and 9) and 2 students (students 3 and 6) returned to their original scores after the six-month period suggesting no long term effect. Six students indicated a long term effect (students 1, 7, 8, 10, 11 and 12), while only one student had his change partly undone and matched our $H_2 b$ hypothesis (student 8). Students 2, 4, 5 and 13 moved to the opposite direction in the third interview than they had in the second, meaning once again that they might be unsure of their opinion, change their minds very easily or be dishonest with their responses. We therefore cannot consider them as indications of a lasting effect.

Below is a detailed discussion regarding particular items comprising the fifth dimension of the ESQ. The specific questions concerning Scientists’ Ethical Education are:

1. Morality is different for everyone so young scientists don’t need to be educated about it.
2. Morality can be (positively and/or negatively) influenced, so young scientists need a formal education on scientific ethics with a positive (moral) influence.
3. Young scientists can learn about integrity by observing older scientists, they don’t need a formal education.

4. Not all young scientists have good role models (older scientists), therefore they need a formal education to learn about the code of ethics of the world-wide scientific community.

5. Ethics (both integrity and morality) is important in science and young scientists should be educated about it.

6. There are no ethical principles in science that are so important that they should be part of any code of ethics.

Interestingly enough, when looking at the results of the corresponding questions on the ESQ, that is, the means of the specific items, (Table 6.7), we observe a strange fluctuation in most items. Specifically in items 1, 2, 3, and 5 we see that the scores in the third interview move to the complete opposite direction than they did in the second.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3.07</td>
<td>2.92</td>
<td>3.30</td>
</tr>
<tr>
<td>Q2</td>
<td>4.84</td>
<td>5.00</td>
<td>4.76</td>
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<tr>
<td>Q3</td>
<td>3.69</td>
<td>3.76</td>
<td>3.38</td>
</tr>
<tr>
<td>Q4</td>
<td>5.30</td>
<td>5.30</td>
<td>5.46</td>
</tr>
<tr>
<td>Q5</td>
<td>5.00</td>
<td>4.92</td>
<td>5.46</td>
</tr>
<tr>
<td>Q6</td>
<td>3.92</td>
<td>3.92</td>
<td>3.23</td>
</tr>
</tbody>
</table>

Table 6.7: Mean scores of Scientists’ Ethical Education items.

For example, item 5 (Q5. Ethics (both integrity and morality) is important in science and young scientists should be educated about it) had a mean score 5.00, which dropped a little bit to 4.92 right after the intervention, and then went up higher than the original score to 5.46, showing an increase in students’ level of agreement.

On the other hand, item 4 (Q4. Not all young scientists have good role models (older scientists), therefore they need a formal education to learn about the code of ethics of the world-wide scientific community) and item 6 (Q6. There are no ethical principles in science that are so important that they should be part of any code of ethics) had a change in their mean only after the six-month period. Overall, we can see that all items which suggested that scientists need some form of ethical education scored higher than the items which suggested the opposite. From the mean scores we can confirm that
there seemed to be an increase in students’ appreciation of ethical rules in science and the need for an ethical education.

### 6.3 Correlations

Concerning the correlation between the two instruments (the EPQ and the ESQ), we calculated the Pearson correlation coefficient as a measure of the strength of the linear relationship between pairs of variables. Of course, if the relationship between the variables is not linear, then the correlation coefficient does not adequately represent the strength of the relationship between the variables. However, once again we were looking for indications. What we were also interested in was to look at the changes in the correlations during the three time periods of the research.

Specifically, before the intervention (Table 6.8) a correlation was observed only between **Idealism** and **People vs. Science**, meaning that the more idealistic a person was, the less accepting he/she was of harmful scientific projects or projects that support warfare, and less willing to sacrifice people’s wellbeing for the advancement of science.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrity</strong></td>
<td>0.24</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Morality</strong></td>
<td>-0.06</td>
<td>-0.30</td>
</tr>
<tr>
<td><strong>Scientists’ social responsibility</strong></td>
<td>-0.31</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>People vs. science</strong></td>
<td>0.63*</td>
<td>-0.17</td>
</tr>
<tr>
<td><strong>Scientists’ ethical education</strong></td>
<td>0.30</td>
<td>-0.22</td>
</tr>
</tbody>
</table>

Table 6.8: Correlations between the EPQ and the ESQ variables before the intervention.

However, just after the intervention, we observe a stronger correlation between **Idealism** and **People vs. Science** (0.71), but also a correlation between **Idealism** and **Personal Career vs. Social Responsibility** (0.75), meaning that the more idealistic a person was, the less willing they were to sacrifice aspects of integrity or morality for the promotion of scientists’ personal career (Table 6.9).
Finally, six months after the intervention there was an even stronger correlation observed between Idealism and Personal Career vs. Social Responsibility (0.85), a decrease in the correlation between Idealism and People vs. Science (0.63), while there also seemed to be an additional correlation between Relativism and Integrity as well (0.57) (Table 6.10).

Furthermore, we calculated the correlation between the two instruments based on the mean scores from the three phases of the research for each variable, which confirmed once again the correlation between Idealism and People vs. Science (0.67), and revealed an additional correlation between Idealism and Scientists’ Ethical Education (0.42) (Table 6.11).
<table>
<thead>
<tr>
<th>Factors</th>
<th>Idealism</th>
<th>Relativism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity</td>
<td>0.57</td>
<td>0.22</td>
</tr>
<tr>
<td>Morality</td>
<td>0.17</td>
<td>-0.11</td>
</tr>
<tr>
<td>Scientists’ social responsibility</td>
<td>0.30</td>
<td>0.09</td>
</tr>
<tr>
<td>People vs. science</td>
<td>0.67**</td>
<td>-0.06</td>
</tr>
<tr>
<td>Scientists’ ethical education</td>
<td>0.42**</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

Table 6.11: Correlation between the EPQ and ESQ variables based on the mean scores.

Overall, due to the small population it is hard to reach to any concrete conclusions regarding the meaningfulness of the correlations. Once again we are talking about indications. In spite of that, reason suggests that a meaningful correlation between Idealism and Scientists’ social responsibility as well as between Idealism and People vs. Science is highly probable. We would have expected a correlation to appear also between Idealism and Morality, however this relation was not observed during any stage of the research.

In sum, based on the quantitative analysis of the two instruments using the Pearson correlation coefficient, our final hypothesis is confirmed (H₃: There will be an effect on the relationship between the EPQ and the ESQ due to the intervention).
7. QUALITATIVE ANALYSIS & RESULTS

In this chapter I discuss both the analysis and the results that were based on the data obtained through the qualitative methods that were deployed in three separate sections (7.1 Classroom Debates, 7.2 Homework Assignments, and 7.3 Students’ Final Comments), as well as how these relate to our last two research questions (R.Q.4 and R.Q.5).

7.1 Classroom Debates

Three classroom debates were orchestrated during the meetings with the students. The debates aimed to engage students in an active way, while motivating them to express and support their opinion with a coherent argument. At the same time, students were able to hear their peers’ opinions which should have caused them to reflect on their own views and potentially alter them. All debates were audio and video-recorded.

Each student was given 30 seconds to defend his/her decision with an argument (a digital clock was used on the board), after which he/she had to randomly point to a person from the opposite group, who in turn had to support his/her opinion in 30 seconds and then point to someone across, and so on. Unfortunately not all students were pointed out, while some were reluctant to speak or they simply stated they agreed with another student’s argument previously heard so not everybody expressed his opinion during every debate, while it became clear that some students were more eager to speak. Another issue was the time pressure, as such an activity eventually demanded more time than was available to us. However, it was a very entertaining process which the students seemed to enjoy a lot, while there were many interesting points heard and many students were eager to engage in dialogue and expressed more than one argument.

The first debate question was presented on the board at the end of the 2nd meeting after we had discussed issues of profiling and anonymity:

1. “Should data-miners be allowed to make use of any kind of data in order to maximize their company’s profit / serve their organization’s purpose?”

Students who agreed with the proposition had to move to the left side of the classroom, while those who disagreed had to move to the right. Unfortunately, students’ presentations that were organized in the beginning of our 2nd meeting took more time
than expected, which left very little time for the first debate. However, despite its short duration, it yielded some interesting results:

Specifically, 12 out of the 13 students moved to the right side (which meant they disagreed) and only one student (Mohamed) moved to the left side. When he was asked to express his opinion, he said that it should be allowed but it should be done in a regulated form and that he was against its use by commercial agencies. At that point, some remarks were heard that he was on the wrong side of the classroom, since he himself stated that is should be done in a regulated form.

Unfortunately the bell rang shortly after that and no one else got to express their views. However, we are able to say that at the time of the first meeting a majority of students (12/13) appeared to be against the unauthorized use of sensitive private information for research purposes.

The second debate question was presented during our third and final meeting and it focused on placing moral boundaries in science.

2. “Should there be boundaries on the kinds of research that are being conducted or do we consider science’s purpose to provide us with knowledge at any cost?”

The question aimed to clarify students’ position regarding the underlying purpose of science. Did they consider science’s purpose being to serve humanity, or humanity’s purpose to serve science at all costs; a question that was also related to one of the dimensions of the ESQ (People vs. Science). When the two contradict each other, for example in cases where aspects of human wellbeing or dignity are at stake due to the research being conducted (e.g. human experimentation), or the risk of environmental damage is too high (e.g. nuclear testing), we must make a choice that reflects our priorities and our values as individuals but also those relating to society. If students acknowledge the need for boundaries in science, then this would mean they are more willing to sacrifice the attainment of knowledge than consider people’s wellbeing. Furthermore, this question was directly related to issues of morality in science to attempt to ascertain whether they acknowledged the importance of morality in science and thus the need for moral boundaries.

Again, students seemed to be unanimous regarding their views except for one student (Edwin) who disagreed with the question and supported that there should be no boundaries in science. Interestingly enough, it was not the same student as before.

The main arguments that were heard during the debate are shown in Box 7.1 below:
Arguments in favor

1. People should not be sacrificed for science. **Fatima**

2. Because of the consequences. It (the lack of boundaries) can have bad consequences on society itself. (The example that the student gave was one that had been discussed previously about the possibility of insurance companies denying or charging enormous fees to potential clients due to statistically high possibility of incurable illness based on their genetic information.) **Mohamed**

3: The lack of boundaries is not good for human beings. For example nuclear developments can harm people. **Haitam**

Arguments against

1. There can be other methods of research that don’t need to sacrifice people. **Edwin**

2. It doesn’t always have to be used for bad things, it can also be used for good things. For example nuclear bombs, they can be used to kill people but they can also be used to destroy comets. **Edwin**

3. If you risk (use) people, the knowledge that the experiments give you, can help you cure people. For example if you risk people for an experiment and you find a new medicine, millions of people can heal from a disease. **Edwin**

Box 7.1: Student arguments for and against the second debate question

Finally, one student (Mohamed) said that perhaps the work of Einstein should have had boundaries because it opened the road for the creation of the atom bomb, which began a discussion around scientists’ level of responsibility regarding the applications of their work. The main point of the discussion was that the boundaries between theoretical work and application are often very blurry in modern science and therefore ethical dilemmas come into play.

In sum, based on the second debate, 12 out of the 13 students agreed that there should be boundaries in scientific research, and were against risking people for the advancement of science. Regarding the one student who disagreed and supported that by risking people, science can progress and help the greater good, when looking at his responses to the ESQ, item 4 on the People vs. Science scale (Q4. It's okay for some people to be harmed or sacrificed in order for science to advance) we see that his responses go along with the opinions he expressed during the debate during all phases of the research.
The last debate question was presented during our 3rd and final meeting. Unfortunately, the debate was interrupted by the bell once again before everyone expressed their arguments.

3. “Is it moral for scientists to work on projects that support warfare?”

During the last lecture, we had mentioned how science has often advanced through warfare, so the final question was solely focused on warfare related research; a part of science that also raises ethical dilemmas often, although again, not for everybody. There was an interest in recording students’ views on the matter, as it was expected that they could greatly vary considering it is an issue with many arguments in favor and many arguments against. This question was also directly related to one of the questions of the ESQ, on the scale People vs. Science (Q3. We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare.)

In this question students were about evenly decided: Seven students disagreed with the question and six agreed. In Box 7.2 below are the main arguments recorded during the debate:

<table>
<thead>
<tr>
<th>Arguments in favor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think it depends on the situation or the type of war. I think it’s wrong if you want to invade a country or dominate a part of the world but it (the development and use of weapons) can stop another country from doing that, and if all the United Nations agree, then it’s ok in my opinion to make weapons to stop the countries that want to invade other countries. <strong>Tim</strong></td>
</tr>
<tr>
<td>2. Through weapon development we can make weapons safer and more precise, with less collateral damage, so they can only hit the target and not a greater area. <strong>Mohamed</strong></td>
</tr>
<tr>
<td>3. Weapons can be used for self defense. <strong>Mohamed</strong></td>
</tr>
<tr>
<td>4. Weapons can be used to destroy or divert comets or other objects. <strong>Edwin</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arguments against</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. You use the power and money to hurt people instead of save people that are poor and need help. <strong>Fatima</strong></td>
</tr>
<tr>
<td>2. I don’t trust people with weapons that can destroy us all. <strong>Haitam</strong></td>
</tr>
<tr>
<td>3. Without weapons you couldn’t do harm in the first place. <strong>Tim</strong></td>
</tr>
</tbody>
</table>

Box 7.2: Student arguments for/against third debate question

Even though the debate was interrupted, this time there was a more productive discussion and a number of clear and valid arguments were recorded. Some students were reluctant to speak, while others, who were less shy, shared more than one argument. What was also interesting is that one student (Tim) shared both an argument
in favor and an argument against, something that could mean that he himself experienced an ethical dilemma.

When looking at the results on this particular question in the ESQ (People vs. Science Q3. We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare), we observe a constant increase in students’ level of agreement through the three phases of the intervention, which may be an indication of the effect of the debate (.2).

### 7.2 Homework Assignments
At the end of the first meeting, students were divided in four groups of 4 and were given a homework assignment to prepare for the second meeting.

Each group was assigned one famous historic scientific figure who they were to research and present to the class. The students were asked to research information about the scientist’s life and work, and discuss as a group with the purpose of exchanging views based on their understanding of his personal position regarding morality and the social responsibility of science. Students were asked to write their personal comments about the scientist’s work and the ethical dilemmas they thought it raised.

#### 7.2.1 Homework Coding Categories
During the qualitative analysis we categorized and coded the data as follows, using a heuristic approach and inductive reasoning. The overall hierarchical coding scheme is shown below (Box 7.3):
**Category: Students' views about the researched scientific figures**

**Sub-category 1: Students' views about the scientists' work**
- Code: Approval
- Code: Disapproval
- Code: Dilemma
- Code: Scientific Progress

**Sub-category 2: Students' views about the scientists’ ethics**
- Code: Admiration
  - Sub-code: Promotion of World Peace and Human Rights
- Code: "Madman" (In Vivo coding)

**Sub-category 3: Students' views about experimentation on prisoners**
- Code: Condemnation
- Code: "Useless"

---

Box 7.3: Coding categories for homework assignments

Below is a detailed explanation of the categories and the codes selected for the analysis of student’s homework assignments.

**Sub-category 1: Students' views about the scientists' work**
In this category, participants express feelings and ideas regarding the scientists’ actions and the work that they conducted. This category focuses on what the scientist *did*. In Box 7.4 below, are the codes that were selected, followed by an explanation and an example from the data.
<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
<th>Example from data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval</td>
<td>Participants show a level of agreement with the scientific work of the researched figures.</td>
<td>I think it’s really good that Joseph Rotblat helped invent the first atom bomb together with James Chadwick, especially because in those days there wasn’t so much knowledge about how to makes these weapons or use them.</td>
</tr>
<tr>
<td>Disapproval</td>
<td>Participants disapprove of the work and the actions of their researched scientist.</td>
<td>What Shiro Ishii did was horrible.</td>
</tr>
<tr>
<td>Dilemma</td>
<td>Participants expressed a dilemma regarding the work of their appointed scientist.</td>
<td>It was good that they made the bomb so they could save the world from Germany, but on the other side if he hadn’t invented the atom bomb there wouldn’t be so much atom bombs in the world and they wouldn’t be used so much.</td>
</tr>
<tr>
<td>Scientific Progress</td>
<td>Participants acknowledge the overall benefits from the scientists’ work, which helped scientific progress</td>
<td>I’m not a fan of what he (Shiro Ishii) did, but it was a huge step for science.</td>
</tr>
</tbody>
</table>

Box 7.4: Coding of students’ views about the scientists’ work

Sub-category 2: Students’ views about the scientists’ ethics
In this category, participants’ comments revolve around the scientist’s ethics underlying their scientific work and their actions. The difference between Sub-category 1 and Sub-category 2 is that Sub-category 1 focuses on what the scientist did while Sub-category 2 focuses on what the scientist was. In Box 7.5 below, are the codes that were selected, followed by an explanation and an example from the data.
<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
<th>Example from data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admiration</td>
<td>Participants express a level of admiration regarding the moral choices and</td>
<td>The story of this man (Joseph Rotblat) is quite intriguing, after reading more</td>
</tr>
<tr>
<td></td>
<td>the personal ethics and values of their appointed scientist.</td>
<td>about it it’s something to stand still and think over. Not that many people think</td>
</tr>
<tr>
<td></td>
<td></td>
<td>about the issue of morality in science.</td>
</tr>
<tr>
<td>Sub-code: Promotion of World Peace and Human Rights</td>
<td>Participants express admiration towards the overall ethics of their appointed scientist, especially due to their attempts for promotion of world peace and human rights protection.</td>
<td>I think that even though Einstein’s theory led to the atomic bomb, he made up for it by dedicating himself to create, enhance and/or maintain world peace and with his view (and battle) to protect human rights.</td>
</tr>
<tr>
<td>Madman” (In Vivo coding)</td>
<td>Participants express negative thoughts regarding the morality of their appointed scientist.</td>
<td>Shiro Ishii was a madman. His way of doing things is unacceptable. He crossed the line of human ethics.</td>
</tr>
</tbody>
</table>

Box 7.5: Coding of students' views about the scientists' ethics

**Sub-category 3: Students' views about experimentation on prisoners**

In this category, participants express views regarding the use of people for experimentation, mainly prisoners, as was the case with two of the appointed scientists (Shiro Ishii and Joseph Mengele). In Box 7.6 Box 7.4: Coding of students' views about the scientists' work below, are the codes that were selected, followed by an explanation and an example from the data.

<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
<th>Example from data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation</td>
<td>Participants express negative views regarding human experimentation.</td>
<td>He doesn’t have the right to experiment on people’s lives, it’s just awful.</td>
</tr>
<tr>
<td>“Useless” (In Vivo coding)</td>
<td>Participants express agreement towards the use of prisoners for human</td>
<td>He did murder people, but they were useless to the community, because they were</td>
</tr>
<tr>
<td></td>
<td>experimentation.</td>
<td>prisoners.</td>
</tr>
</tbody>
</table>

Box 7.6: Coding of students' views about experimentation on prisoners
For an illustration of the coding as applied to the raw data, please refer to Box 7.7 below:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Approval</th>
<th>Disapproval</th>
<th>Dilemma</th>
<th>Scientific Progress</th>
<th>Admiration</th>
<th>Promotion of</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Shiro Ishii was a madman. His way of doing things is unacceptable. He crossed the line of human ethics.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joseph Mengele was a cold unscrupulous person. The experiments that he run were extremely dangerous for the environment and humanity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think that he was a dangerous scientist with plenty of sick ideas in his head. He only cared about the results of his experiments and not about the people who were the victims. He was resistant to people’s pain while he was hurting them in concentration camps. So I think that he was a monster without a heart.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“What Shiro Ishii did was horrible, even though it was in the name of science. He doesn’t have the right to experiment on people’s lives, it’s just awful.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joseph Mengele is one of those people that no one can really understand. How can a human do the terrible things he did to other humans? He deserves to burn in Hell.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mengele was given too much power and nobody did anything to stop him. I think that’s wrong, you can’t just experiment on people the way he did. He was a sick, twisted, psychopathic man.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What Mengele did was terrible. He helped science progress but that could have been done otherwise. He was a sick man with a sick mind, otherwise he wouldn’t use humans as a play toy.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think what Shiro Ishii did, was not moral. He murdered and experimented on people. Okay, thanks to what he did, we know now what the consequences are, and the medical world is improved. And a lot of people died, but maybe not as many as if he didn’t experimented on the prisoners, who were doing time and weren’t helpful to the community. I don’t know, what he did was horrible, but it saved millions of people afterwards. So I’m not a fan of what he did, but it was a huge step for science.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My personal opinion about Shiro Ishii is, that what he did was not human. But the reason of why he did it, was good. He did murder people, but they were useless to the community, because they were prisoners. Because of what he did, we came far in the technology of medicine, vaccinations and injections. I think it was a good idea that he used prisoners instead of innocent people.”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Albert Einstein was a big contributor to the knowledge we have and use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
right now. I think that without his visions and discoveries we would not have developed as far as we have now. Even though Einstein’s discoveries (considering the theory of relativity) led to the creation of the atomic bomb \(^1\), see him as a positive and not as a negative influence of the past, presence and probably also the future. After he found out how a possible mass destruction weapon could be processed he tried to prevent it from happening. Also he stated that if he had known about the consequences of his theories, he would have immediately stopped. He spent a great amount of time in trying to prevent misuse of the atom bomb and warfare and due to his efforts the Russell-Einstein came into existence. \(^6\) In my vision this was an attempt to create and/or maintain world peace and therefore a somewhat heroic action. To conclude my opinion: I think that even though Einstein’s theory led to the atomic bomb, he made up for it by dedicating himself to create, enhance and/or maintain world peace and with his view (and battle) to protect human rights.” Tim

1 “I think it’s really good that Joseph Rotblat helped invent the first atom bomb together with James Chadwick, especially \(^4\) because in those days there wasn’t so much knowledge about how to make these weapons or use them.

3 It was good that they made the bomb so they could save the world from Germany, but on the other side if he hadn’t invented the atom bomb there wouldn’t be so much atom bombs in the world and they wouldn’t be used so much.” Darifa

5 “My opinion about the ideas of Joseph Rotblat is that they were great (meaning his campaign against the use of nuclear weapons), because the scientists make the nuclear bomb, so it is the scientists’ responsibility for the use of nuclear bombs.” Edwin

5 “The story of this man (Joseph Rotblat) is quite intriguing. After reading more about it, it’s something to stand still and think over. Not that many people think about the issue of morality in science.” Mohamed

6 “I find Einstein’s way of thinking special. I read that he did a lot for human rights. I also find his campaign against nuclear weapons special (the Russell-Einstein manifesto), because he tried to warn the world about the bad consequences in the future and aimed for world peace.” Merve

Box 7.7: Students’ comments on their appointed scientists

Overall, regarding the work of Joseph Mengele and Shiro Ishii, all students expressed negative comments and condemned the scientists’ work and ethics. Three students mentioned the scientific progress that was achieved due to the scientists’ work, however, only one out of the three disagreed completely with the way scientific knowledge was obtained. The other two made some rather interesting remarks about
the experimentations on prisoners that took place, indicating an overall approval of the use of prisoners for experimentations as compared to the use of innocent people. Since the comments were expressed in writing after the intervention and not in a classroom discussion there was no opportunity to discuss possible identities of prisoners-of-war. For example, a majority of prisoners during war time are no doubt conscripted soldiers, some may be innocent civilians, not common criminals as the students might have thought. Or even in the case of imprisoned criminals, who decides, and how, which ones should be used in experimentations? This would have been an interesting discussion, unfortunately however, we didn’t get the chance to talk about it with the students and explore their views on such issues.

Regarding the other two scientific figures, Joseph Rotblat and Albert Einstein, students seemed puzzled by the atom bomb dilemmas, mainly due to Adolph Hitler’s invasion in Europe which made the use of the atom bomb in Japan seem salvational. Despite that dilemma regarding the scientists’ work, all students seemed to really appreciate and admire both men’s morality, while two students clearly acknowledged the scientists’ never-ending efforts to promote world peace and the protection of human rights, as well as their indisputable contribution to science.

7.3 Students' Final Comments
At the last stage of the research, right after the completion of the intervention, students were asked to send in their final comments regarding the main topic of the lectures, scientific ethics, as well as what stood out as important to them individually and their views about teaching ethics in science.

The return rate of the comments was good: 10 out of 13. It should also be noted that students’ comments were very helpful in answering our final two research questions. Here we discuss the analysis and results regarding our quasi-questions which came out of our data analysis (described below). We leave our specific answers to R.Q.4 and R.Q.5 for chapter 8.

R.Q.4 Do students acknowledge the importance of scientists’ moral reasoning and ethical education?

R.Q.5 Do students enjoy hearing, researching and discussing about ethical issues in science and do they find it meaningful?
7.3.1 Students’ Final Comments Coding Categories

In our analysis, we used the questions to which students responded as the main categories. Our sub-category, when needed, refers to the follow-up question, “why or why not”. Our codes for the specific categories used once again a heuristic approach and inductive reasoning as shown in Box 7.8:

<table>
<thead>
<tr>
<th>Category 1: Did you find the topic (scientific ethics) interesting?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: Interesting</td>
</tr>
<tr>
<td>Code: Not interesting</td>
</tr>
</tbody>
</table>

**Sub-category: Why or why not?**

- Code: “Crossing the line”
- Code: Two sides of ethics in science
- Code: “No correct answer”
- Code: Science based on people
- Code: “Earlier scientists”
- Code: Effects of science
- Code: Personal growth
- Code: “Gray area”

<table>
<thead>
<tr>
<th>Category 2: What stood out as important to you?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: Atom bomb</td>
</tr>
<tr>
<td>Code: Assignments</td>
</tr>
<tr>
<td>Code: Questionnaires</td>
</tr>
<tr>
<td>Code: Ethical questions</td>
</tr>
<tr>
<td>Code: “Applicability of ethics”</td>
</tr>
<tr>
<td>Code: “Bad scientists”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category 3: Do you think an ethical education would be useful for future scientists?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: Useful</td>
</tr>
<tr>
<td>Code: Not useful</td>
</tr>
</tbody>
</table>

**Sub-category: Why or why not?**

- Code: “Minimize corruption”
- Code: “Learn from it”
- Code: Think in a good way
- Code: Society
- Code: “Rules and regulations”
- Code: “Study scientific ethics”
- Code: Master-Apprentice

Box 7.8: Coding categories for students’ final comments

Below is a detailed explanation of the categories and the codes selected for the analysis of student’s final comments.
**Category 1: Did you find the topic (scientific ethics) interesting?**

In this category, students discuss whether they were interested in the lectures about scientific ethics, followed by a sub-category which focused on the question “Why or Why not”. In Box 7.9 below, are the codes that were selected, followed by an explanation of the codes.

<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interesting</td>
<td>Participants clearly state that they found the topic of scientific ethics interesting.</td>
</tr>
<tr>
<td>Not interesting</td>
<td>Participants state that they did not find the topic of scientific ethics interesting.</td>
</tr>
<tr>
<td><strong>Sub-category: Why or why not?</strong></td>
<td>Participants discuss why they found the topic of scientific ethics interesting or not.</td>
</tr>
<tr>
<td>“Crossing the line” (in Vivo coding)</td>
<td>Participants believe it’s important for a scientist to know when he is crossing the line of ethics.</td>
</tr>
<tr>
<td>Two sides of scientific ethics</td>
<td>Participants found interesting to learn about the two sides of scientific ethics, integrity and morality.</td>
</tr>
<tr>
<td>“No correct answer” (in Vivo coding)</td>
<td>Participants found interesting to discover that on ethical questions there are often no correct answers.</td>
</tr>
<tr>
<td>Science based on people</td>
<td>Participants believe that scientific ethics is important because science is based on people and their ethics, which can be good or bad.</td>
</tr>
<tr>
<td>“Earlier scientists” (in Vivo coding)</td>
<td>Participants found interesting to research about historic events and earlier scientists.</td>
</tr>
<tr>
<td>Effects of science</td>
<td>Participants found scientific ethics interesting because they acknowledge how science can affect everyone</td>
</tr>
<tr>
<td>Personal growth</td>
<td>Participants found scientific ethics interesting for their own growth either because they are interested to study science themselves, or simply because they consider it valuable knowledge to have.</td>
</tr>
<tr>
<td>“Gray area” (in Vivo coding)</td>
<td>Participants found interesting to realize that many scientific achievements and knowledge come from an ethically “gray area”.</td>
</tr>
</tbody>
</table>

Box 7.9: Coding of students' comments regarding the main topic of the lectures, scientific ethics
An illustration of the coding as applied to the raw data for Category 1 can be found in Box 7.10 below.
**Category 1: Did you find the topic (scientific ethics) interesting?**

1"I find the topic scientific ethics interesting. It is very important for a scientist to know when he is crossing the line with his research." **Edwin**

I found the topic very interesting, even though I couldn’t understand everything, because since I was born, I was interested in science and the effects of it. I didn’t know the two differences of science, morality and integrity. Thank you for explaining that to us.” **Eray**

I found the topic interesting, because I didn’t really know all lot about science and the morality and integrity sides of it.” **Fatima**

To be honest in the beginning I’d never heard of scientific ethics before. But when I heard what the meaning of it was, I found it quite interesting. Especially because the science is based on people who can improve their ideas and their attitude instead of being a person with bad ideas and a bad attitude. I find things like this very important.” **Merve**

At first I did not like the topic, but as I studied it I became more interested. I never really gave much thought about ethics in science, but now I understand it’s a difficult subject with no correct answer.” **Haitam**

The lessons were useful for me in some ways. Since I am finishing the Preparatory College next year and I will study after that, I find it extremely useful to learn something about the integrity and morality of science and to discuss about earlier scientists. To discuss what their work was, and what their views on morality and integrity were. This is because I myself want to study applied math or applied physics. This is why it was useful for me and because it was quite extraordinary compared to normal lessons, and was quite fun also. I hope to experience such lessons in the future.” **Mohamed**

I think that topic was really interesting because I already had a favor for history so I enjoyed to do some research about it.” **Ilias**

In my opinion the classes we had with you were very interesting, because I learned a lot about scientific ethics. The subjects were deep so I think it was very interesting to read about.” **Jessica**

I did find the topic very interesting. It isn’t the usual subject everyone talks about every day. And it is important that people know what is happening in the world, and in science because it can affect a lot of people.” **Kiran**

I think the topic scientific ethics is an interesting topic. It’s something no one ever really thinks about, even though a lot of technology and scientific knowledge we have now came forth out of the ethically “gray area”. **Tim**

---

**Box 7.10: Students’ raw comments regarding whether they found the topic of scientific ethics interesting and why.**
Nine out of the ten students who sent in their final comments responded that they found the topic of scientific ethics interesting, while one student said he didn’t like the topic at first, however, he became more interested as he studied it. So overall, ten out of the thirteen students confirmed that they were interested in the subject. Looking at the reasons given by the students as to why they found the topic interesting, we noticed a few similarities in their responses.

Specifically, three students found the topic of scientific ethics interesting because they learn about the two different sides of ethics in science, integrity and morality.

Two students found the topic of scientific ethics interesting because they learned about historic events and the work of earlier scientists.

Two students found the topic of scientific ethics interesting because of the effects science has on people.

Two students found the topic of scientific ethics interesting because they considered it valuable as knowledge for their personal growth.

Finally, the last four students did not appear to have similarities in their responses.

In sum, based on the qualitative analysis so far, we can suggest that most students enjoyed hearing, researching and discussing about ethical issues in science and they found it meaningful for several different reasons.

Below is a detailed explanation of Category 2 and the codes that were selected for the analysis (Box 7.11):

**Category 2: What stood out as important to you?**
In this category participants discuss what stood out as particularly important to them during the lectures.
## Code | Explanation
--- | ---
Atom bomb | Participants found important to learn about the details around the creation or use of atom bombs.
Assignments | Participants found their assignments and presentations important.
Questionnaires | Participants found the questionnaires important because they learned from them.
Ethical questions | Participants found important to think about ethical questions and ethical dilemmas.
“Applicability of ethics” (in Vivo coding) | Participants found important to realize the applicability of scientific ethics in reality.
“Bad scientists” (in Vivo coding) | Participants found interesting the realization that there can be good and bad scientists and that sometimes science can be used for the wrong purpose.

Box 7.11: Coding of students’ comments regarding what stood out as important to them during the lectures.

We now provide our illustrations of the raw data for Category 2 (Box 7.12).

**Category 2: What stood out as important to you?**

1 “The events that surrounded the creation of the atomic bomb seemed the most important to me. With the creation of the atomic bomb, scientists showed the world how terrible science could be if it were to be used for the wrong purpose.” Edwin

2 “What mostly stood out for me was the youtube movie with the atomic bomb experiments and the US being the one doing the most experiments.” Eray

2 “I think I liked the assignment the most, because we had to find out things on our own. And our team (4) figured out what Shiro Ishii did, I didn’t even know him before this, but now I know what he did and formed my own opinion about it.” Fatima

4 “The thing I found most important where questions like: “to what extend can scientists experiment without causing an ethical dilemma?” “Do scientists even need to think about ethics when they could achieve greater knowledge which would profit us in the end?” Questions like these cannot be answered so easily, everyone has different opinions.” Haitam

1 ATOM BOMB

2 ASSIGNMENTS

3 QUESTIONNAIRES
I found the presentations of last Friday very important because they showed new people to us. And the most important thing about this is that we learned what their ideas were and what they did. We saw that there were good but also bad scientists. I also found the questionnaires learnful, because in the beginning I didn’t like it but later I learned thanks to that, what scientific ethics was.” Merve

“The things that stood out for me where the many different ways of understanding ethics in science and the different opinions that come with them.” Ilias

“Important for me was that your presentation was very clear and also that the scientific ethics are applicable in the reality. Also, the topics that you gave us to do a research about were very special.” Jessica

“The thing I thought was interesting was our own subject Joseph Mengele. It’s also very difficult to say that we are going to kill two people to save a hundred. It’s not right to kill those people. That’s the dilemma that you used as well in your power-point presentation about the train. That made me think a lot.” Kiran

“The most useful and important thing we covered in our lesson, in my opinion, is that behind great minds and in first instance harmless inventions and researches lie a lot of controversial items; how was the information gathered? Was everything well documented and are all outcomes of researches 100% true?” Tim

On the question of what stood out as most important during the lectures, four students responded their homework assignments, four students responded the ethical questions that often arise (either within science or our everyday lives), and two students responded the information around the atom bomb creation and experimentation. The rest of the responses did not appear to share any similarities.

Below is a detailed explanation of Category 3 and the codes that were selected for the analysis (Box 7.13):

**Category 3: Do you think an ethical education would be useful for future scientists?**
In this category participants express their views about the usefulness of an ethical education for future scientists.
<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th><strong>Explanation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Useful</strong></td>
<td>Participants express positive views about the usefulness of an ethical education.</td>
</tr>
<tr>
<td><strong>Not useful</strong></td>
<td>Participants do not express positive views about the usefulness of an ethical education.</td>
</tr>
<tr>
<td><strong>Sub-category: Why or why not?</strong></td>
<td>In this subcategory participants discuss why they believe and ethical education would or wouldn’t be useful</td>
</tr>
<tr>
<td><strong>“Minimize corruption” (in Vivo coding)</strong></td>
<td>Participants believe an ethical education could minimize corruption in the future.</td>
</tr>
<tr>
<td><strong>“Learn from it” (in Vivo coding)</strong></td>
<td>Participants believe that people can learn a lot from an ethical education.</td>
</tr>
<tr>
<td><strong>Think in a good way</strong></td>
<td>Participants believe that through an ethical education, people would learn to “think in a good way”.</td>
</tr>
<tr>
<td><strong>Society</strong></td>
<td>Participants believe that an ethical education would benefit society.</td>
</tr>
<tr>
<td><strong>“Rules and regulations” (in Vivo coding)</strong></td>
<td>Participants do not find an ethical education the best or only way to control people’s actions, but advocate the use of strict rules and regulations for scientists.</td>
</tr>
<tr>
<td><strong>“Study scientific ethics” (in Vivo coding)</strong></td>
<td>Participants believe that a basic ethical education for scientists will motivate them to study scientific ethics further.</td>
</tr>
<tr>
<td><strong>Master-Apprentice</strong></td>
<td>Participants believe that an ethical education is important because of the influence younger scientists receive from older and more experienced scientists.</td>
</tr>
</tbody>
</table>

Box 7.13: Coding of students’ comments regarding the usefulness of an ethical education for scientists.

Below (Box 7.14) is an illustration of the coding as applied to the raw data for Category 3.
### Category 3: Do you think an ethical education would be useful for future scientists?

<table>
<thead>
<tr>
<th>USEFUL</th>
</tr>
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<tbody>
<tr>
<td>Edwin</td>
</tr>
<tr>
<td>&quot;I think it is useful for future scientist. We know that certain people are easy to corrupt, but at least we could try to talk some sense into them before they are corrupted and use science the wrong way.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOT USEFUL</th>
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<tbody>
<tr>
<td>Eray</td>
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<tr>
<td>&quot;I think that the future scientist should learn from the more experienced scientists of nowadays, so they can learn from them and take their experience with them and then make their own decisions. So I think that ethical education is useful.&quot;</td>
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<table>
<thead>
<tr>
<th>MINIMIZE CORRUPTION</th>
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<tbody>
<tr>
<td>Fatima</td>
</tr>
<tr>
<td>&quot;I think an ethical education would be useful, because people learn a lot from it, not only we, but everybody gets something out of it.&quot;</td>
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</tbody>
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<table>
<thead>
<tr>
<th>LEARN FROM IT</th>
</tr>
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<tbody>
<tr>
<td>Haitam</td>
</tr>
<tr>
<td>&quot;I think ethical education is important in science but not a necessity. I think ethical problems can also be solved by rules and regulations. For example getting permission to start researching, &quot;something that might be ethnically harmful&quot;, from those who are specialised in scientific ethics. I think ethics are important (It’s what keeps us humans sane) and there are different ways to control it. Education is one of them.&quot;</td>
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<tr>
<th>THINK IN A GOOD WAY</th>
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<tbody>
<tr>
<td>Merve</td>
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<tr>
<td>&quot;I think it is, because by learning the basics to students, that students will learn the good way of thinking instead of imagining by themselves. This education will also be a motivation for them to study scientific ethics.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOCIETY</th>
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<tbody>
<tr>
<td>Ilias</td>
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<tr>
<td>&quot;My opinion is that ethical education is very important because the world is filled with many different people and we don’t want to harm each other with the things we say or do, so it’s possible that an ethical education could help to create a closer community.&quot;</td>
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<table>
<thead>
<tr>
<th>RULES AND REGULATIONS</th>
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<tbody>
<tr>
<td>Jessica</td>
</tr>
<tr>
<td>&quot;I think that the ethical education would be useful for future scientists, because they should learn about important stuff such as how to think logically about the society.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STUDY SCIENTIFIC ETHICS</th>
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</thead>
<tbody>
<tr>
<td>Kiran</td>
</tr>
<tr>
<td>&quot;I think that an ethical education is very important to give, everyone should know what the risks are, and you can't just do stuff without informing the society. It's the right of everyone to know what is happening, or with what scientist are experimenting with. In this way everyone is aware of what might happen.&quot;</td>
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<tr>
<th>MASTER - APPRENTICE</th>
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<tbody>
<tr>
<td>Tim</td>
</tr>
<tr>
<td>&quot;I don’t think there is a way to teach ethics in science. Because fact is, there are no clear rules to what is and what isn’t ethical. I think the only solution to the problem &quot;what is and what isn’t ethical” is to make a rule book, containing strict rules and boundaries to which scientist should keep true to at all times, no exceptions. This supported, of course, by the UN, or any other high-authority organization.&quot;</td>
</tr>
</tbody>
</table>

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**Box 7.14: Students' comments regarding whether they believe an ethical education would be useful for future scientists.**
Based on the qualitative analysis of Category 3 above, seven out of the nine students who answered the third question responded that an ethical education is important and that it would be useful for future scientists. One student responded that it is important but not a necessity, while another student responded that he does not believe ethics is something that can be taught. Both of these two students advocated the use of strict rules and regulations as an alternative to better control people’s actions. Further on, three students shared some similarities regarding the reason behind their choice, discussing how an ethical education would be useful because it would benefit society. The other reasons that were given (minimize corruption, learn from it, think in a good way and study scientific ethics), could also be considered as different ways to benefit society eventually, however students did not make such an explicit statement, therefore it was decided to code their responses separately.

Summarizing, we can say that most students believe an ethical education to be quite important and meaningful for future scientists but also for society as a whole.
8. CONCLUSIONS & DISCUSSION

In this section, all the research questions will be answered followed by a short discussion, before moving on to the limitations and suggestions for future research.

8.1 Students’ Ethical Ideology

The Ethics Position Questionnaire focused on measuring the changes in students’ ethical ideology. More specifically, the EPQ aimed to answer the following two research questions:

R.Q.1 Can students’ personal ethical ideology be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

R.Q.1.b What kind of effect might the intervention cause on students’ ethical ideology?

The results based on the three different times of measurement showed that there were some changes observed in students’ mean level of Idealism and Relativism right after and six months after the intervention.

Specifically, based on the ANOVA tests that were conducted (Tables 5.2 and 5.3 in chapter 5), we see that the scores of both scales decreased during the second interview, but then a small part of the change disappeared after the six-month period as was originally hypothesized (H₁b: The effect immediately after the intervention will be greater than the effect six months after the intervention.) However, based on the Multivariate Tests we conducted for the main effect of the factors Idealism and Relativism (Tables 5.4 and 5.5 in chapter 5), we discovered no statistically significant difference among the three stages of intervention for either factor. This is a general indication about the changes of Idealism and Relativism during the intervention based on the mean scores of all students, which disproves our first hypothesis (H₁a: There will be a significant difference in students’ ethical ideology as a result of the intervention).

Possible explanations for our results are the small number of participants and/or one individual’s change might be balanced by another individual’s change in the opposite direction since we are using the mean score. For that reason, apart from the mean we also looked at changes in the individuals to see any potential lasting effect there. Indeed, based on the statistical analysis, we noted several changes either in one or both dimensions of the EPQ in students, many of which seemed to remain six months after the intervention as well (Graph 6.1-6.2, section 6.1.2).
Conclusively, regarding:

**R.Q.1 Can students’ personal ethical ideology be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?**

*Even though the quantitative analysis of the EPQ based on the mean scores did not show a statistically significant change in the three phases of the research, when looking at individual changes, we can say that the intervention did cause a seemingly lasting effect to many students’ ethical ideology. Therefore, students’ ethical ideology can be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments, even though a change cannot be expected to be recorded on every student.*

Our next research aim was to record any directional effect on students’ ethical ideology, using Forsyth’s ethical taxonomy (Table 4.2, section 4.3.1.1). When looking at the graphs that we plotted to classify students accordingly and illustrate individual changes in students’ levels of Idealism and Relativism (Graphs 6.3 and 6.4, section 6.1.3), we did not observe a specific directional change in students’ ethical ideology. All students before the intervention were classified as Situationists (high Idealism and high Relativism), except for two students, student 1 who was originally classified as a Subjectivist (low Idealism, high Relativism) and student 5 who was originally classified as an Absolutist (high Idealism, low Relativism), both of whom eventually moved into the Situationists zone. Some students moved towards Absolutism right after the intervention, however a part of the change was undone six months later, indicating that the intervention did not cause a change on their ideological category. Overall, many students appeared to have changes in their Idealism or Relativism scores, even though that did not move them into a different ethical category.

Conclusively, regarding:

**R.Q.1.b What kind of effect might the intervention cause on students’ ethical ideology?**

*Based on the quantitative analysis of the data we cannot observe a specific direction of effect on students’ ethical ideology. We can see that there are a number of different directions and different magnitudes in students’ changes. This could be explained by the fact that the intervention did not aim to have a specific directional effect on students’ ethical ideology, but rather motivate them to consider alternatives to their original view.*
8.2 Students’ Views about Ethics in Science

Next, the Ethics in Science Questionnaire focused on recording students' views regarding five dimensions related to ethical issues in science:

- Integrity: *Do students acknowledge the importance of integrity in science?*
- Morality: *Do students acknowledge the importance of morality in science?*
- Personal Career vs. Social Responsibility: *Should either integrity or morality be sacrificed for the promotion of scientists’ personal career?*
- People vs. Science: *Is science’s purpose to serve humanity or humanity’s purpose to serve science?*
- Scientists’ Ethical education: *Should scientists be educated about matters of ethics in science and should both morality and integrity be included in that education?*

Furthermore, the ESQ aimed to answer:

**R.Q.2** *Can students’ views regarding ethics in science be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?*

**R.Q.2.b** *What kind of effect might the intervention cause on students’ views regarding ethics in science?*

After conducting the statistical analysis on the ESQ, we discovered that the mean scores of Morality, Personal Career vs. Social Responsibility and Scientists’ Ethical Education showed an increase during the three phases of the research, meaning that students were more likely to acknowledge the importance of morality, scientists’ social responsibility and the need for an ethical education. On the other hand, the mean scores of Integrity and People vs. Science showed an overall decrease (Table 6.2 in section 6.2.1). However, the Multivariate tests that were conducted showed that the significance values were greater than 0.005 for all of the dimensions indicating that there were no statistically significant differences among the measurements in the three stages of the research for any of the factors based on the mean scores (Table 5.13 in section 5.4). That means that our $H_2a$ hypothesis is disproved (*There will be a significant difference in students’ views about ethics in science as a result of the intervention*).

Again, possible explanations for our results are the small number of participants and/or one individual’s change might be balanced by another individual’s change in the opposite direction since we are using the mean score. When looking at individual changes instead of the mean scores, we observe several changes in students’ responses during the three stages of the investigation (Graphs 6.5 - 6.9, section 6.2.2).
Conclusively, regarding:

**R.Q.2** Can students’ views regarding *ethics in science* be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments?

*Even though the results of the quantitative analysis based on the mean scores did not show a statistically significant change, when looking at individual changes, we can say that the intervention did cause an effect to most students’ views regarding ethics in science. Therefore, students’ views regarding ethics in science can be affected by an interactive intervention in the form of lectures, classroom discussions, debates, group work and homework assignments, although we cannot expect a lasting effect to be observed on every single student.*

Furthermore, we were also interested in recording the kind of effect that the intervention might have on the students regarding their views about ethics in science. As was mentioned earlier the intervention did not aim to have a specific effect on students, but tried to motivate them to think about several different issues concerning ethics in science and give them the opportunity to exchange views and debate on several topics, either in the classroom or during their group assignments.

Overall, concerning:

**R.Q.2.b** What kind of effect might the intervention cause on students’ views regarding ethics in science?

*Based on the quantitative analysis of the data we cannot observe a specific direction of effect on students’ views about ethics in science, perhaps because the intervention did not aim to have a specific directional effect on their views. We can see however, that there are a number of different directions on students’ individual changes. We observe an overall increase in the dimensions of Morality, Personal Career vs. Social Responsibility and Scientists’ Ethical Education, which means that after the intervention students were more likely to acknowledge the importance of these issues, even though the changes were not found to be statistically significant. Finally, based on individual responses our H₂b hypothesis (The effect on students’ views about ethics in science immediately after the intervention will be greater than the effect 6 months after the intervention) was disproved, as it only holds for a few students, not everyone.*
8.3 Correlations

Next, we were interested in recording a possible correlation between the factors measured by the two instruments used in the research, the EPQ and the ESQ. The EPQ measured two dimensions, *Idealism* and *Relativism*, while the ESQ measured five dimensions, *Integrity*, *Morality*, *Personal Career vs. Social Responsibility*, *People vs. Science*, and *Scientists’ Ethical Education*. According to the statistical tests that were applied on the two instruments which calculated the Pearson correlation coefficient as a measure of the strength of the linear relationship between pairs of variables, we recorded a correlation between *Idealism* and *People vs. Science*, meaning that the more idealistic a person was, the less accepting he/she was of harmful scientific projects and less willing to sacrifice people’s wellbeing for the advancement of science (Table 6.8, section 6.3). The results are based on the scores collected during the first round of questionnaires, before the intervention took place.

Overall, regarding:

**R.Q.3 Is there a correlation between students’ personal ethical ideology and their views about ethics in science?**

*Based on the quantitative analysis of the data that was collected in the first phase of the research, we can say that there appears to be a correlation between the EPQ and the ESQ, specifically, between Idealism and People vs. Science, which was observed before the intervention.*

Also, we were interested in recording potential changes in the correlations between variables during the other two stages of the research, right after the intervention and six months later, as well as calculate the correlation between variables based on the mean scores of the three phases. Specifically, right after the intervention we observed a stronger correlation between *Idealism* and *People vs. Science*, as well as a new correlation between *Idealism* and *Personal Career vs. Social Responsibility*, meaning the more idealistic a person was, the less willing he was of sacrificing aspects of morality and integrity for the promotion of scientists’ personal career (Table 6.9 in section 6.3). Finally, six months after the intervention we observed an increase in the correlation between *Idealism* and *Personal Career vs. Social Responsibility*, a decrease in the correlation between *Idealism* and *People vs. Science*, while there appeared to be an additional correlation between Relativism and Integrity as well (Table 6.10 in section 6.3). Therefore, our H₃ hypothesis (*There will be an effect on the relationship between the EPQ and the ESQ due to the intervention*) is confirmed. Concerning the correlation based on the mean scores of the two instruments, we observed a correlation between *Idealism* and *People vs. Science*, as well as between *Idealism* and *Scientists’ Ethical Education* (Table 6.11, section 6.3).
Conclusively, regarding:

**R.Q.3.b What kind of effect might the intervention have on the correlation between students’ personal ethical ideology and their views about ethics in science?**

_Based on the quantitative analysis of the data that was collected right after the intervention and six months later, we can say that the intervention appeared to strengthen the correlation between the EPQ and the ESQ, as it seemed to cause additional correlations between Idealism and Personal Career vs. Social Responsibility during the second phase of the research which remained even after the six-month period, as well as between Integrity and Relativism in the third phase of the research. Based on the mean scores, there was also an additional correlation observed between Idealism and Scientists’ Ethical Education._

### 8.4 Acknowledgment of Morality and Scientists’ Ethical Education

As was extensively discussed in chapter 3, another focal point of the research was to contribute to the debate concerning the relation between ethics and science, specifically regarding the importance of morality. Therefore, a subsequent aim was first to find out whether students understand the importance of scientists’ moral reasoning, and secondly, whether they believe an ethical education to be meaningful in order to raise scientists’ ethical awareness. To be able to answer to this question, we used a combination of students’ responses to several items of the ESQ during the three stages of the research (section 6.2.2), as well as the qualitative data that was collected during the intervention through students’ homework assignments (section 7.2) and their final comments after the end of the intervention (section 7.3).

Concerning the importance of morality, first we examined all items in the ESQ related to morality:

All items from the second dimension (Morality) and their results:

1. Moral values are irrelevant to the scientific world.
2. Morality in science is critical to the survival of our world and the global population.
3. As long as the evidence is recorded and reported correctly (integrity), the morality of the topic being researched is not important.
4. Morality is important in science to keep the public’s trust (in science).
5. Morality should be included in the ethical code of scientists.
<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3.38</td>
<td>4.15</td>
<td>3.15</td>
</tr>
<tr>
<td>Q2</td>
<td>4.92</td>
<td>5.30</td>
<td>5.23</td>
</tr>
<tr>
<td>Q3</td>
<td>4.23</td>
<td>3.76</td>
<td>3.53</td>
</tr>
<tr>
<td>Q4</td>
<td>5.38</td>
<td>5.30</td>
<td>5.38</td>
</tr>
<tr>
<td>Q5</td>
<td>5.07</td>
<td>5.07</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Table 8.1: Mean scores of Morality items in all three interviews

Items 2, 3, 4 and 6 from the third dimension (*Personal Career vs. Social Responsibility*) and their results:

2. In order to compete in a global environment over funds, reputation and success, scientists can disregard morality.

3. If you are a scientist and your employer asks you to participate in scientific misconduct, you have a moral obligation to “blow the whistle”.

4. Like other employees, scientists have to do what they are told without moral questioning.

6. The moral aspects of a research project is also the employee's responsibility, not only the employer's.

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2</td>
<td>4.53</td>
<td>3.61</td>
<td>3.07</td>
</tr>
<tr>
<td>Q3</td>
<td>5.69</td>
<td>4.53</td>
<td>5.30</td>
</tr>
<tr>
<td>Q4</td>
<td>4.07</td>
<td>3.69</td>
<td>3.00</td>
</tr>
<tr>
<td>Q6</td>
<td>5.92</td>
<td>5.38</td>
<td>5.30</td>
</tr>
</tbody>
</table>

Table 8.2: Mean scores of items related to morality in *Personal Career vs. Social Responsibility*
Items 3 and 4 in the fourth dimension (People vs. Science) and their results:

3. *We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare.*

4. *It’s okay for some people to be harmed or sacrificed in order for science to advance.*

<table>
<thead>
<tr>
<th>Item/Mean</th>
<th>1st Interview</th>
<th>2nd Interview</th>
<th>3rd Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3</td>
<td>4.84</td>
<td>4.92</td>
<td>5.46</td>
</tr>
<tr>
<td>Q4</td>
<td>3.07</td>
<td>3.30</td>
<td>2.61</td>
</tr>
</tbody>
</table>

Table 8.3: Mean scores of items related to morality in People vs. Science

Overall, the above results show that students understood the importance of morality in science, and their level of acknowledgment increased after the intervention. The only items that contrasted this apparent increase in students’ support of morality were items 3 and 6 in the third dimension Personal Career vs. Social Responsibility), which however, even though they showed a minor decrease in their results compared to their original scores, students’ level of agreement still remained particularly high.

Next, we looked at students’ responses to the debate questions, which were either directly or indirectly related to morality in science:

1. “*Should data-miners be allowed to make use of any kind of data in order to maximize their company’s profit / serve their organization’s purpose?*”
2. “*Should there be boundaries on the kinds of research that are being conducted or do we consider science’s purpose to provide us with knowledge at any cost?*”
3. “*Is it moral for scientists to work on projects that support warfare?*”

In the first two debate questions, 12 out of the 13 students supported the existence of moral boundaries in science, while in the third question 7 students disagreed and 6 agreed (section 7.1). However, we note that question 3 was similar to item 3 (*We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare*) in the fourth dimension (People vs. Science) which showed a continuous increase in students’ level of agreement after the intervention. This could mean that after all arguments were heard during the debate, it appears more students were against harmful projects or projects that support warfare than there were when the debate took place.

Overall, the results of the debate questions showed a significant level of acknowledgement of morality in science.
Finally, we examined students’ comments in their homework assignments, where they were asked to express their views regarding the researched scientists’ morality. All students who were appointed a negative scientific figure (Joseph Mengele or Shiro Ishii) expressed negative comments and disapproved of the scientists’ conduct and ethics. Regarding the other two scientific figures (Albert Einstein and Joseph Rotblat) all students seemed to really appreciate and admire both men’s morality, while two students clearly acknowledged the scientists’ never-ending efforts to promote world peace and the protection of human rights, as well as their indisputable contribution to science (Box 7.7 in section 7.2.1)

Next, concerning the importance of an ethical education for scientists, we looked into all items in the fifth dimension (Scientists’ Ethical Education).

1. Morality is different for everyone so young scientists don’t need to be educated about it.
2. Morality can be (positively and/or negatively) influenced, so young scientists need a formal education on scientific ethics with a positive (moral) influence.
3. Young scientists can learn about integrity by observing older scientists, they don’t need a formal education.
4. Not all young scientists have good role models (older scientists), therefore they need a formal education to learn about the code of ethics of the world-wide scientific community.
5. Ethics (both integrity and morality) is important in science and young scientists should be educated about it.
6. There are no ethical principles in science that are so important that they should be part of any code of ethics.

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<th>Item/Mean</th>
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<th>3rd Interview</th>
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<td>3.38</td>
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<tr>
<td>Q4</td>
<td>5.30</td>
<td>5.30</td>
<td>5.46</td>
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<tr>
<td>Q5</td>
<td>5.00</td>
<td>4.92</td>
<td>5.46</td>
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<tr>
<td>Q6</td>
<td>3.92</td>
<td>3.92</td>
<td>3.23</td>
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Table 8.4: Mean scores of Scientists’ Ethical Education in all three interviews
Concerning the items in the fifth dimension of the ESQ, we notice some conflicting results in students’ responses. Items 3, 4, 5, and 6 show an increased level of support for scientists’ ethical education, while items 1 and 2 do not. However, in item 1, which showed an increase in students’ results, the scores were not particularly high and did not show a strong level of agreement. Similarly, despite the fact that item 2 showed an overall decrease six months after the intervention, it had scored particularly high during all phases of the research showing a strong level of agreement.

Finally, we looked at students’ final comments, where they were specifically asked whether they think an ethical education would be useful for future scientists. The results from the qualitative analysis showed that seven out of the nine students who answered the question, responded that an ethical education is important and that it would be useful for future scientists and one student responded that it is important but not a necessity (Box 7.14 in section 7.3).

Conclusively, regarding:

**R.Q.4 Do students acknowledge the importance of scientists’ moral reasoning and ethical education?**

*Regarding scientists’ moral reasoning, when looking at students responses in the particular items in the ESQ, we observe that students scored relatively high in their morality scores and also showed a small but constant increase during the intervention, therefore we can suggest that most students do acknowledge the importance of morality in science. This was also supported by students’ responses to the debate questions and their individual comments regarding the work of the scientific figures that they researched for their homework assignments (Box 7.4 Box 7.7).*

*Based on the particular items in the ESQ and the qualitative analysis of students’ final comments regarding scientists’ ethical education, we can say that, yes, most students believe an ethical education to be important and quite valuable (Box 7.14: Students’ comments regarding whether they believe an ethical education would be useful for future scientists).*
8.5 Students’ Views about the Lectures

Nine out of the ten students who sent in their final comments responded that they found the topic of scientific ethics interesting, while one student said he didn’t like the topic at first, however, he became more interested as he studied it. So overall, ten out of the thirteen students confirmed that they were interested in the subject (Box 7.10, section 7.3).

Therefore, concerning:

**R.Q.5 Do students enjoy hearing, researching and discussing about ethical issues in science and do they find it meaningful?**

*Based on the qualitative analysis of students’ final comments, we can conclude that most students in the study enjoyed hearing, researching and discussing about ethical issues in science and they found it meaningful for several reasons (Box 7.9, section 7.3). Moreover, the homework assignments and discussions among students as well as between students and researcher appeared to motivate and engage them cognitively, in so doing, it helped them to deeply evaluate all the information and decide for its importance for themselves. Conclusively, an intervention in the form of interactive lectures, classroom discussions, debates, group work and homework assignments seems a very good way to engage students.*

Below are a few spontaneous comments sent in by students after the end of the intervention concerning the lectures:

“Dear Electra,
I learned a lot, so thank you for everything, it was a nice experience!
Good luck with everything,
Love,
Kiran”

“Hi Electra,
Thank you very much for everything you taught us!
It was nice to meet you, and thank you again ;p
Loveeee & lot of hugs & greetz from Holland,
Fatima & team 4”

“I think you did a really great job in tutoring and informing us about ethics. I didn’t really know much about it, but now I do know more about it. My team and me just got to know more about the scientist Shiro Ishii. The time flew by and our lessons with you just ended...
I just wanna thank you for all the interesting lessons and hope you enjoyed our class. (And us of course haha ;p)
Denise”
“In my opinion the classes we had with you were very interesting, because I learned a lot about scientific ethics. The topics that you gave us to do a research about were very special. The subjects were deep so I think it was very interesting to read about.

Jessica.”

“The lessons were useful for me in some ways. First of all, I am enjoying that Electra don’t speak Dutch but English. This seems odd but I like to speak English and have the ability to practice it in such a good way that even our English teacher couldn’t provide to us. 😊

Second, since I am finishing the Preparatory College next year and I will study after that, I find it extremely useful to learn something about the integrity and morality of sciences and to discuss earlier scientists. This because it is possible that I myself possibly will study applied math or applied physics. To discuss what their work was, and what their views on morality and integrity was. This is why it was useful for me and because it was quite extraordinary compared to normal lessons, and was quite fun also. 😊 I hope to experience such lessons in the future.

Mohamed”

Generally, concerning our research questions, it would be naïve to draw concrete conclusions from such a small population which is hardly representative of a general population, as even one person’s change can greatly affect the mean. Furthermore, the possibility of hastiness or misinterpretation on behalf of some students can have a considerable effect on the results, therefore, we are only able to talk about indications which may be useful for future research.

That being said, we did observe a change in views (scores) for many subjects right after the intervention, which means that the intervention did have an immediate effect on the students and apparently caused a long-term change to some of them. For other subjects however, and regarding certain dimensions, a change was observed only after the six-month period. This is particularly interesting, as it is an indication that cognitive activity and information processing can continue for a long time before causing an eventual change on a person’s beliefs, and is also an indication that the intervention kept having an effect long after its completion which is rather interesting. Concerning Rokeach’s Beliefs, Attitudes and Values Theory, we are not in position to make an assertion regarding whether we accomplished to affect students’ core values or their more peripheral beliefs, however, we used his theory as a guide in our attempt to motivate students to examine some of their deeper values by providing them with some inspirational excerpts from notable personalities such as Albert Einstein, Nikola Tesla, Martin Luther King Jr. and Mahatma Ghandi, as well as a number of rhetorical questions concerning our moral priorities as people and as a society (Homework Assignments and Food For Thought slides in the Appendix).
Finally, concerning the cases of unexpected directional change (meaning the cases where the scores of the third interview move to the opposite direction than in the second, and even further than the original score), it is difficult to make suggestions as to what it may mean. We would expect that if the intervention did not have a deep impact but only a superficial and temporary one, the scores would move back to their original place. Conclusively, this could either mean that they changed their mind very easily, they were uncertain regarding their actual opinion, or that they were not honest with their views in all three interviews.

**What Was New in This Research**

Once again, I will point out the importance of researchers’ own biases, hopes or expectations and their personal experiences that have shaped their worldview and opinion. Therefore, I myself was led to this particular research from a personal feeling that provision of a course in scientific ethics was missing from my own education, and for reasons elucidated earlier in this thesis, I believe that this is something which should be implemented in schools.

Since in my literature search, I could find no reference to an intervention in which it was attempted to introduce school level students to scientific ethics, it appears that this research provides a new approach to eventual introduction of scientific ethics. It also meant that I could not compare my work with that of other researchers. It seems evident that more research is needed to establish the extent to which it would prove to be interesting and yet useful for students.

The work reported in this thesis appears to be very new, most especially the intervention design. To our knowledge this is the first time that such a student-friendly and motivational approach to introducing scientific ethics has been used at the upper secondary level. It is possible that our activities could form a partial basis of a new course in scientific ethics. Of course individual teachers are likely to want to choose their own debate issues and examples, but perhaps the structuring of the debates, homework, and inclusion of provocative videos might serve teachers and researchers well.

Also interesting from a research perspective is our new application of the Ethics Position Questionnaire. Further research should validate the new formulation (reorganizing the order of the questions and reducing the number of answer choices from nine to seven to be more in line with secondary level students’ maturity levels). The Ethics in Science Questionnaire was designed by us and is therefore completely new. For that reason, it should undergo validation if used by others.
9. LIMITATIONS & SUGGESTIONS

In this section all the limitations of the research will be discussed, with the purpose of proposing a few suggestions for future research.

1. Small Number of Participants

The small number of students that participated in the study gave us the opportunity to do some qualitative research and get a closer look at students’ views, while it allowed us to focus more in depth in some interesting cases. However, concerning the quantitative part of the research and the statistical analysis, it makes it impossible to generalize our results. We are therefore speaking only about indications. Also, the small number of participants ruled out the possibility of looking into gender differences or differences based on ethnicity, which would be a suggestion for future research.

At the same time, our group of students is not representative of the general population, as they were specifically selected by their Informatics teacher based on their ability in computer science (so that they could afford to miss a few lessons since the research took place within the time-frame of the Informatics course) and their understanding of the English language. Therefore, one other suggestion would be to have a more random group of subjects.

2. Data collection methods

Another important limitation is that one of the instruments, the ESQ, was not validated before its use in the research. For that reason we do not have information concerning its credibility. Also, we observed that Cronbach’s alpha was insufficient for some dimensions of the ESQ in several occasions (Table 5.12, section 5.4). Due to the small number of participants it’s difficult to draw concrete conclusions regarding the internal consistency of the instrument, however, it remains an important setback. In order to tackle this problem during the data analysis, we also examined in detail students’ responses on isolated questions, rather than base our conclusions solely on the aggregated scores of each dimension that the ESQ was meant to measure. That helped us get a clearer look at student’s views and their changes and it was very useful because several isolated questions were related to some of the debate questions (as was discussed in section 6.2.2). Furthermore, our qualitative data supported many of our findings from the questionnaires concerning individuals.
3. Time restrictions

Unfortunately, there was a restricted time frame for the intervention. A study that focuses on tapping into students’ core beliefs with the purpose of affecting them, while at the same time promoting critical thinking which is absolutely vital, would ideally require a lot more time in order to draw students’ attention, engage them in an active way and give them the necessary cognitive tools to “rise to the challenge”. Four hours of actual lecture time is considered extremely small to achieve all these goals and to actually have a meaningful impact on students’ views regarding their ethical position. Despite all that, we were able to observe a lasting effect in many cases. Unfortunately, the short time frame impacted severely on two of the three debates, which were found to be very interesting for most students, but failed to provide us with sufficient data regarding everyone’s view on the questions asked. Again we were able to collect information only on certain subjects. Therefore, one important suggestion for future research would be to secure adequate time for the research and for all the different parts of the intervention (debates, students’ presentations, etc.).

4. Language barrier

It should be noted that English was not the students’ native language, and in some cases we were able to observe difficulties in some students’ writing (as seen in some of the quotations in sections 7.2 and 7.3). We do suggest that there may have been difficulties in following the lectures and the discussions for some subjects. However, all students appeared to make an effort as they really seemed to pay attention during the lectures instead of engaging in other activities (especially since the lessons took place in the computer room where students had access to the computers right in front of them). Furthermore, all students completed the homework assignments successfully and participated in the presentations, and almost everyone gave his/her final comments in writing after the end of the lectures.

5. Psychological barriers

Regarding our results, we need to take into account that people can be classified as yeasayers or naysayers (Couch & Keniston, 1960), defined as the tendencies to agree (or disagree) with questionnaire items regardless of their content. However, even though we did not specifically try to explore students’ tendencies towards that direction and classify them accordingly, we did not observe such a tendency in any student (based on their responses to the questionnaires). Furthermore, there is also the possibility that
some students were perhaps more affected by the researcher’s ‘charisma’ rather than
the arguments that were presented during the lectures. That means that for some
students it’s likely that the relationship that they developed with the researcher had a
greater influence towards a change of their view rather than the actual information that
was exchanged during the intervention (Ehrhart & Klein, 2001). Regarding identifying
with the teacher, this could mean that a student’s attention is more likely to be engaged
with the subject presented, and perhaps more open to change. Bored and disinterested
students are usually not cooperative and they may be less open to change as they are
not fully engaged in the classroom activities and the whole process. Finally, people can
be classified according to their level of psychological rigidity, meaning their level of
"resistance, or lack of readiness, to be influenced" (Meresco et al., 1954), regardless of
the arguments or charisma of the teacher. Of course, all of the above can be considered
a limitation to all research involving human subjects if researchers do not include an
attempt to classify their participants accordingly in advance. In our case however, even
though we did not research our subjects’ psychological tendencies in that respect, we
did collect student’s views in advance before the intervention, so before the influence of
any arguments or the lecturer herself. These preliminary views were later used as a
reference point, as well as students’ views collected six months after the end of the
intervention. Regarding the latter we hoped that if there was a superficial influence
interfering with their actual views, it would have faded away by the time of the third
data collection.
10. POST SCRIPTUM

“Everyone talks about leaving a better planet for our children.
Perhaps we should be striving to leave better children for the planet.”

Anonymous

Joseph Rotblat gave his last speech in 1997 as president of the Pugwash Conferences\(^\text{28}\), just before he retired at the age of 89. Despite his years of striving for world peace and the tremendous efforts towards nuclear disarmament, there was truly nothing complacent in his words. (retrieved from www.pugwash.org)

Was there a need to have done more? Should we have done more? I can’t help feeling that the answer to both questions is Yes.... Many scientists are still not willing to face reality. Many discourage or actively hamper young scientists from being concerned with the social impact of science. We scientists have to realize that what we are doing has an impact not only on the life of every individual, but also on the whole destiny of humankind. All of us who want to preserve the human race owe an allegiance to humanity; and it’s particularly the job of scientists, because most of the dangers to the world result from the work of scientists. The ethics and logic of science are universal. They transcend geographic frontiers and ideological divides. Respect for facts and abhorrence of prejudices are inherent in the scientist’s morality. All this makes the scientific community a model for a world community of nations. A task not just for scientists but for everybody.

That is how Joseph Rotblat perceived the struggle for peace, a task for everybody, not just for scientists.

'Ve are gradually realizing the futility of war.... Now we must begin to think about security in global, rather than national, terms. We must get used to the idea that we are members of a world community... We have to develop in each of us a sense of loyalty to humankind that will be an extension of our present loyalties to family, city, nation. And science - the same human activity that can bring the whole of humankind to an end - can help; indeed, scientists, who are already citizens of the world, can lead our effort to learn to live without war. Technology, communication, transport can and often do bring the world together. If you want peace, prepare for peace.

\(^\text{28}\)“The purpose of the Pugwash Conferences since its origin in 1957, is to bring together, from around the world, influential scholars and public figures concerned with reducing the danger of armed conflict and seeking cooperative solutions for global problems.” www.pugwash.org
Rotblat used the same words he had used when he was awarded the Nobel Peace Prize in 1995 to end his talk:

*The quest for a war-free world has a basic purpose: survival. But if in the process we learn to achieve it by love rather than fear, by kindness rather than compulsion; if in the process we learn to combine the essential with the enjoyable, the expedient with the benevolent, the practical with the beautiful, this will be an excellent incentive to embark on this great task. But above all, remember your humanity.*

Contemplating on the words of Joseph Rotblat, it becomes apparent how ethics and an ethical education might be used as perhaps the single most powerful tool to help transform our world-view, and create a sense of loyalty towards the human family and the planet. It also becomes apparent how essential it is to enlighten humanity regarding both the dangers we are facing due to the wrong decisions we have collectively or individually made disregarding the long term consequences, as well as the opportunities that lay ahead of us thanks to the tremendous scientific and technological capabilities we currently have at hand.

Considering all the above, perhaps it is time to advocate that ethics and philosophy -in the sense of critically examining our place and function within society with the purpose of improving all aspects of social life and social conduct, as well as interpersonal or international relationships-, should be a basic and fundamental element of education, aiming to inspire all students and therefore all future world citizens towards world peace, real sustainability and spiritual growth. Perhaps promoting a conscious ethical ideology which is clearly dedicated to transmitting humanitarian and environmental values should be our first priority, rather than continuing the blind enforcement of specialized disciplines such as math, science or religion, through all years of primary and secondary education, which, after the attainment of some fundamentally essential level of knowledge, could be optional to the students who genuinely wish to study them.

As Marie Curie (1923) said

*You cannot hope to build a better world without improving the individuals. To that end each of us must work for his own improvement, and at the same time share a general responsibility for all humanity, our particular duty being to aid those to whom we think we can be most useful.*

Concluding, it’s my belief, that the ones that we can be most useful to and have a sacred duty to aid, are, and always will be, the most innocent and valuable members of the human race, the children of this world.
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APPENDIX A “THE GREAT DICTATOR”
Lectures on Ethics
Speech Fragment (The Great Dictator)

(Charlie Chaplin): “I'm sorry but I don't want to be an emperor. That's not my business. I don't want to rule or conquer anyone. I should like to help everyone if possible; Jew, Gentile, black men, white. We all want to help one another. Human beings are like that. We want to live by each other's happiness, not by each other's misery. We don't want to hate and despise one another. In this world there is room for everyone. And the good Earth is rich and can provide for everyone. The way of life can be free and beautiful, but we have lost the way.

Greed has poisoned men's souls; has barricaded the world with hate; has goose-stepped us into misery and bloodshed. We have developed speed, but we have shut ourselves in. Machinery that gives abundance has left us in want. Our knowledge has made us cynical; our cleverness, hard and unkind. We think too much and feel too little. More than machinery we need humanity. More than cleverness, we need kindness and gentleness. Without these qualities, life will be violent and all will be lost. The airplane and the radio have brought us closer together. The very nature of these inventions cries out for the goodness in man; cries out for universal brotherhood; for the unity of us all.

Even now my voice is reaching millions throughout the world, millions of despairing men, women, and little children, victims of a system that makes men torture and imprison innocent people. To those who can hear me, I say 'Do not despair'. The misery that is now upon us is but the passing of greed, the bitterness of men who fear the way of human progress. The hate of men will pass, and dictators die, and the power they took from the people will return to the people. And so long as men die, liberty will never perish.

Soldiers! Don't give yourselves to brutes, men who despise you and enslave you; who regiment your lives, tell you what to do, what to think and what to feel! Who drill you, diet you, treat you like cattle, use you as cannon fodder! Don't give yourselves to these unnatural men; machine men with machine minds and machine hearts! You are not machines! You are not cattle! You are men! You have a love of humanity in your hearts! You don't hate! Only the unloved hate; the unloved and the unnatural.

Soldiers! Don't fight for slavery! Fight for liberty! In the seventeenth chapter of St. Luke, it's written 'the kingdom of God is within man', not one man nor a group of men, but in all men! In you! You, the people, have the power, the power to create machines, the power to create happiness! You, the people, have the power to make this life free and beautiful, to make this life a wonderful adventure!

Then, in the name of democracy, let us use that power! Let us all unite! Let us fight for a new world, a decent world that will give men a chance to work, that will give youth a future and old age a security. By the promise of these things, brutes have risen to power. But they lie! They do not fulfill their promise. They never will! Dictators free themselves but they enslave the people. Now let us fight to fulfill that promise! Let us
fight to free the world! To do away with national barriers! To do away with greed, with hate and intolerance! Let us fight for a world of reason, a world where science and progress will lead to all men’s happiness.

Soldiers, in the name of democracy, let us all unite! “
Welcome to my research project!

Research Questions:

• What are the students' opinions about ethics in science?
  Should both integrity and morality be included in an Ethical Code for science?
  Can Scientific Ethics help?
  Should students be educated about Scientific Ethics?

What is “Ethics”?

• Derived from the Greek word ethics (ἦθος), which means the individual moral status of each person.
• Branch of Philosophy which addresses questions about morality (right-wrong, good-bad, sense of justice, virtue, etc.)
• It defines a set of principles of right conduct.

Types of Ethical Theory 1

Deontology: (e.g. Immanuel Kant)
Deontologists look at duties and universal moral rules to base and judge actions, not the consequences. The duties can derive from various sources, such as religion, culture, etc. and they can only be overridden by a more important moral duty.

Example:
It doesn’t matter if the drunk driver made it home safely. Driving drunk was still wrong because the intention to drive drunk was wrong (or to drink alcohol when one knows one needs to drive).

Criticism:
1. The famous “paradox of deontology”
2. The unchanging principles that deontologists attribute to natural law or universal reason are really a matter of subjective opinion
3. Problem of priority (when rules and duties conflict)

Types of Ethical Theory 2

Consequentialism: (e.g. Siddhārtha Gautama - the Buddha)
Consequentialists make judgments based on the results/consequences of an action, they do not follow blindly universal or absolute moral guidelines. Thus, from a consequentialist standpoint, a morally right act is one that will produce a good outcome.

Criticism:
1. Moral theories such as cosequence theories are unable to adequately explain why a morally wrong action is morally wrong. The example of an "obliging stranger" who agrees to be baked in an oven!

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Other types of Consequentialism:

- **Teleology**: Teleologists focus on achieving a purpose not only the immediate consequences ("telos" Greek word for end).

  - *Sophocles in Electra (409 B.C.)*, ‘The end excuses any evil’ a.k.a. “The end justifies the means”.

- **Utilitarianism**: Holds the idea that the moral worth of an action is determined solely by its usefulness in maximizing utility as summed among all living/conscious beings.

  Question: Consequences for whom?

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**Ethical Egoism vs. Ethical Altruism**

- **Ethical Egoism**: (e.g. Max Stirner - individualist anarchism) Is the ethical position that moral agents ought to do what is in their own self-interest.

- **Ethical Altruism**: (e.g. Auguste Comte - founder of sociology and positivism) Is the ethical position that moral agents have an obligation to help and serve others.

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**Virtue Ethics** (Aristotle)

Virtue ethics describes the character of a moral agent as a driving force for ethical behavior, rather than rules (deontology) or outcomes (consequentialism).

Aristotle begins by saying that the highest good for humans, the highest aim of all human practical thinking, is "eudaimonia", a Greek word translated as well-being or happiness. According to Aristotle such happiness can be reached by possessing high virtues such as excellent reasoning.

Aristotle believed that ethical knowledge is not only a theoretical knowledge, but rather that people must have "practical wisdom" of the actions they take, and have lived "through thick and thin" experiences. It is not just to study what virtue is, but must actually do virtuous things. For example, a tree with some broken branches and marks on it is only a deteriorated version of the perfect tree of tree-ness, the true pure form that we can compare it to.

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**Platonic Idealism**

Plato believed in *Ideas*, which are the perfect forms of objects and concepts. He believed we are all born with a priori knowledge of Ideas which exists in our immortal soul. In that sense he was highly idealistic and he believed that these ideas are the only true form of reality.

For example, a tree with some broken branches and marks on it is only a deteriorated version of the perfect tree of tree-ness, the true pure form that we can compare it to.
**Types of Ethical Theory 6**

**Plato vs. Aristotle**

- **The concept of human function (purpose):**
  - For Plato, the human function is defined as deliberation (careful consideration), ruling, living and taking care of things.
  - For Aristotle, the human function is to perform activities that express reason which ultimately will lead to "eudaimonia," Aristotle's synonym for happiness.

These two different definitions illustrate the chasm between the ways that each philosopher is thinking regarding the concept of human function.

Plato uses his argument to set up his model city and to define the roles of the different parts of the community. Aristotle, on the other hand, offers a more individualistic approach. Expressing reason in one's action does not have anything to do with a relationship with other people or a community, but relates mostly to the individual.

**Scientific Ethics**

- **Is the set of guidelines that scientists need to follow within their professional endeavors.**
  - Scientific Ethics covers a broad range of issues related to science and it can be categorized in two major sections:
    1. **Ethics of the method and process (integrity):** It deals with the conduction of research, observation, and the process of data recording and reporting.
    2. **Ethics of the topics and findings (morality):** It deals with the question of whether science is good or bad in specific areas, for example, when human and animal subjects are involved or when there is a high risk of danger related to the research.

Patricia A. Bolton (Chapter 16 Scientific Ethics)

- **Professional Integrity and the Scientific Method:**
  1. Unprejudiced observation of natural phenomena as they happened, without reference to religious or philosophical beliefs.
  2. Experimentation. Every scientific theory should be put to test in a practical experiment. Galileo is said to have climbed a tower in Pisa in order to drop two bodies of different masses to show that they fall with apparently equal velocities.
  3. Correct knowledge of nature should be expressed in mathematical terms. For example, declaring that the distance travelled by a falling body is proportional to the square of the time taken in falling.

- **Morality Issues:**
  - When scientists manipulate animals, engage in research that involves the suffering of animals, or use animals as research models, they are faced with ethical dilemmas.

  In a world where science is closely intertwined with commerce and private funding, ethical issues seem to be at odds with scientific agendas.

Jennifer Andrew, Ian Robottom (2000)

- Young researchers get ethical training and don't know the type of ethical dilemma they might face in their professional career.
Scientific Ethics

• What does today’s scientific community say about professional guidelines?

According to the National Academy of Sciences (On Being A Scientist: A Guide to Responsible Conduct in Research, 2009), research is based on the same ethical values that apply in everyday life, including:

- honesty,
- fairness,
- objectivity,
- openness,
- trustworthiness and respect for others.

Scientific Ethics

According to the Guide, researchers have three sets of moral obligations:

• First, researchers have an obligation to honour the trust that their colleagues place in them.

• Second, researchers have an obligation to themselves.

• Third, researchers have an obligation to act in ways that serve the public.

Scientific Ethics

Why should scientists act in ways that serve the public?

The ultimate philosophical dilemma…

OR

Ethical Egoism

Ethical Altruism

http://www.youtube.com/watch?v=QcvjoWOwnn4

Scientific Ethics

Next time:

- Scientific dilemmas
- Scientific misconduct
- Scientists’ responsibility
- Classroom discussion
- Game 😊

Assignment

Four groups of 4 students.

A) Each group gets a famous historic scientific personality
• Research the ethical position of this scientist
• Debate about it with your group members
• Each of you will write a paragraph with your individual understanding of the professional ideology and your personal criticism and comments.
• Prepare a group report divided in 4 sections, with your individual paragraphs
• Prepare a group presentation 5-7 min for next time (2 of you will present)

B) Each group gets a modern scientific conspiracy theory and does a small research about it
• Prepare a second presentation 5-7 min describing the theory to us (the other two will present)

C) Prepare to state your opinion in a classroom discussion next time 😊
Each group gives 2 presentations:
- During the 1st presentation you need to think about the differences between the ethical positions of various scientists.
- During the 2nd presentation you need to consider the responsibilities and the morality of scientists whose work has a dramatic effect on the population and/or the environment.
- Be ready to discuss your opinion at the end of our meeting (group work is finished). 

Main forms of scientific misconduct:
- Fabrication: making up of research data
- Falsification: manipulation of research data to prove one's conjecture or results
- Obfuscation: leaving out critical data or results
- Bare assertions: making unsupported claims
- Plagiarism: the act of taking credit for the work of another, for example not referencing other people’s work that you used in your research. Could be the most common type of misconduct

Some Biotechnology categories:
- Medical/Health applications (Red Biotechnology)
- Agricultural applications (Green Biotechnology)
- Marine/Aquatic applications (Blue Biotechnology)
- Industrial applications (White Biotechnology)

Biotechnology: Any application of scientific and technical advances in life sciences to develop commercial products

Medical/Health applications (Red Biotechnology)
- Includes all applications that deal with human and animal health (humans or animals) while others can affect the global population

Agricultural applications (Green Biotechnology)
- Involves the manipulation of genetic material in plants or animals to improve their productivity or characteristics.

Marine/Aquatic applications (Blue Biotechnology)
- Deals with applications that involve marine organisms, such as seafood production, and marine agriculture.

Industrial applications (White Biotechnology)
- Refers to applications in industries such as pharmaceuticals, bioplastics, biofuels, and others.

Scientists’ Ethical Issues (Morality)
- Not all scientists’ work raises moral dilemmas
- Not all moral dilemmas are the same
- Some might affect only a small experimental group (humans or animals) while others can affect the global population

Scientists’ Ethical Issues (Morality)
- Not all ethical dilemmas are the same
- None of these scientists.

Some Biotechnology categories:
- Medical/Health applications (Red Biotechnology)
- Agricultural applications (Green Biotechnology)
- Marine/Aquatic applications (Blue Biotechnology)
- Industrial applications (White Biotechnology)

Biotechnology: An application of scientific and technical advances in life sciences to develop commercial products.
Scientists’ Ethical Issues (Morality)

**Red Biotechnology: Human genetic manipulation-modification, designer babies (biological improvement of humans) & eugenics (e.g. Dr. Mengiste and Nazi experimentation)***

**Blue Biotechnology:**

**Green Biotechnology: Genetically modified Food**

Other countries that practiced sterilization based on eugenics:

Between 1907 and 1945, over 62,000 individuals were forcibly sterilized under eugenic laws for various reasons.

History of Eugenics:

The field of Eugenics became extremely controversial due to its use in Nazi Germany and other countries.

Ethical Issues?

The use of data mining in governmental or commercial data sets can have serious discrimination in the employment or the insurance industry.

Example:

- The Information Awareness Office (IAO) was created to analyze data from social networks, credit card records, phone calls, medical databases to gather and store the personal information of anyone in the United States, including personal email, work e-mail, social media, photos, medical records, and numerous other sources including, without any requirement for search warrants.

- **Ethical Issues?**

Data mining (a.k.a. Knowledge Discovery in Databases process, KDD)

- It’s a very powerful tool that is increasingly used in the economic and social sectors, as well as in other areas.
- It’s a very powerful tool that is increasingly used in the economic and social sectors, as well as in other areas.
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Scientists’ Ethical Issues
(Morality)

Privacy, legality, ethics

Due to heavy criticism and the fact that it was leading to a mass surveillance system, the IAO was de-funded but not stopped by Congress in 2003. According to several sources, many IAO projects continued to be funded, and simply run under different names.

Speaking about privacy

http://www.youtube.com/watch?v=B37wW9CGWyY

Time for a little game 😊

Debate Question:

1. "Are data miners allowed to use any sort of data in order to maximize their company’s profit or serve their organization’s purpose?"

Those who agree go to the left, those who disagree go to the right!

(Your left, your right!)

30 seconds for each to state his argument!

http://ideas.gstboces.org/programs/timer/
Last time...

- Moral issues in science (a few examples):
  - Eugenics (racial classification, enforced sterilizations and abortions in order to “purify” genetically the next generations, holocaust)
  - Biotechnology (genetically modified plants and animals)
  - Cloning
  - Data mining techniques (issue of privacy, “profiling”)
  - Nuclear energy testing (problem of pollution and the high risk of nuclear accidents)

http://www.youtube.com/watch?v=I9lquok4Pdk&feature=related

The eternal “witch hunt”

Science and technology have always advanced rapidly under the fear of an upcoming threat.

- Witches
- Religious diversities (e.g. Catholics vs. Protestants)
- National and/or political threats (e.g. Communism and the Cold War)
- Terrorists
- Next (?)

Scientists’ Ethical Issues (Morality)

Second round of debate

Debate Question:
2. “Should there be boundaries on the kinds of research that are being conducted?”
   Do we consider science’s purpose to provide us with every possible knowledge at any cost?
   Few “bad” examples: Genetic modification of humans, cloning, racial classifications

Those who agree go to the left, those who disagree go to the right!
(Your left, your right!)
30 seconds for each to state his argument!

The eternal “witch hunt”

In 1891 Alfred Nobel (Nobel Prize), inventor of dynamite, said to the peace campaigner Bertha von Suttner:

“Perhaps my factories will put an end to war sooner than your congresses: on the day that two army corps can mutually annihilate each other in a second, all civilized nations will surely recoil with horror and disband their troops.”

Unfortunately, while his thought seemed logical, he couldn’t have been more wrong...

Einstein, in a speech on the problems of being a scientist and managing social responsibility for others made just after the atomic bomb had been dropped on Japan, compared their problems (physicists) to that of Nobel.

“Alfred Nobel invented an explosive more powerful than any then known, an exceedingly effective means of destruction. To atone for this ‘accomplishment’ and to relieve his conscience, he instituted his award for the promotion of peace.”

Scientists’ Ethical Issues (Morality)

Third round of debate

Debate Question:
3. “Is it ethical for scientists to work on projects that support weapons?”
   Few “bad” examples: Nuclear weapons, biological weapons, chemical weapons...

Those who agree go to the left, those who disagree go to the right!
(Your left, your right!)
30 seconds for each to state his argument!

Thank you all!

Have a nice summer!
**Food For Thought**

**What if?**

Question to ponder:

What if all this intelligence, originality and creativity of humans was motivated by solving current problems such as scarcity issues, energy problems, and new occurring health problems?

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**Scientists’ personal ideology differs but matters…**

"Today we must abandon competition and secure cooperation. This must be the foundation, the true foundation of international politics, cooperation and unity among countries in each country and in the whole world.

Albert Einstein: Only the Bold Will Find Peace (1948)

Some as Aristotle, Einstein believed that the ethical development of people depends greatly on the environment they grow up in and the moral standards that they learn.

Each person's character and psychological makeup is largely formed by the environment in which he or she happens to find himself during his development, by the philosophy of the society in which he grows up, by the traditions of that society, and by its approval of particular types of behavior.

Albert Einstein, (1949)

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**Every man’s personal ideology differs but matters…**

"Only the individual can think, and thereby create new values for society, new ways of acting, new directions in which the spirit of the community moves. Only the individual can be a creative and a productive participant in a true democracy. The individual can be the producer of the affairs of his time. He can be a political factor in the community."

Albert Einstein, (1954)

Food for thought:

What are the moral standards you want people and society to adopt, and how do you believe this can be achieved?
APPENDIX C QUESTIONNAIRES
Ethics Position Questionnaire (EPQ)
(English)

1. People should make certain that their actions never intentionally harm others even to a small degree.
2. Risks to another should never be tolerated, irrespective of how small the risks might be.
3. The existence of potential harm to others is always wrong, irrespective of the benefits to be gained.
4. One should never psychologically or physically harm another person.
5. One should not perform an action which might in any way threaten the dignity and welfare of another individual.
6. If an action could harm an innocent other, then it should not be done.
7. Deciding whether or not to perform an act by balancing the positive consequences of the act against the negative consequences of the act is immoral.
8. The dignity and welfare of people should be the most important concern in any society.
9. It is never necessary to sacrifice the welfare of others.
10. Moral actions are those which closely match ideals of the most "perfect" action.
11. There are no ethical principles that are so important that they should be part of any code of ethics.
12. What is ethical varies from one situation and society to another.
13. Moral standards should be seen as being individualistic; what one person considers to be moral may be judged to be immoral by another person.
14. Different types of moralities cannot be compared as to "rightness."
15. Questions of what is ethical for everyone can never be resolved since what is moral or immoral is up to the individual.
16. Moral standards are simply personal rules which indicate how a person should behave, and are not to be applied in making judgments of others.
17. Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes.
18. Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment.
19. No rule concerning lying can be formulated; whether a lie is permissible or not totally depends on the situation.
20. Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action.
1. Individuele personen moeten er zeker van zijn dat zij door hun acties niet met opzet, ook niet in de geringste mate, anderen zullen schaden.
2. Risico’s voor anderen zouden nooit getolereerd moeten worden, ongeacht hoe klein het risico ook mag zijn.
3. De mogelijkheid dat anderen schade lijden is ten alle tijde onacceptabel, ongeacht wat de voordelen kunnen zijn.
5. Men mag nooit een actie uitvoeren, waardoor de waardigheid en welbevinden van anderen in gevaar wordt gebracht.
6. Als een actie een onschuldig individu kan schaden, dan mag deze actie niet uitgevoerd worden.
7. De beslissing om een actie te ondernemen af te laten hangen van de afweging van positieve en negatieve consequenties, wordt immoreel geacht.
8. De persoonlijke integriteit en het welbevinden van mensen zouden het belangrijkste geacht moeten worden in elke samenleving.
9. Het mag nooit nodig zijn het welbevinden van anderen op te offeren.
10. Moreel verantwoorde acties zijn die, die het meest overeenkomen met de perfecte actie.
11. Er zijn geen principes in ethiek die belangrijk genoeg zijn om een ethische basiscode te vormen.
12. Wat ethisch is, is altijd gerelateerd aan situatie en maatschappelijke omgeving.
13. Een morele standaard zou gezien moeten worden als persoonlijk; wat één individu beschouwt als moreel acceptabel, kan het andere individu beschouwen als immoreel.
14. Verschillende soorten van moraliteit kunnen niet bestemd worden “juist of onjuist”.
15. Vragen over wat ethisch verantwoordt is voor iedereen kunnen nooit beantwoord worden, omdat het per individu kan verschillen wat moreel is of immoreel.
16. Morele standaarden zijn simpele persoonlijke regels die aangeven hoe men zich zelf wenst te gedragen, en zijn niet toepasbaar op de beoordeling van anderen.
17. Ethische overwegingen in een persoonlijke relatie zijn zo complex dat individuen de ruimte moeten hebben hun eigen ethiek te formuleren.
18. Rigide codificatie van een ethische positie die bepaalde acties voorkomt zou in de weg kunnen staan van betere menselijke relaties en aanpassingen.
19. Geen enkele regel kan geformuleerd worden over het liegen; of een leugen toelaatbaar is of niet, hangt compleet af van de situatie.
20. Of een leugen als moreel of immoreel wordt beschouwd hangt af van de omstandigheden rondom de actie.
Ethics in Science Questionnaire (ESQ)
(English)

A. Understanding and acknowledgement of Integrity (Do students acknowledge the importance of integrity in science?)
1. Integrity is important in science and everyone should share the same rules of scientific conduct (regarding observation, data collection, reporting, etc.).
2. Scientists don't need to share the same rules on how research is done and reported, every case is different.
3. Integrity is important to keep some basic levels of trust among scientists.
4. We live in a free world, therefore everyone has the right to conduct and report research as he/she likes and it should be considered equally valid.
5. Rules about integrity in science should form an ethical code for scientists.

B. Understanding and acknowledgement of Morality (Do students acknowledge the importance of morality in science?)
1. Moral values are irrelevant to the scientific world.
2. Morality in science is critical to the survival of our world and the global population.
3. As long as the evidence is recorded and reported correctly (integrity), the morality of the topic being researched is not important.
4. Morality is important in science to keep the public's trust (in science).
5. Morality should be included in the ethical code of scientists.

C. Personal career vs. Social responsibility (Should either integrity or morality be sacrificed for the promotion of scientists’ personal career?)
1. Despite the global competition over funds, reputation and success, scientists should not disregard integrity.
2. In order to compete in a global environment over funds, reputation and success, scientists should disregard morality.
3. If you are a scientist and your employer asks you to participate in scientific misconduct, you have a moral obligation to “blow the whistle”.
4. Like other employees, scientists simply have to do what they are told without moral questioning.
5. Scientists have no social responsibility for the harmful creations and applications of their science.
6. The moral aspects of a research project is also the employee's responsibility, not only the employer's.
7. Scientists should have a greater allegiance to society than their employer.

D. People vs. Science (Is science’s purpose to serve humanity or humanity’s purpose to serve science?)
1. Science is more about discovering interesting truths, not about serving people.
2. Science has a social responsibility beyond providing new knowledge.
3. We cannot consider a scientist ethical if he works on harmful projects or projects that support warfare.
4. It’s okay for some people to be harmed or sacrificed in order for science to advance.
5. The overall effectiveness of science can be determined by the amount of interesting knowledge that it has given us.
6. The overall effectiveness of science can be determined by the degree to which it improves people's lives.

E. Scientists’ ethical education (Should scientists be educated about matters of ethics in science and should both morality and integrity be included in that education?)

1. Morality is different for everyone so young scientists don't need to be educated about it.
2. Morality can be (positively and/or negatively) influenced, so young scientists need a formal education on scientific ethics with a positive (moral) influence.
3. Young scientists can learn about integrity by observing older scientists, they don't need a formal education.
4. Not all young scientists have good role models (older scientists), therefore they need a formal education to learn about the code of ethics of the world-wide scientific community.
5. Ethics (both integrity and morality) is important in science and young scientists should be educated about it.
6. There are no ethical principles in science that are so important that they should be part of any code of ethics.
A. Understanding and acknowledgement of Integrity
1. Integriteit is belangrijk in de wetenschap en iedereen zou dezelfde gedragsregels moeten toepassen (betreffende observatie, data verzamelen, rapportage etc.).
2. Wetenschappers hoeven niet dezelfde regels toe te passen in verband met hoe het onderzoek wordt gedaan en hoe het wordt gerapporteerd. Elke situatie kan anders zijn.
3. Integriteit is belangrijk om een basis van vertrouwen te houden onder wetenschappers.
4. We leven in een vrije wereld, daarom heeft iedereen het recht om wetenschappelijk onderzoek te verrichten en daarover te rapporteren op zijn eigen manier.
5. Regels over integriteit in de wetenschap zouden een gedragscode moeten vormen voor wetenschappers.

B. Understanding and acknowledgement of Morality
1. Morele waarden zijn irrelevant in de wetenschappelijke wereld.
2. Moraliteit in de wetenschap is noodzakelijk voor het overleven van deze planeet en de wereldbevolking.
3. Zolang de wetenschappelijke bewijzen correct worden geregistreerd en gerapporteerd (integriteit) is de morele standaard van het onderwerp niet van belang.
4. Moraliteit is belangrijk in de wetenschap om het vertrouwen van de samenleving te waarborgen.
5. Moraliteit zou opgenomen moeten worden in een ethische code voor wetenschappers.

C. Personal Career vs. Social Responsibility
1. Om te kunnen concurreren in een wereldwijde markt van fondsen, reputaties en succes, kunnen wetenschappers hun integriteit negeren.
2. Om te kunnen concurreren in een wereldwijde markt van fondsen, reputaties en succes, kunnen wetenschappers hun morele verantwoordelijkheid negeren.
3. Als je een wetenschapper bent en je werkgever wil dat je deelneemt aan wetenschappelijk wangedrag, dan is het morale verantwoordelijkheid van de wetenschapper om “aan de bel te trekken”.
4. Als een werknemer, moet een wetenschapper zonder morele scrupules doen wat hem/haar wordt opgedragen.
5. Wetenschappers hebben geen maatschappelijke verantwoordelijkheid voor schadelijke ontwikkelingen en toepassingen van hun onderzoek.
6. De morele aspecten van een onderzoek is ook verantwoording van de werknemer, niet alleen van de werkgever.
7. Wetenschappers zouden een sterker gevoel van plicht moeten hebben tegenover de maatschappij dan hun werkgever.

D. People vs. Science
1. De wetenschap gaat vooral over het ontdekken van interesante feiten en niet over het dienen van de maatschappij.
2. De wetenschap heeft een verantwoordelijkheid die verder reikt dan het aanbrengen van nieuwe inzichten.
3. We kunnen het werk van een wetenschapper niet als ethisch verantwoord beschouwen, als hij/zij werkt aan projecten die schadelijk en gevaarlijk zijn.
4. Het is acceptabel dat sommige mensen leed wordt aangedaan of dat zij worden opgeofferd voor de ontwikkeling van de wetenschap.
5. De algemene effectiviteit van wetenschap kan worden vastgesteld aan de hand van de nieuwe kennis die het ons opgeleverd heeft.
6. De algemene effectiviteit van wetenschap kan worden vastgesteld naar aanleiding van de mate waarin het het leven van mensen heeft verbeterd.

E. Scientists’ ethical education
1. Moraliteit is anders voor iedereen, dus jonge wetenschappers hoeven hier geen onderwijs in te krijgen.
2. Moraliteit kan zowel negatief als positief beïnvloed worden, dus moeten jonge wetenschappers een formele opleiding krijgen over ethiek in de wetenschap met een positieve (morele) invloed.
4. Niet alle jonge wetenschappers hebben een goed voorbeeld (bijvoorbeeld een ervaren wetenschapper), daarom hebben zij hiervoor onderricht nodig om te leren over de gedragscode in de wereldwijde wetenschappelijke gemeenschap.
5. Ethiek, zowel mbt integriteit als moraliteit, is belangrijk in de wetenschap en jonge wetenschappers zouden hierover onderricht moeten krijgen.
6. Er is geen enkel principe in de wetenschap, dat zo belangrijk is dat het opgenomen zou moeten worden in een gedragscode.
Homework Assignment

In

Scientific Ethics

Team 1
Abstract

Science and technology has had a major impact on our lives and has radically changed our societies within a very short period of time. If you look around you, you will notice that most of the things that surround you are technology. From the simplest things such as the pen and paper, the glasses that you wear, the streets that you walk, up to the most wondrous and complex artifacts such as quantum computers, under-water tunnels or space shuttles. Technology has solved many of our daily difficulties and has opened many new possibilities. Science has given us medicine, cures and vaccines, and has increased the life expectancy of people, while at the same time it gave back to them the ability to see, walk, procreate, and so much more.

Unfortunately however, the biggest percentage of the world’s population does not enjoy the benefits and the advancements of science and technology since half of the population (that is more than 3 billion people) lives with less than $2.50 per day.

The major disadvantage of science and technology however, is not that the fruits of its creations are not accessible to everyone, but that the negative consequences are. Due to wrongful and inconsiderate use of science and technology, we have over-exploited Earth’s resources, and we have created serious global issues such as water, ground and atmospheric pollution which affect everyone. The consequences from our misuse, ranging from severe environmental pollution to fatal transmittable diseases, such as BSE (bovine spongiform encephalopathy - a.k.a. the mad cow disease), the dioxin poisoning of animals in Germany in January 2011 which caused so many deaths and health problems, or even perhaps HIV, recognize no boarders and no nationalities. Japan’s recent nuclear accident, which is of course not the only one recorded in history, raised again worries and fear about potentially new irreversible nuclear disasters. And while it is easy to blame a few, (e.g. BP for the oil spill in the Gulf of Mexico or the Japanese Government for not being prepared enough to avoid a nuclear incident), we must realize that as long as we use science and technology for monetary profit and not for our protection and real betterment (globally), then we are bound to undergo all the terrible consequences and lead our planet and race to decay. The problem seems to be the tremendous amounts of powerful (and often harmful) knowledge that science has given us, in combination with our flawed human nature. Because instead of focusing on ways to help each other, scientists, funding organizations and governments are still working on discovering more and more ways to harm one another. Example, chemical weapons, biological weapons, nuclear weapons, deadly viruses, human experimentations (e.g. Nazi experimentations), or genetic experimentation and mutation on animals and food are not supported and created by a few “mad men” but by simple commonly educated scientists who follow orders without a deep moral consideration. All these issues raise the question of scientists’ social responsibility towards the whole population and the environment on which we are completely dependent on.

So what is the relation between science and society and why is it important to keep the trust safe (and protect this relation)? Lets scan through the thoughts of bright minds in science (and not only) regarding the use or misuse of science.
Some famous quotes about Science and Technology:

“No one should approach the temple of science with the soul of a money changer.”
Thomas Browne (1605-1682)

“Science is but a perversion of itself unless it has, as it's ultimate goal the betterment of humanity”
Nikola Tesla, 1919

“Our scientific power has outrun our spiritual power. We have guided missiles and misguided men.”
Martin Luther King, Jr. (1929-1968)

“Technological progress is like an axe in the hands of a pathological criminal.”
Albert Einstein (1879-1955)

“It has become appallingly obvious that our technology has exceeded our humanity.”
Albert Einstein (1879-1955)

“Humanity is acquiring all the right technology for all the wrong reasons.”
R. Buckminster Fuller (1895–1983)

“The most important and urgent problems of the technology of today are no longer the satisfactions of the primary needs or of archetypal wishes, but the reparation of the evils and damages by the technology of yesterday.”
Dennis Gabor, 1970

“The atomic bomb was the turn of the screw, it has made the prospect of future war unendurable. It has led us up those last few steps to the mountain pass; and beyond there is a different country.”

“The physicists have known sin; and this is a knowledge which they cannot lose.”
Julius Robert Oppenheimer (1904–1967) about the atomic bomb

“The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom.”
Isaac Asimov, 1988

“We’ve arranged a civilization in which most crucial elements profoundly depend on science and technology. We have also arranged things so that almost no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces.”
Carl Sagan, 1995

“Science progresses with sound, reliable results only to the degree that scientists are honest.”
Henry H. Bauer, 1995

“If there is a risk that politics is being placed above empirical truth on issues of vital national importance, inaction by scientists may be unethical.”
Lawrence M. Krauss, 2003

Finally, we turn to the ideas of Mohandas Gandhi, a figure that Einstein himself admired deeply, something that shows from Einstein's own words:
“A leader of his people, unsupported by any outward authority: a politician whose success rests not upon craft nor the mastery of technical devices, but simply on the convincing power of his personality; a victorious fighter who always scorned the use of force; a man of wisdom and humility, armed with resolve and inflexible consistency, who had devoted all his strength to the uplifting of his people and the betterment of their lot; a man who had confronted the brutality of Europe with the dignity of the simple human being, and thus at all times risen superior. Generations to come, it may be, will scarce believe that such a one as this ever in flesh and blood walked on this earth.” Albert Einstein, 1939, on the occasion of Mahatma Mohandas Gandhi’s 70th Birthday

Seven Deadly Sins / Mohandas Gandhi

Wealth without work
Pleasure without conscience
Knowledge without character
Commerce without morality
Science without humanity
Worship without sacrifice
Politics without principle

Our main focus is of course science, but there is no doubt about the tight interrelation of science and commerce today, therefore we cannot ignore the importance of morality in science as well.

It’s becoming clearer that the private monetary interests of nations and corporations are colliding against the interests of the global ecosystem, including the human race. How much of the people’s welfare or the environment are we willing to sacrifice in order to “progress”? How much time, energy and human intelligence should we waist on creating more and more weapons of mass destruction? Do we only conduct science for science or science for people? If a big percentage of scientists are working on harmful and dangerous projects, who will work on energy solutions, who will try to solve food and water scarcity issues due to overpopulation? If scientists don’t feel a moral obligation towards society, who will stand in the way of our self-destruction? These are just a few questions that arise when we try to picture the future and the possible outcomes, which will be based on the decisions we make today.

The question therefore is, what kind of ethics does this world need in order to survive and protect its inhabitants?
Assignment: Albert Einstein

Each team will be given a famous historic figure related to science, and a modern scientific conspiracy theory to investigate and present to us in our next meeting!

Task: Your team (Team 1) has to research and explain (present) to us the ethical position of our famous Albert Einstein regarding science and society. To do this you need to investigate both his work and his personal ideology. The most controversial part of his carrier seems to be his relation with the atomic bomb and therefore we are interested in his opinion about the use of weapons of mass destruction and the wrong use of science and technology. Maybe some of you don’t know it, but Albert Einstein has not only written brilliant scientific books, but also non-scientific books with a philosophical essence, such as “The world as I see it”, “Einstein on Cosmic Religion and Other Opinions and Aphorisms”, “Ideas and Opinions” and more. You can find many of his quotes online (wikiquote.org is one example out of many), which will give you a clear idea of his views and his personal ideology. Albert Einstein was undoubtedly a privileged mind with major scientific and social influence, and we are interested to learn what were his views about people, science and society. We are also interested in understanding the political scene of the time (World War II and the anti-communist movement in USA) and the effects it had on people and scientific evolution, so try to find out if and how Einstein was influenced by the events that took place that time. In general you need to consider what the relation between science and war is. Tip: You might want to research and read the Russell-Einstein Manifesto as well and learn about the Pugwash Conferences on Science and World Affairs.

http://www.pugwash.org/about/manifesto.htm

1) You need to write a report divided in 4 sections/paragraphs (each section is for each member and it should be minimum 15 lines) where you describe to me your own understanding of Einstein’s views and your personal comments about it. It is important that you debate with the rest of your group and exchange opinions before you write your personal conclusions. Remember to write your name before your paragraph and each one’s references after (websites or videos you went through)!
2) You need to prepare a **ppt presentation** of about 5-7 min where you explain to us this historic figure under a new light, scientific ethics. It’s an open assignment, meaning you are free to decide and select the information that you think describes him best. Keep in mind, we are not interested in E=mc² however fascinating, but to discover new aspects of this extraordinary personality!

The assignment is due in two weeks (**Friday 27/5/2011**). Good luck and contact me if you have any questions or you need any help! My email is [electra_lgr@yahoo.gr](mailto:electra_lgr@yahoo.gr)
Homework Assignment

In

Scientific Ethics

Team 2
Abstract

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The question therefore is, what kind of ethics does this world need in order to survive and protect its inhabitants?
Assignment: Joseph Mengele

Each team will be given a famous historic figure related to science, and a modern scientific conspiracy theory to investigate and present to us in our next meeting!

Task: Your team (Team 2) has to research and explain (present) to us the ethical position of the famous Angel of Death, Dr. Joseph Mengele, regarding science and society. To do this you need to investigate mainly his work to help you understand his personal ideology. Joseph Mengele was a German SS officer and a physician in the Nazi concentration camp Auschwitz-Birkenau. He became famous mostly through his human experimentations on prisoners and children in the name of science. We are interested to learn what his views about people, science and society were and how he applied these into his profession. Tip: You can find a lot of information online and many videos and documentaries about his work. We are also interested in understanding the political scene of the time (World War II) and the effects it had on people and scientific evolution, so make sure you also consider the relation (as you understand it) between science and war.

1) You need to write a report divided in 4 sections/paragraphs (each section is for each member and it should be minimum 20 lines) where you describe to me your own understanding of Mengele’s views and work and your personal comments about it. It is important that you debate with the rest of your group and exchange opinions before you write your personal conclusions. Remember to write your name before your paragraph and each one’s references after (websites or videos you went through)!
2) You need to prepare a **ppt presentation** of about **5-7 min** where you explain to us this historic figure under a new light, scientific ethics. It's an open assignment, meaning you are free to decide and select the information that you think describes him best.

The assignment is due in two weeks (**Friday 27/5/2011**). Good luck and contact me if you have any questions or you need any help! My email is electra_lgr@yahoo.gr
Homework Assignment

In

Scientific Ethics

Team 3
Abstract

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Unfortunately however, the biggest percentage of the world’s population does not enjoy the benefits and the advancements of science and technology since half of the population (that is more than 3 billion people) lives with less than $2.50 per day.

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Seven Deadly Sins / Mohandas Gandhi

- Wealth without work
- Pleasure without conscience
- Knowledge without character
- Commerce without morality
- Science without humanity
- Worship without sacrifice
- Politics without principle

Our main focus is of course science, but there is no doubt about the tight interrelation of science and commerce today, therefore we cannot ignore the importance of morality in science as well.

It's becoming clearer that the private monetary interests of nations and corporations are colliding against the interests of the global ecosystem, including the human race. How much of the people’s welfare or the environment are we willing to sacrifice in order to “progress”? How much time, energy and human intelligence should we waist on creating more and more weapons of mass destruction? Do we only conduct science for science or science for people? If a big percentage of scientists are working on harmful and dangerous projects, who will work on energy solutions, who will try to solve food and water scarcity issues due to overpopulation? If scientists don’t feel a moral obligation towards society, who will stand in the way of our self-destruction? These are just a few questions that arise when we try to picture the future and the possible outcomes, which will be based on the decisions we make today.

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Assignment: Joseph Rotblat

Each team will be given a famous historic figure related to science, and a modern scientific conspiracy theory to investigate and present to us in our next meeting!

Task: Your team (Team 3) has to research and explain (present) to us the ethical position of the famous physicist, activist and Nobel prize winner Sir Joseph Rotblat, regarding science and society. To do this you need to investigate his dedication against weapons of mass destruction (nuclear weapons). We are interested to learn what his views about science and society were and how he applied these into his career decisions. Tip: You need to investigate mainly his relation to the Manhattan project and his involvement with the Russell-Einstein Manifesto and the Pugwash Conferences on Science and World Affairs (http://www.pugwash.org/about/manifesto.htm). We are also interested in understanding the political scene of the time (World War II and the anti-communist movement in USA) and the effects it had on people and scientific evolution, so make sure you also consider the relation (as you understand it) between science and war.

1) You need to write a report divided in 4 sections/paragraphs (each section is for each member and it should be minimum 20 lines) where you describe to me your own understanding of Rotblat’s views and work and your personal comments about it. It is important that you debate with the rest of your group and exchange opinions before you write your personal conclusions. Remember to write your name before your paragraph and each one’s references after (websites or videos you went through)!

2) You need to prepare a ppt presentation of about 5-7 min were you explain to us this historic figure under a new light, scientific ethics. It’s an open assignment, meaning you are free to decide and select the information that you think describes him best.
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Homework Assignment

In

Scientific Ethics

Team 4
Abstract

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 Assignment: Shiro Ishii

Each team will be given a famous historic figure related to science, and a modern scientific conspiracy theory to investigate and present to us in our next meeting!

**Task**: Your team (Team 4) has to research and explain (present) to us the **ethical position** of Shiro Ishii, a Japanese microbiologist and the lieutenant general of Unit 731, a biological warfare unit of the Imperial Japanese Army. We want to understand his ideology regarding science and society, by looking at his professional career. You will need to research about his work and his famous “accomplishments”.

We are also interested in understanding the political scene of the time (the Second Sino-Japanese War) and the effects that war has on people and scientific evolution. **Tip**: A website with some useful relevant information: [http://www.deepblacklies.co.uk/unit731-part1.htm](http://www.deepblacklies.co.uk/unit731-part1.htm)

1) You need to write a report divided in 4 sections/paragraphs (each section is for each member and it should be minimum 15 lines) where you describe to me your own understanding of Shiro Ishii’s views and your personal comments about his ideology. It is important that you debate with the rest of your group and exchange opinions before you write your personal conclusions. Remember to write your name before your paragraph and each one’s references after (websites or possible videos you went through)!

2) You need to prepare a **ppt presentation** of about **5-7 min** were you explain to us this historic figure under a new light, scientific ethics. It’s an open assignment, meaning you are free to decide and select the information that you think describes him best.
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