The humanistic viewpoint

Master's thesis in Master Programme Learning and Leadership

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Gothenburg, Sweden 2020
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Abstract

Interest in STEM-subjects is declining. One proposed solution would be to apply a more humanistic approach to teaching, Vision II, instead of the canonical approach, Vision I. This study reviews the current stand on Vision II in science education and examines one way of introducing Vision II to a group of students with streamlined technical backgrounds, enrolled in a master program which gives both an engineering and a teaching degree, how they perceive it and why they think it should be applied. Using a phenomenographic analysis their perceptions of Vision II are categorized and hierarchically sorted in an outcome space. The results show that students' perceptions in regard of the "how"-question can be sort in a matrix with axis corresponding to different levels of autonomy and concretization. The answers to the "why"-question can be sorted in an outcome space with an increased level of complexity corresponding to the two categories "Literacy" and "Utility" and a low level of complexity corresponding to the category "Interest/Relevance". The study is concluded with a short discussion on the need for humanities in swedish high school science and technology education.

Keywords: Vision II, humanistic, phenomenograpy, learning.

Acknowledgements

I would like to express my gratitude towards my supervisor, Jens Kabo, who provided not only insightful guidance and suggestions, but who also was very patient and supporting.

I would also like to express my great appreciation towards my fellow students of the Masters Programme Learning and Leadership, who took part in this study.

Finally I wish to thank my wife and family, who supported me in my decision to return to the classroom as a student, a perhaps mild midlife crisis, but still demanding for a father of four. Thank you Malin, Frida, Filippa, Felicia and Fleur for your patience.

Olof Jakobsson, Orust, May 2020.

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1 Introduction

Interest in STEM-subjects is declining. One proposed solution would be to apply a more humanistic approach to teaching, instead of the canonical approach. In the following subchapters a short background is given, a purpose for the study is formulated and a research question is posed. Subchapter 1.1 gives a personal introduction to the concept from the author of thesis, in order to contextualize the study.

1.1 Personal introduction

During my highschool years I had a teacher in Technology who, during a class in mechanics, shared with us his view on intelligence: “There is only one kind of intelligence. If you study humanities, well, then you simply do not have it.” This quote became a running gag in our small community, consisting of students who focused on getting high grades in STEM subjects, in order to later be able to apply for a higher education in the same field.

At the end of my senior year, as this teacher and I were discussing my final grade in Mechanics, he asked me what my plans for the future were. I answered, truthfully, that I had applied for the Engineering Physics program at Chalmers. His conclusion was to give me the highest grade in his subject.

My science education in high school had little or no connection to my everyday life, Biology and Chemistry more or less ended up as a set of rules, formulas and sometimes exceptions to the rules. Physics, however, with its clear connection between mathematics and reality always seemed more interesting and intriguing, a mindset that influenced my decision to pursue engineering degree at Chalmers.

The Physics education at Chalmers turned out to be a lot more theoretical than applied, and after some time struggling I resigned with a mind-set that I just had to learn this, a shallow learning of concepts without deeper understanding, in order to get my degree and start working. After some years in the automotive industry I landed, by chance, a job as an educator at a local junior high school. I rediscovered my interest in the subject Physics, and decided to continue for some time. In the end I had spent ten years as an educator and decided to apply for a teaching degree via the Masters-program Learning and Leadership at Chalmers.

My interest in Physics, the contrast between the real-world physics in high school and the abstract, theoretical physics in university education accompanied by a growing interest in humanities led me to investigate the more critical views on science education known by concepts such as *scientific literacy* amongst others, but ultimately presented in this thesis as *Vision II*.

1.2 Background

In 2007, a number of distinguished science educators gathered at a research conference held at Uppsala University to celebrate the 300th birthday of Linnaeus. They made presentations on their research and agreed to a Statement of Concern regarding the current science education, including the following points:

> • Many students find little of interest in science and actually express an active dislike of it.
> • Compared to other subjects, science is seen as a transmission of facts of little relevance and more difficult than other school subjects.
> • School experience leads to loss of interest in science and technology as career possibilities, and only a mildly positive sense of their social importance. (Linder, Östman, & Wickman, 2007)

Findings from the ROSE-Project also indicate that the interest in STEM-subjects is on the decline, a trend more heavily pronounced in developed countries. One proposed reason is that science education does not attend to students interests or experiences, that it simply is neither motivating, meaningful, nor engaging. There seems to be a need to show that science and technology plays a major part in our history and culture and that they are a cornerstone of modern society and worldview. (Sjøberg, 2010).

Thus, a possible way to increase interest in STEM-subjects would be to align it with Vision II, defined and contrasted to Vision I by Roberts (2014) in the following matter:

> Vision I looks inwards to science itself - its products of concepts, laws and theories and its process of investigation. Vision II looks outward at societal situations in which science has a role.

1.3 Purpose

The general purpose of this thesis is to research the possibility to equip future educators and engineers with a broader set of tools, thus enabling them to supply a more varied education and range of perspectives to their students, colleagues and customers. The focus in this study is on the role of the educator, however, it also applies to engineers and other professionals whenever they approach a multidisciplinary problem whose solution would include some sort of knowledge-transfer.

1.4 Research question

With regard to the background and purpose of this thesis, the question in this study is:

> How do engineering students with streamlined technical backgrounds, enrolled in a master program which gives both an engineering and a teaching degree, perceive the integration of a humanistic perspective on science and technology education and the value of such an integration?

2 Situating the study: Vision I and II for Science Education

This chapter reviews the previous literature; the theoretical framework for Vision II and to what degree it is present in the current Swedish high school curriculum.

2.1 A chronological review of Vision I and II

The call to humanize science (education) (Sjøberg, 2010), as mentioned in the introduction, is by no means a new phenomena. This subchapter aims to review the current dominant perspectives in a (somewhat) chronological order. Although different terminology is used, I will refer to, and compare, the presented viewpoints with the two broad visions mentioned in the introduction. Roberts (2014) expands his discussion on the two visions in a *Handbook of Research on Science Education, Volume II*:

> Vision I, so named because the image of student as novice scientist was probably the earliest guide used to plan precollegiate school science, offers a blueprint for science education that introduces students systematically to the scientific enterprise itself.

In other words, Vision I regards science as an isolated concept, separated from the surrounding society, a static concept ready to be analysed and deconstructed in a scientific way. Compared to the other broad vision:

> Vision II, developed later in the history of school science, begins by looking outside science to build curriculum that illuminates how science permeates and interacts with many areas of human endeavor and life situations.

By this definition, Vision II encompasses the demand for a more humanistic approach to science.

In his article *Science for all: A reflective essay* the Australian professor Peter J. Fensham (1985) criticises the curriculum movement of the 1960s and 1970s (who…behaved as if school and science education takes place in a social and political vacuum) and outlines two societal demands that have been placed on science education in many countries: the demand for specialist manpower and the demand for a more scientifically literate citizenry. He describes a vision called "Science for all", where he calls for a change in science education, towards a more humanistic methodology where a science based issue, application or technology is placed at the center of the lesson, mainly as a motivational tool. His ideas align with the ones presented as Vision II.

Richard Felder analyses Sheila Tobias (1990) definition of two tiers of college students in his *Reaching the Second Tier: Learning and Teaching Styles in College Science Education* (1993). The first tier is consisting of those who go on to earn science degrees and the second those who have the initial intention and the ability to do so but instead switch to nonscientific fields. Disregarding his reasoning and analysing using learning styles, a concept somewhat criticised (Coffield et al. 2004), Felders conclusion is that the students who switch to nonscientific fields do so because teachers "instinctively teach the way they were taught in most college classes" (Felder, 1993). This points toward a cultural aspect of teaching and learning, where teachers teach with a Vision I mindset, which leads to students adopting this mindset and later, as teachers, teaching it again. This "streamlining" or "pipelining" of science education leads to a noninclusive environment which could contribute to the declining interest mention in the introduction.

Glen S. Aikenhead (2006), a Canadian professor, presents a thorough view on humanities in science education in his book *Science Education for Everyday Life* (2006). Although he does not use the same terminology as previous authors his argument aligns with Fensham's. Vision I could be equal to what Aikenhead calls canonical chemistry, i.e. a preset agenda or curriculum that has to be followed. Vision II would be what Aikenhead calls humanistic science education. According to Aikenhead, and as mentioned earlier, humanistic science education is not a new concept, but has always faced difficulties when compared to the more “pipeline”-oriented Vision I which prepares a STEM-elite for higher education instead of the more democratic approach of Vision II.

Jonathan Osbourne (2007) argues in his article *Science Education for the Twenty First Century* that the dominant form of science education, which would be a Vision I education, has a negative impact on students attitudes towards science and rests on a set of arcane cultural norms, much like the previous argument from Felder (1993). Osborne concludes that the primary goal of any science education should be to develop scientific literacy, to enable students to become critical consumers of scientific knowledge. Only by bringing a change to the three main components of education: curriculum, pedagogy and assessment can this be achieved.

Fensham returns to the subject in a later article, *Real World Contexts in PISA Science: Implications for Context-Based Science Education* (2009), where he quotes Roberts (2007/2014), introducing the concepts of Vision I and Vision II in the article *Scientific literacy/science literacy* in Handbook of Research on Science Education. By approaching the subject in this manner; that is a context-based education, Fensham argues that:

> Real world contexts from the students’ lives outside of school have the potential to generate personal intrinsic interest, and their social or global significance can add to this potential an extrinsic quality to this interest. This potential needs then to be realized with engaging pedagogies. (Fensham, 2009)

Osborne (2010) picks up the discourse in a later article, *Arguing to Learn in Science/ The Role of Collaborative, Critical Discourse*. In this article the emphasis lies on using argument and debate as tools for engaging students in learning. Arguments and debates are common in science, but virtually absent from science education. Osborne concludes that:

> What is in little doubt is that employers, policymakers, and educators believe that individuals' ability to undertake critical, collaborative argumentation is an essential skill required by future societies. Of its own, the evidence from research to date is that mere contact with science does not develop such attributes. (Osborne, 2010)

Svein Sjøberg has been studying the relevance of science education with an international perspective within the international comparative research project ROSE. Sjøberg finds that the interest in science is declining, and suggests, based on aggregated data from questionnaires in the Eurydice study on science education, where students up to the age of 15 where questioned on their attitudes towards science. Sjøberg suggests that:

> The learners should also learn to see that S&T form the basis of our current way of life as well as a basic element of many jobs and occupation, also for those who do not choose to work in what is perceived to be the S&T sector. (Sjøberg, 2010)

Sjøberg also concludes that there seems to be a need to "humanize" science education, in order to increase and maintain interest in STEM-subjects.

Drawing these perspectives together there seems to be a solid theoretical framework for analyzing curricula and teaching. In this study the concept Vision I is used for the canonical, streamlining, pipelining, subject-centered education. Vision II on the other hand, represents a humanistic view on science education.

2.2 The Swedish curriculum

Several of the previously mentioned scholars emphasise the role of the curriculum. In this subchapter, the Swedish high school curriculum is analysed in order to find relevant sections for Vision II. Quotes from the curriculum are translated by the author with the original text in footnotes. Already in the first paragraph of the first chapter there is some evidence of a Vision II mindset:

> The educational system stands on a democratic ground. The school law (2010:800) states that education within the educational system refers to that students shall obtain and develop knowledge and values.[1]

This paragraph takes a democratic approach and refers to the school law, that all students shall collect and develop both knowledge and values. A few subchapters down we find that:

> The school shall be open for differing opinions and encourage them to be put forward. It shall emphasize the importance of personal positioning and give opportunities for such.[2]

Aligning with the argument from Osborne (2010), this paragraph puts emphasis on debate and differing opinions as not only a tool, but means, of education. In the subchapter “Rights and obligations”[3] we find that this also includes forms of work and once again return to the democratic principle:

> The education shall moreover be conducted in democratic forms of work and develop students abilities and will to take personal responsibilities and actively participate in society.[4]

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[1] Skolväsendet vilar på demokratins grund. Skollagen (2010:800) slår fast att utbildningen inom skolväsendet syftar till att elever ska inhämta och utveckla kunskaper och värden. (Skolverket, 2011a)

[2] Skolan ska vara öppen för skilda uppfattningar och uppmuntra att de förs fram. Den ska framhålla betydelsen av personliga ställningstaganden och ge möjligheter till sådana. (ibid.)

[3] Rättigheter och skyldigheter. (ibid.)

[4] Undervisningen ska dessutom bedrivas i demokratiska arbetsformer och utveckla elevernas förmåga och vilja att ta personligt ansvar och aktivt delta i samhällslivet. (ibid.)

A critical approach is encouraged and it is argued that this will lead to a scientific way of thinking and working.

> The students shall learn to think critically, to examine information and conditions and realize consequences of different options. In that way, the students will approach a scientific way of thinking and working.[5]

This aligns with the principles presented by Osborne, Fensham and Aikenhead in earlier subchapters, and could be interpreted as a call for a Vision II oriented education.

2.3 The Swedish science and technology curricula

In this subchapter, the Swedish science curriculum is analysed in order to find relevant sections for Vision II. Focus lies on the *Physics* curriculum, which is similar to the *Chemistry* curriculum, however it is contrasted to the *Technology* and *Science studies* curricula. Only students on the Science and Technology programs (NV & TE) take *Physics, Chemistry* and *Technology*, however, all other high school students have *Science studies* as a mandatory course. This could be a hint of the "pipelining" mentioned earlier in this thesis.

Each subject in the Swedish curriculum is presented by a short introduction situating the subject. In the *Physics* curriculum there are no direct references to the concepts of Vision II, it is focussed on the connection between Mathematics and Physics, and the scientific principles that it is built upon:

> Physics is a scientific subject that has its origins in the need of human beings to understand and explain the world around them. Physics covers everything from the interaction of the smallest particles of matter to the origins and structure of the universe. On the basis of systematic observations and experiments, physics strives to discover basic principles

[5] Eleverna ska träna sig att tänka kritiskt, att granska information och förhållanden och att inse konsekvenserna av olika alternativ. På så vis närmar sig eleverna ett vetenskapligt sätt att tänka och arbeta. (ibid.)

> that can be expressed mathematically in models and theories. (Skolverket, 2011b).

If we compare the introduction to the one presenting *Science studies*:

> The subject of science studies is by its nature interdisciplinary with a foundation in biology, physics, earth sciences and chemistry. The subject covers health, energy and sustainable development, knowledge areas that have emerged in the intersection between science and social science. (Skolverket, 2011b).

We find that Science studies take a much more Vision II oriented stance, even mentioning that it is a interdisciplinary subject emerging from the intersection between science and social science, which could be interpreted as a very “humanistic” approach. This stance is also present in the introduction of *Technology*:

> The subject of technology is by its nature interdisciplinary. Technology involves fulfilling human needs and preferences by transforming the physical resources of nature or immaterial assets in products, processes, facilities and systems. The subject focuses on the role of technology in societal development and the interaction between people and nature. (Skolverket, 2011b).

The same statement can be made on *Technology* as for *Science studies*, the first sentence is by all measures identical. *Technology*, however, puts more emphasis on the role of humans, people and society, placing the subject as a part of the current world, a cultural product. Technology also highlights the transformation of natural resources to fulfil human needs.

After the introductions comes the “Aim of the subject”, a number of paragraphs that specify the overall objective of the education within the subject and it ends with a number of abilities the student is supposed to develop. In Physics, there is only one ability that directly corresponds to a Vision II mindset, “4) Knowledge of the importance of physics for the individual and society.“ (Skolverket, 2011b). In comparison with Science studies, where all six abilities could be viewed as Vision II aligned:

> **1)** The ability to use knowledge of science to discuss, form views and formulate different courses of action.
> **2)** Knowledge of the role of science in current social issues and in relation to sustainable development.
> **3)** Knowledge of the consequences of different lifestyles for both personal health, public health and the environment.
> **4)** Knowledge of the structure and function of the human body, and its interaction with its surroundings.
> **5)** Knowledge of how science is organised and how it can be critically examined and used for critical examination.
> **6)** Knowledge of the significance of scientific theory for the development of societies and people's world view. (Skolverket, 2011b)

Comparing with Technology, which takes a more middle ground, combining Vision I and Vision II abilities. Of the nine mentioned abilities, four are more Vision II oriented:

> **2)** The ability to analyse and assess technological solutions taking into account sustainable societies.
> **6)** Knowledge of how technology has developed and is developing in interaction with society, and also knowledge of existing technology and current technological development.
> **7)** Knowledge about the role and driving forces of technology from ethical perspectives.
> **8)** Knowledge of how attitudes and traditions in the area of technology shape our understanding of gender perceptions and how this has affected and affects technology and technological development. (Skolverket, 2011b)

This contrast between the subjects is continued in the "Core content" of each course within the subjects. The *Physics* courses are very subject oriented with only one of twentyseven bullet point paragraphs directly corresponding to (or inviting) a Vision II mindset, "Views on societal questions based on explanatory models of physics, e.g. questions about sustainable development." (Skolverket, 2011b). Science studies, on the other hand, has a plethora of bullet point paragraphs that directly could be taught in a Vision II manner:

> • Issues concerning sustainable development: energy, climate and impact on the ecosystem. Ecosystem services, utilisation of resources and the viability of ecosystems.
> • Different aspects of sustainable development such as consumption, allocation of resources, human rights and gender equality.
> • Scientific aspects, reflection on and discussion of norms concerning human sexuality, sexual desire, relationships and sexual health.
> • Working methods of science, such as observation, classification, measurement and experimentation, and ethical perspectives related to scientific exploration.
> • The scientific approach, how to put questions that can be investigated scientifically, and how to go about examining phenomena in the surrounding world.
> • How science can be critically examined, and how a scientific approach can be used to critically examine statements lacking a scientific basis. (Skolverket, 2011b).

Technology places itself as a middle ground in this aspect as well, with several bullet points inviting more Vision II oriented aspects of the subject:

> • All parts of the technological development process from idea and model, product or service, to the use and reuse with practical applications of technology and technological development in one or more areas of technology.

• The role of technology and technicians with a focus on technologies of the future and a sustainable society with a starting point based on efficient use of energy.

• The history of technology and the importance of technological development for society, and also introduction to current development areas in technology.

• Basic technological philosophy: ethical values and gender structures, and also how they have affected and affect technology, its use and accessibility. How technology's attributes relate to gender. (Skolverket, 2011b)

It is clear that Technology is more Vision II oriented, mentioning aspects of the subject such as sustainable society, history, philosophy, ethics and gender structures.

These contrasts between the *Physics, Technology* and *Science studies* curricula could be viewed as an example of the "pipelining" or "streamlining" mentioned earlier, taking place in the *Physics* curriculum, a subject only taught in programs for students who aim for university, specifically STEM degrees. It is interesting that the compulsory science course for all other programs not aiming for later STEM studies, including vocational programs and programs aiming for university studies within the humanities, place such emphasis on Vision II oriented subject matter.

3 Method

This chapter outlines the methods used in this thesis, their theoretical background, the limitations for the study, it's ethical concerns, repeatability, reliability and validity.

3.1 Phenomenographic principles

Since the mid seventies, research on student learning in higher education has benefited from a qualitative approach known as "phenomenography". This approach is associated with Ference Marton and his colleagues at the University of Gothenburg in Sweden. It has also been used by many other researchers in the United Kingdom, Australia and the Netherlands. Marton (1986, 1988b) described phenomenography as "an empirically based approach that aims to identify the qualitatively different ways in which different people experience, conceptualize, perceive, and understand various kinds of phenomena." Learning takes a central role within this approach, because it represents a qualitative change from one conception concerning some particular aspect of reality, to another (Marton, 1988a). In this study, we are examining the students views on the concept of Vision II.

Research into the understanding of different concepts by students is most meaningful if you specifically look to understand students interactions with these issues through their eyes, or rather, from their perspective. Research of this nature is referred to as second-order research (Marton, 1981). Here a researcher explores the relationship between a student and an aspect of the world as it is experienced by that student. The researcher is not making statements about a phenomenon, but rather about students' ideas of that phenomenon. In this study, we are using a short hand-in as data for the research. The short hand-in represents the students experience of the concept Vision II.

This research technique differs from the traditional first-order perspective where a researcher studies a phenomenon directly. Research in the natural sciences is generally of this type where a researcher tries to describe things as they are. This first-order approach would be typical of an objectivist, or positivist, stance.

In the description of phenomenography presented above, the central premise was that it takes a non-dualist, second-order position. Säljö (1997) defines a non-dualist stance as a position where "the internal (thinking) and the external (the world out there) are not posited as isolated entities" (p.173). For phenomenography to develop from a fundamentally non-dualist ontology implies that meaning stems from the relationship between an individual and a phenomenon, or rather, the relationship between a subject and an object. The subject and object of an experience are not separate and an individual's experience of a phenomenon is the internal relationship between them. It is this relational view that forms a cornerstone of phenomenography. Marton (2000) has argued that:

> From a non-dualistic ontological perspective, there are not two worlds: a real, objective world, on the one hand, and a subjective world of mental representations on the other. There is only one world, a really existing world, which is experienced and understood in different ways by human beings. It is simultaneously objective and subjective. An experience is a relationship between object and subject, encompassing both. (p.105)

There are a number of research approaches that take a non-dualist ontological position. However, they tend to interpret and derive meaning in the action of others by studying this action directly. Phenomenography takes an alternative position and looks to understand individuals' interactions with the world through their eyes, or rather, as described above, from their perspective. This is the second-order view of the development of knowledge where a researcher is not making statements about a phenomenon directly, but rather about individuals' ideas of that phenomenon. Furthermore, the phenomenon can be thought of in terms of the 'complex' of the distinctly different ways in which it can be experienced. In figure 3.1 an overview of different research approaches is presented:

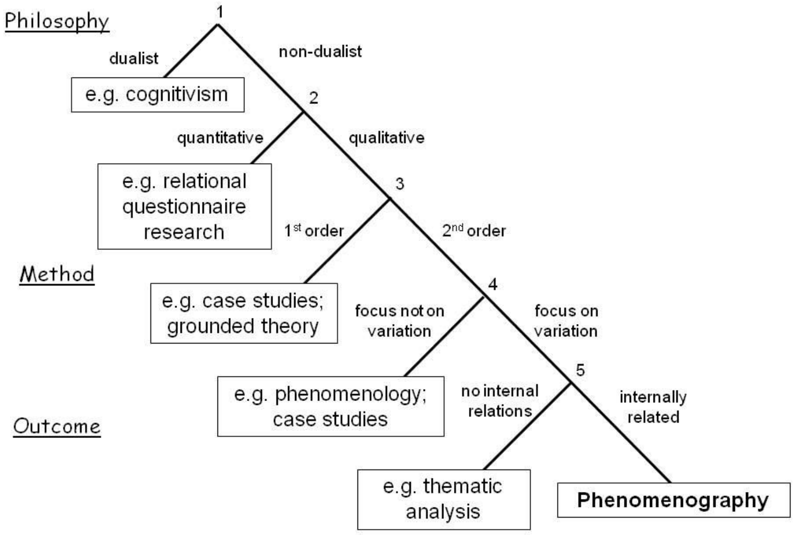

Figure 3.1 Hierarchy of qualitative research methods. (Trigwell, 2000)

The goal of a phenomenographic analysis is to produce an outcome space consisting of a system of categories of description, which are distinguished from one another in terms of the presence or absence of certain critical aspects of the concept but also are logically related to one another (Kabo and Adawi 2011). The data analysis is an iterative and inductive process, where the researcher tries to apply a narrow focus on the object of study, which is the variations in the relation between subjects and some aspect of the world (see figure 3.2), and remove their own conceptions in order to minimize their own preconceived notions. In phenomenography, the preferred way is to work in iterations together with colleagues. When the researcher analyses the data on their own, iteration is the key to establishing a robust outcome space. It is very important to let the data speak on it's own and letting the categories emerge from the data.

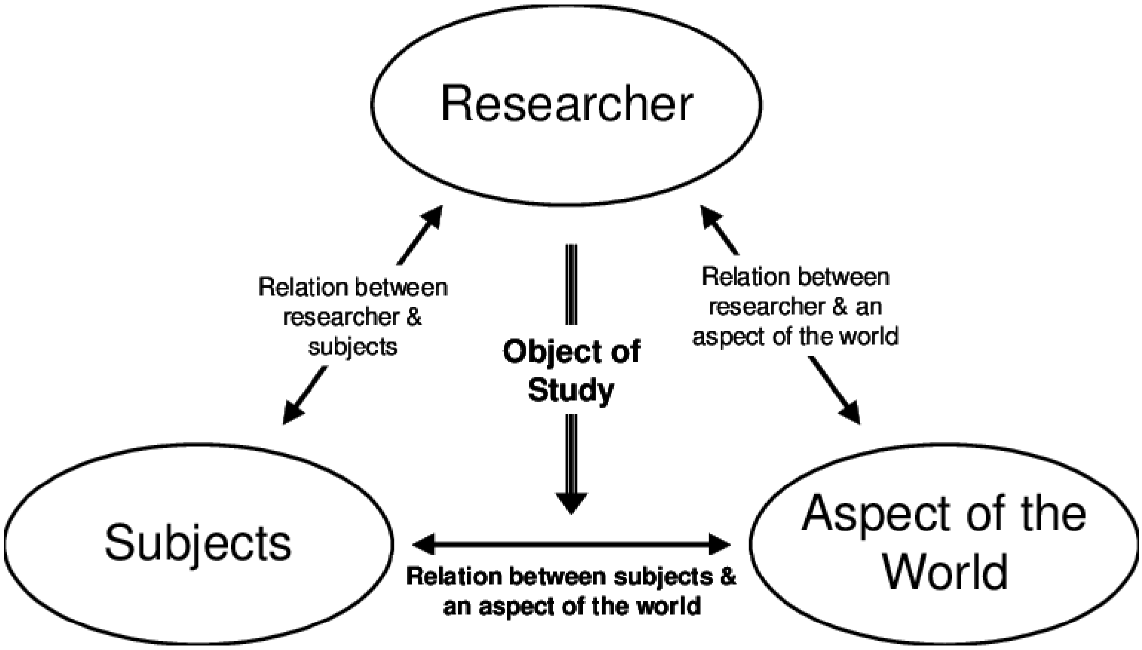

Figure 3.2 The Focus of Phenomenographic Research (Bowden, 2005).

3.2 Data collection

Reed (2006, p. 8) means that a "typical phenomenographic study would first have people perform a task or engage in some activity." In this study, the students were taking part in a course called *Humanistic and social scientific perspectives on natural science and technology (CLS040)* which emphasized different humanistic perspectives on science and technology (see Appendix A for syllabus). As part of that course, the students attended a lecture where they were introduced to the concept of Vision II. The lecture was followed a few weeks later by a seminar, where the students were asked to combine their knowledge of different humanistic perspectives on their subject with their subject-knowledge, knowledge and experience of learning and teaching in order to construct a Vision II-inspired lesson plan.

In the context of this study, the lecture and the following seminar were where the concepts were presented to, and experienced by the students. Reed continues "[t]hereafter they would report on it and describe how they had gone about this task or activity." Reed also mentions the two predominant ways of collecting data. It is "either through an interview or through the text written by the person in response to a specific question". In this study, data were collected by written hand-ins from the students, utilizing the second method, however, Reed also discusses other possible methods of data-collection, such as reviewing film footage. In this study, the students were asked to supply a short essayistic hand-in describing their conceptions of Vision II and its role in education in the Swedish secondary school (See Appendix B). Interviewing and transcribing as a data collection method were not chosen, due to the time-constraints of the thesis. The resulting hand-ins were anonymized and pooled in a single document with standard formatting.

3.2.1 Limitations

Within the framework of this study, the data collection was limited to the participating student group, which consisted of second year master-students at the Masters Program Learning and Leadership at Chalmers University of Technology.

Qualitative research traditionally focuses on reaching a ”theoretical saturation" as proposed by Glaser and Strauss (1967) by collecting as much information as necessary, until no further relevant data is found. However, as Reed (2006) mentions, the critical question in phenomenographic studies is who to interview about their experiences of a phenomenon. Essential in answering this question is to realize that the outcome of a phenomenographic analysis is "the variation in the ways of experiencing a phenomenon". This focus on variation enables the selection of a relative few, but distinctly different, data sources. Including these distinctly different cases in the purposively selected sample will thus give the best opportunity of realising the full width of the various ways of experiencing the phenomenon.

Before a phenomenographic analysis takes place, there is no way of knowing the extent of the variation that has been captured during the sampling. Trigwell (2000a, p.66) argues that between fifteen and twenty people is the ideal number to interview. He continues that 'ten to fifteen would be the minimum to create a reasonable chance of finding variation in the range' (ibid). Dahlgren (1995, as cited in Åkerlind, 2003, p.54) suggests that as long as the sample is selected to maximise variation, ten interviews is normally enough to capture the variation.

The student group participating in this study consisted of 24 students with different ages, gender, educational as well as vocational background. However, the majority of them had finished their Bachelor at Chalmers and could in the framework of this study and in retrospect of the discussions earlier be regarded as “streamlined”. In regard of the research question of this study, which specifically requested such a streamlined group, the variation is considered to be sufficient. Reed (2006) concludes: “In determining the individuals most likely to provide this variation in ways of experiencing, consideration is not necessarily given to being inclusive of gender or particular cultural groups as may be central to many other methods.”

3.2.2 Non-response analysis

Almost 100% participation rate. A majority of the students handed in their papers on time, and only one student did not hand in at all, resulting in an overall participation rate of 96%.

3.3 Data analysis

A phenomenographic data analysis sorts perceptions, which emerge from the data collected, into specific “categories of description”. The discrete set of these categories is referred to as the “outcome space.” These categories, and their underlying structures, become the phenomenographic kernel of the phenomenon. They are the primary outcomes and they are the most important result of phenomenographic analysis (Reed, 2006). The document containing all anonymized data was thoroughly read through in order to discern these categories.

After this first reading, and regarding the research question, it was clear that some sort of data organization was needed. The aforementioned single document consisting of all anonymized hand-ins was first categorised, sentence by sentence, in regard to whether they answered the three questions, where the first one directly was not connected to the research question but still present in the data:

1) WHAT is Vision II,
2) HOW could Vision II be implemented in an everyday teaching practice and
3) WHY should Vision II be implemented?

The three questions emerged from the data and were probably a result of how the hand-in was constructed (see Appendix B), thus it was a natural way the organize the data. Sentences responding to these three questions were marked using a coloured marking pen with different colours for the different answers to the questions (e.g. green for WHAT, yellow for HOW and pink for WHY). By collecting all the answers to the first question, “what is Vision II”, a pool of meaning was constructed that contained the students descriptions of their perceptions of Vision II. The same approach was used to construct the two other initial pools of meaning, who thus contained the students description of perceptions of how Vision II could be implemented and why (or why not) it should be implemented. These pools of meaning are essentially a decontextualized collection of fragments from all the hand-ins that refer to an experience of the phenomenon in question, i.e. Vision II. These pools of meaning form the starting points for further analysis (Reed, 2006).

The following step in the phenomenographic analysis is to develop the limited number of internally and logically related, qualitatively different, hierarchical categories of description of the variation in the way the phenomenon is experienced. It is perhaps best described by a rather lengthy quote from Ference Marton (1986):

> The selected quotes make up the data pool which forms the basis for the next and crucial step in the analysis. The researcher's attention has now shifted from the individual subjects (i.e., from the interviews from which the quotes were abstracted) to the meaning embedded [in] the quotes themselves. The boundaries separating individuals are abandoned and interest is focused on the “pool of meanings” discovered in the data. Thus, each quote has two contexts in relation to which it has been interpreted:

> first, the interview from which it was taken, and second, the "pool of meanings" to which it belongs. The interpretation is an interactive procedure which reverberates between these two contexts. A step-by-step differentiation is made within the pool of meanings. As a result of the interpretive work, utterances are brought together into categories on the basis of their similarities. Categories are differentiated from one another in terms of their differences. In concrete terms, the process looks like this: quotes are sorted into piles, borderline cases are examined, and eventually the criterion attributes for each group are made explicit. In this way, the groups of quotes are arranged and rearranged, are narrowed into categories, and finally are defined in terms of core meanings, on the one hand, and borderline cases on the other. Each category is illustrated by quotes from the data. [...] As the meanings of categories begin to form, those meanings determine which quotes should be included and which should be excluded from specific categories. The process is tedious, time-consuming, labor-intensive, and interactive. It entails the continual sorting and resorting of data. Definitions for categories are tested against the data, adjusted, retested, and adjusted again. There is, however, a decreasing rate of change, and eventually the whole system of meanings is stabilized. (Marton, 1986, p.43)

Walsh (2000) argues that the process of phenomenographic analysis can be viewed as either a construction of the categories, or as a process of discovery of the categories. In the case of "discovery", the categories of description are already "present in, and constitutive of" (p.20) the data and the process of analysis is to let these categories emerge as the analysis progresses. In the case of "construction", the categories of description "emerge from the relationship between the data and the researcher".

The "construction" approach is problematic, as it introduces the possibility that the researcher imposes his or her own framework onto the data or introduce their own preconceived ideas about the phenomenon into the categories (Reed, 2006). Thus, it is important to let the categories emerge from the data and take an objective position as researcher. One way to ensure this is to constantly test and retest the categories, in an iterative process. One could also perform the analysis in a collective of two or more researchers, as mentioned in chapter 3.1.

In this study the first coarse categorization was made by the author but the three other main iterations were made in collaboration with the supervisor for this thesis, Jens Kabo. Thus, analysis of the data was an iterative process and the robustness was ensured by working together with a colleague, the supervisor for this report.

3.4 Ethical concerns

The students were informed that their participation was voluntary (see Appendix C). They were also informed that they could withdraw their participation at any time, and that their answers would be anonymized and that eventual follow-up interview answers would be confidential and that all collected data would only reside with the author and would only be used for research purposes. The students were also assured that their participation in the study did not in any way affect their final grade in the course.

As the supervisor for this project also acted as examiner for the course in which this study took place a strict rule was enforced where the author and the examiner did not discuss the data until a grade was placed and the course was finished. In the phase between the hand-in of the final essay and before the grade was placed, Jens Kabo did not have the active role as supervisor for this thesis.

4 Analysis Process

This chapter describes several iterative steps of the analysis process transforming the collective pool of meaning over emerging categories and their hierarchical structure to the resulting final outcome space. The iterations are presented in a chronological order, consisting of the initial "What, How and Why" categorization and ending with a draft of the final model of the outcome space.

4.1 What, How and Why?

In order to obtain a rough organization of the raw data, the hand-ins were analyzed paragraph by paragraph. Using a colour-marker, the paragraphs were marked depending on which of the questions posed in chapter 3.3 they answered. Some of the paragraphs answered multiple questions, and were marked with two or more colours and some of the paragraphs did not answer any of the questions and were sorted away. The paragraphs were cut out using scissors and each paragraph was marked with the anonymous code relating it to its original hand-in.

In this process, three distinct sets of data were created, and one set of irrelevant data. This process also enabled a close reading of the data. In order to make the selection more robust, the analysis was reiterated. The resulting sets differed in size, with the set responding to the question "WHAT is Vision II" by far being the largest.

In regard of our research question, it is important to discern the variation in the experiences and conceptions of what the subjects perceive that Vision II really is, why it should be applied and how it can be applied.

4.2 First Iteration

Figure 4.1 Photo from the first iteration.

In the first iteration a pool of meaning was formed with all the paragraphs answering the question "WHAT is Vision II". By reading and re-reading each paragraph, looking for common themes, a number of categories emerged from the data. The paragraphs were organized in these categories on a large conference-table and the prozess was re-iterated, looking for ways to make the categories mutually exclusive. This resulted in a large number of categories which implied the need for further iterations.

While conceptions of WHAT Vision II can entail are indeed interesting, at this step in the analysis process we decided that future teachers' conceptions of HOW Vision II can be implemented and WHY it should be implemented were more interesting and important. Consequently, it was decided to focus future efforts on these two dimensions, which resulted in a reformulation of the initial research question.

4.3 Second Iteration

Figure 4.2 Photo from the whiteboard illustrating an emerging hierarchical structure.

In the second iteration the categories were reevaluated and the data was once again analysed. The second iteration also focused on the answers to the “HOW”-question and “WHY”-question. In the second iteration, a hierarchical structure emerged, with qualitatively different answers, corresponding to a matrix with complexity of answers as an y-axis and different conceptions as a x-axis.

4.4 Third Iteration

Figure 4.3 Photo showing the formation of two distinct matrices.

In the third iteration the WHY and HOW categories were separated and two distinct matrices were formed, in order to ensure mutually exclusive categories of description. The result is presented in figure 4.4 and 4.5, and these two matrices formed the basis for the final outcome space presented in Chapter 5.

	Interest	Education	Utility
High compl.			
Low compl.			

Figure 4.4. WHY-matrix

	Training	Subject-matter	Method
High compl.			
Low compl.			

Figure 4.5. HOW-matrix

5 Results: Final models of the outcome space

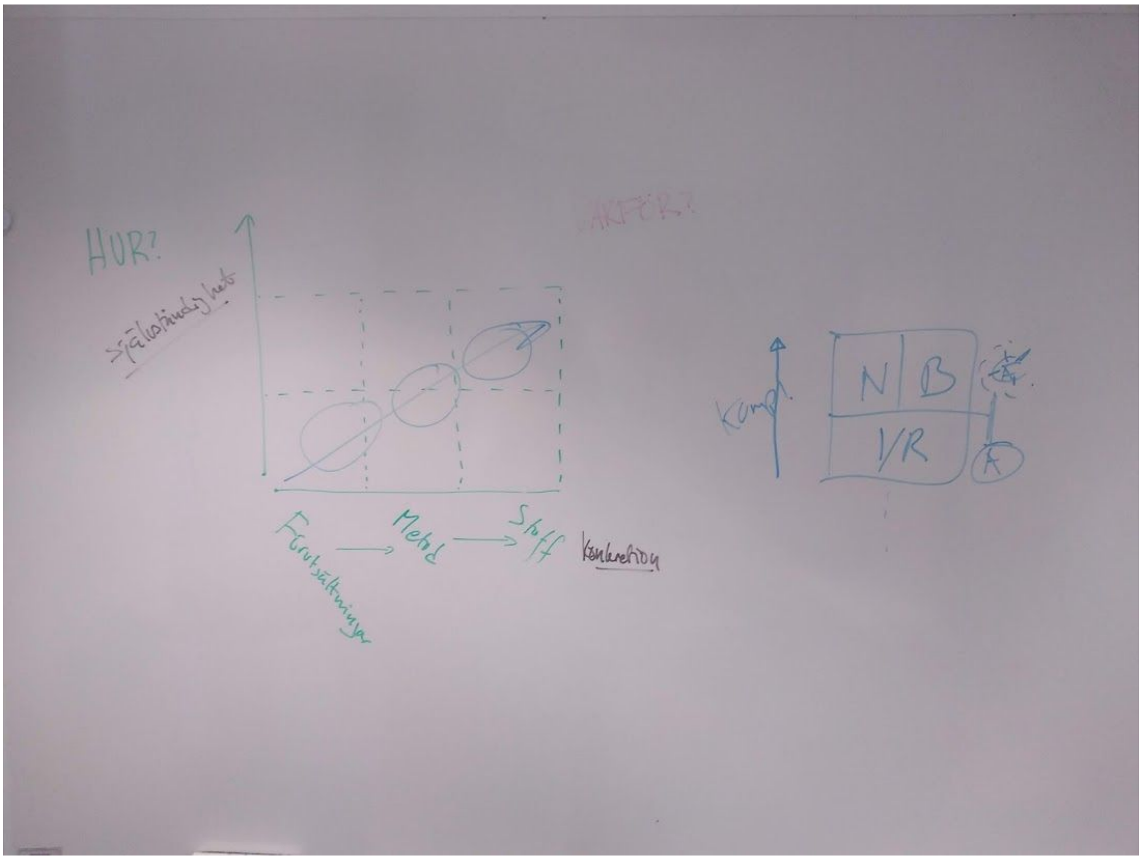

Figure 5.1 Photo showing a draft of the final outcome space.

The aim of this study was to identify and describe the qualitative different ways in which engineering students enrolled in a master-program which gives both an engineering and a teaching degree would apply Vision II in their everyday practice and why they would do it. A number of categories were found from the data and these categories can be arranged in two hierarchical models, the outcome space. These final models of the outcome space are presented in figure 5.2 and figure 5.3. Quotes from the data are translated by the author with the original text in footnotes.

5.1 How do we apply Vision II?

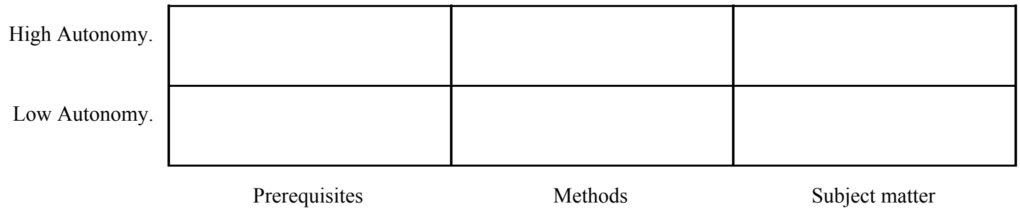

Figure 5.2. HOW do we apply Vision II in an everyday practice?

In figure 5.2, conceptions relating to how Vision II could be realized are presented. On the x-axis three distinct sets were found, with a level of concretization in the positive direction. As we move along the x-axis the concretization increases, from "Prerequisites" to "Methods", and from "Methods" to actual "Subject matter". One could also interpret these categories as different meta levels, "Prerequisites" representing curriculum, school culture etc, "Method" representing general didactic methods and "Subject matter" concerns with what actually takes place during a lesson or module. The increased complexity on the x-axis is represented by the increased understanding or awareness of the concepts required to actually apply them in a teaching or learning situation, moving from the abstract to the concrete. Positions on the leftward side shows a modern advanced level where the subject actually has applied the presented concepts. On the y-axis the qualitative difference lies in the autonomy of the answers, spanning from basic rephrasing to more individual applications. The sets are presented in the following subchapters.

5.1.1 Prerequisites

The two prerequisites categories concern on what basis it is possible to apply a Vision II mindset in the educational system. It concerns itself with matters such as teacher competence, school culture and curricula. The qualitative difference lies in the autonomy of the answers, where a low autonomy corresponds to a mere paraphrasing of the parts of the curriculum that is written in a Vision II mindset. One example from the "Prerequisites" with a low level of autonomy could be:

> K: I can see a pretty big room for implementing a strong societal connection in the Technology in general and Technology 1 specifically. Under "Aim of the subject" one can find the following phrases which I mean has a possibility to incorporate Vision II: [followed by text from curriculum].[6]

In contrast with the higher level of autonomy displayed in the following quote:

> H: The control documents [curricula] does not specify at which depth these broad formulations should be treated, which also opens up for the possibility to redirect from Vision I to Vision II[7]

5.1.2 Methods

The category Methods contains data that focuses on the general methods used when teaching science or technology using a Vision II mindset. Here we find broad statements concerning classroom discourse, using laborations and collaborating with teachers in other subjects.

A low level of autonomy in the "Methods" could be a simple paraphrasing from one of the articles that were part of the recommended reading before the seminar:

> Y: When implementing such activities in the classroom, Osborne (2007) also points at importance of (a) it must be open and dialogic, (b) that the students are given the opportunity to develop the ability to reason and (c) that the activity is owned by the students and is authentic.[8]

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[6] K: "Jag ser ganska stort utrymme för att koppla in en stark samhällskoppling i teknikkurserna i allmänhet och i synnerhet Teknik 1. Under syftet för ämnet finns följande formuleringar jag anser har en möjlighet att inkorporera vision II."

[7] H: "Styrdokumenten anger inte på vilket djup innehållet i dessa breda formuleringar bör behandlas, vilket också öppnar upp för möjligheten att styra om från Vision I till Vision II."

[8] Y: "Vid genomförandet av sådana aktiviteter i klassrummet pekar även Osborne (2007) på vikten att: (a) det ska vara öppen och dialogisk, (b) att eleverna får möjlighet att utveckla resonemangsförmåga och (c) att aktiviteten ägs av studenterna och är autentiska."

While a higher level of autonomy in “Methods” is represented by the following quote:

> K: The tangible which I take with me from this course is to try to view the whole picture both in the introduction of a section, to see the context and provide relevance, but also to return to entirety and see the context again as one finishes a section, module or similar. This does not connect directly to Vision II but I claim that entirety is an important way to apply Vision II to one's education.[9]

This is a interesting quote as it claims to not directly connect to Vision II even though Vision II, as defined by Roberts (2007), puts emphasis on science as a part of something bigger.

5.1.3 Subject matter

In the highest concretization level, Subject matter, we find data that directly concerns itself with what could occur during an isolated lecture or module. This is the highest level of concretization as it requires the teacher to interpret the curriculum and apply a Vision II mindset, i.e. applying the result of a process of concretizing a general principle or idea. A low autonomy example in the “Subject matter” category is:

> Ä: Furthermore, when it comes to acid-base, there are connections to the society when it concerns liming of lakes and overfertilization.[10]

This contrasts and complements the higher level of autonomy displayed in the following quote:

[9] K: “Det konkreta jag tar med mig från den här kursen är att försöka titta på helheten både i introduktionen av ett avsnitt, för att se sammanhanget och ge relevans, men också att komma tillbaka till helheten och se sammanhanget igen när man avslutar ett avsnitt, moment eller liknande. Det här kopplar inte direkt till Vision II men jag hävdar att helheten är ett viktigt sätt att arbeta in Vision II i sin undervisning.”

[10] Ä: “Vidare när det gäller syra-bas finns det samhällskopplingar när det gäller kalkning av sjöar och övergödning.”

Z: The key (and challenge) is to find these different aspects of the subject who in a natural way brings the current debate to the classroom.[11]

In conclusion, the data can be fitted into six qualitatively different categories of description with regards to the concept of how Vision II could be implemented in an everyday practice. Many answers show a high degree of autonomy.

5.2 Why do we apply Vision II?

High compl.	Literacy	Utility
Low compl.	Interest / Relevance	

Figure 5.3. WHY should we apply Vision II in an everyday practice?

In figure 5.3 the outcome space, which corresponds to the subjects perceptions of why Vision II is needed in their teaching practice, is displayed. The y-axis marks an increased complexity in the answers, where the low complexity answers have a low degree of original thoughts and mostly consist of quotes and interpretations of the articles which were a part of the lecture where they were introduced to the concept of Vision II. As we move in the positive y-direction the category splits into two different categories; one being scientific “Literacy” in the figure and the other being societal or economic “Utility”. Many answers in the lower complexity category mentions “Relevance and Interest”. Some examples:

M: Osborne (2007) means that we have to bring science education to the 21th century in order to make it relevant to the pupils. Today, the interest

[11] Z: “Nyckeln (och svårigheten) är att hitta de infallsvinklar till ämnet som naturligt drar in samhällsdebatten i klassrummet.”

for science is lower among swedish pupils than in many other countries (Osborne 2007).[12]

or:

T: In order to increase the interest and relevance among pupils for the subject area, it was introduced by a practical workshop where the pupils were exposed to a problem they recently experienced, and step by step, and with instructions, developed a product that would solve that problem.[13]

The bulk of the answers were placed in the “Interest / Relevance” category of description but a number of answers displayed a higher complexity in their perception of Vision II and could be divided into “Benefit” and “Literacy”. In the category “Literacy” we find that some are a bit critical of the concept:

N: I am not convinced that Vision II should replace Vision I in all aspects of Physics education. In some way, I believe there is a value in letting some things be a bit dusty and dry sometimes, without i we lose some part of the subject. Nevertheless, it is important to often overcome the dry parts and show the lively, colorful and sparkling, outrageous part of Physics that also exists but somehow is easily forgotten.[14]

W: I see a great risk with an overly VIsion II oriented education. That is, that it becomes vague for the student what it actually is supposed to know. In the book Teaching and Learning STEM: A practical guide by Felder (2016) the didactical importance of clear learning goals is emphasized when

[12] M: “Osborne (2007) menar att vi måste ta in den naturvetenskapliga undervisningen i 2000-talet för att eleverna återigen ska tycka det överhuvudtaget är relevant. Idag är intresset för naturvetenskap bland svenska ungdomar lägre än i många andra länder (Osborne 2007).”

[13] T: “För att öka intresset och relevansen för eleverna för ämnesområdet så introducerades ämnet med en första praktisk workshop där eleverna ställs inför ett nyligen eget upplevt problem som de ställs inför med jämna mellanrum och att de steg för steg m.h.a. instruktioner utvecklar en teknisk produkt som löser problemet.”

[14] N: “Jag är inte övertygad om att Vision II borde ersätta Vision I i alla avseenden i fysikundervisningen. På något sätt tror jag att det finns ett värde i att låta något vara lite torrt och dammigt ibland, utan det tappar vi ändå en del av ämnet. Det är dock viktigt att bryta av det torra ofta och istället visa på den livliga, färgsprakande, upprörande delen av fysiken som också finns men konstigt nog lätt glöms bort.”

> one teaches a course in STEM-subjects. If it becomes to convoluted and unclear, the learning is damaged.[15]

Many answers in the "Literacy" category focus on the democratic aspect of a Vision II oriented science education:

> Ö: That's why it is of great importance that the students have the ability to apply their knowledge in chemistry, and science in general, in more contexts than the classroom.[16]

> C: Hopefully the students will receive tools that are useful in everyday life and in the public debate. A clear citizen-educational perspective, that is.[17]

Some answers argued for or against Vision II based on an "Utility" approach, often focussing on the economic aspects:

> M: In other words, something [Vision II] needs to be done in order for us, from a technological developmental viewpoint, to be able to continue to compete with innovation and entrepreneurship. [18]

In conclusion, the categories of description emerging from the data responding to the WHY-question take their base in an "Interest/Relevance" argument and some of the answers extend to a "Utility" category and many extend to a democratic scientific or citizen "Literacy" category.

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[15] W: "Jag ser en stor risk med ett alltför Vision II inriktat lärande. Nämligen att det blir oklart för eleven vad denna faktiskt skall kunna. I boken Teaching and Learning STEM: A practical guide av Felder (2016) betonas den didaktiska vikten av att ha tydliga läromål när man har en kurs i STEM-ämnena. Om det blir för högsvävande och otydligt skadas eventuellt lärandet."

[16] Ö: "Därför är det av stor vikt att eleverna har förmågan att applicera sina kunskaper om kemi, och naturvetenskap överlag, i fler sammanhang än i klassrummet."

[17] C: "Förhoppningsvis ges eleverna verktyg som är användbara i vardagslivet och i samhällsdebatten. Ett tydligt medborgarbildande perspektiv alltså."

[18] M: "Med andra ord måste någonting [Vision II] göras för att vi, ur teknikutvecklingsperspektiv, ska kunna fortsätta konkurrera med innovation och entreprenörskap."

6 Discussion

This chapter contains an overall analysis of the project and a discussion of it's main findings. The subchapters take basis from the research question:

> How do engineering students with streamlined technical backgrounds, enrolled in a master program which gives both an engineering and a teaching degree, perceive the integration of a humanistic perspective on science and technology education and the value of such an integration?

Subchapter 6.1 concerns itself with the actual room for Vision II in the swedish curriculum, 6.2 with the value of such an integration and 6.3 with the actual integration.

6.1 Is there room for Vision II in the Swedish science and technology curriculum and is there an inherent value of Vision II in Swedish secondary education?

As discussed in chapters 2.2 and 2.3 there seems to be room for Vision II in the Swedish [science and technology] curriculum, although that room is somewhat narrow in the *Physics* and *Chemistry* curriculum. The *Science Studies* curriculum, a course not taken by Science and Technology students, has a more clear Vision II focus. The *Technology* curriculum places itself somewhere in between *Science Studies* and *Physics* and *Chemistry* in regards to Vision II focused formulations. The resulting outcome space in chapter 5 suggests an inherent value of Vision II, mostly based on interest and relevance, but also extended to literacy and utility.

6.2 Is there a need for humanities in science?

As discussed in Chapter 1 and 2, interest in science is declining (Sjøberg, 2010), and while some of the data in this study suggests that it might be a product of higher living standards, the demand for science literate citizens is still high. This aligns with the argument put forward by Mariana Mazzucato (2018) in her strategic recommendations on mission-oriented research and innovation in the EU, to guide the future European Union Framework Programme for Research and Innovation. She suggests that in order for mission-oriented research to be successful it needs (amongst others) to be "cross-disciplinary, cross-sectoral and cross-actor innovation" specifically mentioning:

> Missions should be framed in such a way as to spark activity across, and among, multiple scientific disciplines (including social sciences and humanities). (Mazzucato, 2018).

It is clear that the current complex societal problems that we are facing, global warming, climate change, pandemics, all require a broad approach from many different disciplines, and experts from these disciplines need to understand each other. The citizens of today also need a solid science education based on real world applications and complex problems in order to to form an opinion about or take a stand on them.

As shown in chapter 5, the student group that participated in this study were in many cases able to argue for an increased application of Vision II in their everyday practice, basing their argument on an "Interest/Relevance" base, but also extending it in some cases to a more democratic "Literacy" argument, or an economical "Utility" argument. One reason for the basis in "Interest/Relevance" could be that it is mentioned by many authors presented in Chapter 2, where Osborne (2007) was part of the mandatory reading before the seminar and the lecture relied heavily on the ideas from Aikenhead (2006), Roberts (2007/2014), Fensham (2009) and was introduced using graphs from Sjøberg (2010).

6.3 How can future educators be trained to apply Vision II in their everyday practice?

The results from this study suggests that the model presented here is one way of equipping future educators with an alternative perspective on their subject, even though they have a streamlined background. The seminar where the students attempted to create lesson plans using Vision II as a guideline gave the students opportunity to realize their ideas and also discover challenges (and opportunities). The final essayistic hand-in was produced in a period in which many of the students experienced stress and overwork, but despite that a number of students submitted well written texts.

The variance and high level of autonomy in the different categories emerging from the data regarding the how-question suggests that the model inspired the students and encouraged them to apply the concept to their everyday practice. With regards to the problem presented in Chapter 2, that teachers "instinctively teach the way they were taught in most college classes" (Felder, 1993)" or the "streamlining" (Aikenhead, 2006) of science education, the results show that using Vision II is one way that could break that pattern. The results also show a wide range of complexity in the answers, and that many students were able to apply the somewhat abstract concepts and apply them in a classroom situation, even though this student group in many aspects were "streamlined" themselves.

Osborne (2007) also states that only by changing the three main components of education; curriculum, pedagogy and assessment can the change towards a Vision II oriented science education take place. The sole teacher has little influence over the curricula, but greater influence over pedagogy and assessment. It is clear from the results that it is possible to apply this perspective in the everyday practice, within the boundaries of the curriculum.

7 Conclusions

The general purpose of this thesis was to research the possibility to equip future educators and engineers with a broader set of tools, thus enabling them to supply a more varied education and range of perspectives to their students, colleagues and customers. The focus in this study was on the role of the educator, however, it also applies to engineers and other professionals whenever they approach a multidisciplinary problem whose solution would include some sort of knowledge-transfer.

One could include a humanistic perspective by using the model presented in this thesis, thus broadening the toolset, that is: A lecture introducing the concept, a seminar where the students apply the concept and finally a hand-in where the students take a critical approach to the concept and the possibility to apply it within the current curricula. The range of answers from the hand-ins presents a solid data set that could be analysed using phenomenography in order to discerns these different perceptions.

The boundaries for such an inclusion would be the curriculum. In chapter 2.3 the differences between *Physics*, *Technology* and *Science studies* was pointed out. One conclusion could be that perhaps students on Science and Technology programs in the Swedish high school also could take *Science studies,* or at least let the education in *Physics* be inspired from it.

In the introduction I mentioned my own background, and quoted my Technology teacher. My own conclusion after this study is that there probably is one intelligence, but it should include a multidisciplinary perspective, and a humanistic perspective complements the science perspective.

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Appendix A - Syllabus for CLS040

Syllabus for Academic year 2019/2020

CLS040 - Humanistic and social scientific perspectives on natural science and technology[19]
Humanvetenskapliga perspektiv på naturvetenskap och teknik

Syllabus adopted 2019-02-22 by Head of Programme (or corresponding)
Owner: MPLOL

7,5 Credits
Grading: TH - Five, Four, Three, Fail
Education cycle: Second-cycle
Major subject: Technology and Learning
Department: 62 - COMMUNICATION AND LEARNING IN SCIENCE
The course is only available for students having the course in their program plan

Teaching language: Swedish

Application code: 40124

Open for exchange students: No

Maximum participants: 35

Only students with the course round in the programme plan

In programs

MPLOL LEARNING AND LEADERSHIP, MSC PROGR, Year 2 (compulsory)
KPLOL LEARNING AND LEADERSHIP, SUPPLEMENTARY STUDY PROGRAM, Year 2 (compulsory)

Examiner:

Jens Kabo

Replaces

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19 https://student.portal.chalmers.se/en/chalmersstudies/courseinformation/Pages/SearchCourse.aspx?course_id=30062&parsergrp=3

CIU255 Natural science and technology education 2 CIU256 Natural science and technology education 2

Theme:

MTS 7,5 hec

Eligibility:

In order to be eligible for a second cycle course the applicant needs to fulfil the general and specific entry requirements of the programme that owns the course. (If the second cycle course is owned by a first cycle programme, second cycle entry requirements apply.)
Exemption from the eligibility requirement: Applicants enrolled in a programme at Chalmers where the course is included in the study programme are exempted from fulfilling these requirements.

Course specific prerequisites

The course Learning in natural science and technology.

Aim

The students should through various humanistic and social scientific perspectives, such as theory of science,
1) broaden and deepen their understanding of natural science or technology,
2) develop their ability to discuss and assess the purpose and characteristics of natural science or technology, its relation to humans and society, its potential possibilities and limitations as well as ethical and societal aspects, and finally
3) improve their ability to make their subject relevant and accessible to upper secondary school pupils.

Learning outcomes *(after completion of the course the student should be able to)*

- reflect on their subject from different humanistic and social scientific perspectives
- relate their subject to the surrounding society from different relevant humanistic and social scientific perspectives
- discuss and problematise the possibilities and limitations of technology or science from different relevant humanistic and social scientific perspectives
- discuss ethical aspects of research and/or development work from different relevant humanistic and social scientific perspectives
- critically review technology or science from different relevant humanistic and social scientific perspectives with emphasis on ethical and societal aspects and the role and responsibility of humans
- use different humanistic and social scientific perspectives in order to make their subject more relevant and accessible for upper secondary school pupils

Content

The course addresses the natural sciences and technology through a series of humanistic and social scientific perspectives, including historical, theory of science and philosophy of technology perspectives.

Organisation

The course has two parallel tracks, one for technology and one for science, with some joint classroom sessions. The course is run in a seminar format where plenary discussions may be mixed with small group discussions and some practical exercises. The seminars are combined with individual reading and writing as well as assignments.

Examination including compulsory elements

The basic requirement for passing the course is **active participation** in the seminars of the course. Furthermore, an **active reading log** is required for the weekly readings. In addition to seminars and reading logs, the examination consists of **written assignments** that are carried out during the course and are assessed with a differentiated scale (F, 3, 4 or 5). A holistic consideration of these assignments results in a course grade.

Appendix B - Hand-in

Del 3 Vision II i praktiken

Under passen med Olof har ni blivit introducerade till Glen Aikenheads Vision I och Vision II för naturvetenskaplig (och teknisk) utbildning.

Vision I	Syfte: Förbereda några, en NV elit (producenter av kunskap) Fokus: Begrepp och problemlösning
Vision II	Syfte: Förbereda alla, medborgarbildning (konsumenter av kunskap) Fokus: Problemlösning med samhällsanknytning

Grundnivå

Börja med att analysera ämnesplanerna för ditt ämne och diskutera vilket utrymme det finns för Vision II i dessa styrdokument. Gå sedan vidare och argumentera för hur du givet de ramar som styrdokumenten sätter kan integrera Vision II i din pedagogiska praktik för att på så sätt göra ditt ämne mer relevant och tillgängligt för gymnasieelever (gärna genom konkreta idéer du har fått under denna kurs). Diskutera även om och varför integration av Vision II i dagens gymnasieskola är önskvärt.

Rekommenderad litteratur: Osborne (2007), Sjøberg (2010)

Avancerad nivå

Givet att du har flera år av mestadels naturvetenskapliga och tekniska studier (och kanske även arbete) bakom dig så finns sannolikheten/risken att du har blivit något av en teknisk (ursäkta uttrycket) "fackidiot". Problematisera huruvida detta gör det svårare att hitta relevanta sätt att integrera Vision II i din pedagogiska praktik.

Rekommenderad litteratur: Gustavsson (2002), Mezirow (1997).

Ett svar på enbart grundnivå bör omfatta 800 ord (+/- 100) medan ett svar som även inkluderar avancerad nivå bör omfatta 1100 ord (+/- 150).

Appendix C - Consent form

Medgivande för deltagande i forskningsprojekt

Som data för det forskningsprojekt (och examensarbete) jag genomför som avslutning på min utbildning på MPLOL vill jag gärna använda:

1) Det lektionsförslag ni tar fram under workshopen måndag v.44
2) Ert svar på den tredje frågan på den examinerande uppgiften

För att undersöka hur man kan integrera det humanvetenskapliga perspektivet i undervisningspraktiken.

Datan kommer att analyseras kvalitativt genom en fenomenografisk metod, och eventuellt följas upp med enskilda intervjuer.

Handledare för examensarbetet är Jens Kabo, då han även är examinator på kursen kommer vi inte att påbörja vår analys av datan förrän betyg är satt på kursen.

När analysen inleds kommer all data att anonymiseras. Eventuella intervjusvar kommer att behandlas konfidentiellt, samtliga anteckningar, transkriberingar och inspelningar kommer endast att finnas hos mig. Det insamlade materialet kommer alltså endast att användas i forskningssyfte.

Deltagandet är helt frivilligt och ni har rätt att när som helst avbryta er medverkan i projektet genom att skicka ett mail till: olojak@student.chalmers.se.

Olof Jakobsson

Jag ger mitt medgivande till deltagande i studien:

____

Namn

____

Datum