Western Norway University of Applied Sciences

MASTER'S THESIS

Creativity and Ecoscenography in the Global Science Opera

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Creative Disciplines and Learning Processes
Western Norway University College og Applied Sciences
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I confirm that the work is self-prepared and that references/source references to all sources used in the work are provided, *cf. Regulation relating to academic studies and examinations at the Western Norway University of Applied Sciences (HVL), § **10**.*

Abstract

This thesis looks at how the creative process is influenced by the implementation of sustainable design in education. Working with an interdisciplinary collaboration between science and arts in the Global Science Opera initiative (GSO), students were introduced to Ecoscenography when creating the visual frames for the opera. The theory of Wise Humanizing Creativity allowed an assessment of the creativity displayed during interventions, recognizing students "journeys of becoming" trough their creative process. This journey describes the relationship between the creator and his creation, and can be compared to the Ecoscenography trajectory, where the gradual immerging knowledge of sustainable ecology influences the involvement.

The participating students expressed concern over the increasing manmade ecological challenges that will influence their future. This concern may have enhanced their engagement in the workshops, as findings reveal that the implementation of Ecoscenography into the GSO may appear to increase creativity. It appears that the combination of Ecoscenography, creativity and the GSO strengthen each other in this educational intervention. Ecoscenography acts as a bridge between science and arts, as knowledge from both areas are essential for a successful sustainable design. Furthermore it appears to engage the students in it´s transferability into other areas of their lives, they expressed appreciation over being presented with the "tools" of eco design. This engagement was probably what sparked their creativity to reach further than their skill-levels would indicate. The eco creative process and the wise humanizing creative process have in common working towards a higher goal: that of a common good for all life.

The research is structured through the Educational Design Research methodology, with iterative fieldwork on three continents. Based on the executed study, guidelines for how to conduct a GSO Ecoscenography workshop have been developed. Building blocks of theoretical information may contribute to the further research of interdisciplinary educational initiatives like the GSO.

Key words: Ecoscenography, Global Science Opera, eco creativity, creative process

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Researching my way into this thesis, has brought me further in my quest for knowledge about creativity and wisdom. This structured, academic approach to the wild and vibrant force of creativity, has developed into my own journey of becoming. A journey of becoming more mature and more immediate, more determined to contribute, and hopefully of becoming a little wiser. The journey of creating this thesis has shaped my person, who I am as a teacher, as an artist, how I understand and feel about creativity. For me personally, being creative makes me feel alive, it is a way of experiencing life, of understanding it and embracing it.

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一期一会 – Thank you for a uniquely precious experience!

Contents

ABSTRACT II

ACKNOWLEDGEMENTS III

ABBREVIATIONS 1

LIST OF FIGURES AND PHOTOS 1

INTRODUCTION 2

BACKGROUND FOR MY CHOICE OF WORK/THEME 2
LITERATURE AND PREVIOUS RESEARCH IN THE FIELD 2
CREATIVITY IN EDUCATION 2
SUSTAINABILITY IN EDUCATION 3
SUPPORT OR INFLUENCE? 4
THE DEVELOPMENT OF GLOBAL SCIENCE OPERA 5
RESEARCH AREA AND RESEARCH QUESTION 7
CONCEPTUAL CLARIFICATION AND DEFINITIONS 7
CREATIVITY 8
SCENOGRAPHY 8
ECO-DESIGN AND ECOSCENOGRAPHY 9
THESIS STRUCTURE 9

THEORETICAL FOUNDATION 10

THEORIES OF CREATIVITY 10
SKILL LEVELS 11
STAGES OF CREATIVITY: THE FOUR C´S 12
THE THEORY OF WISE HUMANIZING CREATIVITY 13
ECOSCENOGRAPHY – THEORIES OF HOLISTIC SUSTAINABILITY 16
THE HISTORICAL BACKGROUND 16
WHAT IS DEEP ECOLOGY? 16
WHAT IS ECO-DESIGN? 18
WHAT IS ECOSCENOGRAPHY? 20
WHAT IS THE GLOBAL SCIENCE OPERA? 22

RESEARCH DESIGN AND METHODOLOGY 24

METHODOLOGICAL THEORY 24
QUALITATIVE RESEARCH AND INTERPRETATION 24
EDUCATIONAL DESIGN RESEARCH 24
METHODOLOGICAL PRACTICAL APPLICATION 26
THE ECOSCENOGRAPHY WORKSHOP 26
METHODOLOGICAL THEORETICAL APPLICATION 26
DATA COLLECTION AND APPROACH TO ANALYSIS 27
THE SAMPLES OF INFORMANTS 27
THE FIELDWORK (ITERATIONS) 29
THE TEST-PROJECT 30
JAPAN – THE FIRST ITERATION 32

USA – THE SECOND ITERATION 34
DIAGRAM OF THE EDR PROCESS 37
DATA ANALYSIS 38
CODING 38
A CLARIFICATION REGARDING THE CODING OF ECOSCENOGRAPHY 39
ETHICAL CONSIDERATIONS (CONSENT AND APPROVAL) 39

ANALYSIS-RESULTS AND FINDINGS 40

FINDINGS CONNECTED TO WISE HUMANIZING CREATIVITY 40
1. MAKING AND BEING MADE 40
2. NEW IDEAS THAT MATTER 40
3. WORKING ON ONES OWN AND WITH OTHER PEOPLE 41
4. IMMERSED IN CREATIVITY 42
5. TAKING AND SHARING CONTROL 43
FINDINGS CONNECTED TO ECOSCENOGRAPHY 44
BUILDING AWARENESS 44
1. EMBRACING ECOLOGICAL DESIGN AS A CREATIVE STARTING POINT AND OPPORTUNITY 44
2. ALLOW OPPORTUNITIES FOR SERENDIPITOUS AND PLACE-BASED RESPONSES 45
3. ACKNOWLEDGE ECOLOGICAL COMPLEXITY IN OVERCOMING SUSTAINABILITY ASSUMPTIONS AND CHALLENGES 46
4. SCENOGRAPHERS ARE CHANGE-AGENTS THAT CAN EMPOWER AND CATALYZE ECOLOGICAL COLLABORATION 46
5. GO BEYOND THE TRANSIENT IN PURSUIT OF POSITIVE SOCIAL AND ENVIRONMENTAL CONTRIBUTIONS 47
FINDINGS CONNECTED TO GLOBAL SCIENCE OPERA 49
1. CREATIVITY 49
2. COLLABORATION 50
3. DEMOCRACY 51
4. EDUCATION 51
5. GLOBAL 53
6. INQUIRY-BASED SCIENCE EDUCATION 54
7. INTERDISCIPLINARY 55

DISCUSSION AND REFLECTION 56

A SUMMARY OF THE FINDINGS 56
THE COMMON THEMES AND CROSSING POINTS 57
CREATIVE WISDOM 57
LEVEL OF SKILLS = LEVEL OF CREATIVITY? 58
CREATIVITY – AN INTELLECTUAL OR PRACTICAL FEAT? 58
THE JOURNEY OF BECOMING AND THE AWAKENING OF ECO-AWARENESS 61
CREATIVITY AND CONSCIOUSNESS 62
THE SUSTAINABILITY OF QUALITY CRAFTSMANSHIP 62
WHAT IMPACT DOES THE GSO ECOSCENOGRAPHY HAVE? 63
CHALLENGES OF IMPLEMENTATION 65
THE RESOURCES 65
SAVING THE PLANET OR SAVING THE BUDGET? 65
THE TIME-TURNER 66
THE NEED-TO-KNOW CHALLENGE 66
POTENTIAL FUTURE RESEARCH 67

CONCLUSION 69

BUILDING BLOCKS ON THE ROAD TO FUTURE THEORETICAL CONTRIBUTION 69
THE PRACTICAL CONTRIBUTION 72
A PRACTICAL APPROACH TO SUSTAINABLE THEATRICAL PRODUCTION 72

WORKSHOP DESIGN PRINCIPLES 73
INTERESTS OF IMPLEMENTATION 76
THE ARTISTIC FIELD 76
GSO-FACILITATORS 76
OTHER EDUCATIONAL INSTITUTIONS 76
GLOBAL COLLABORATION FOR ALL? 77
MY HOPES 78

REFERENCES 80

APPENDICES 86

APPENDIX 1: THE JAPANESE SURVEY 86
APPENDIX 2: QUESTIONS FOR STUDENTS 87
APPENDIX 3: QUESTIONS FOR TEACHERS/SCIENTISTS/OBSERVERS 88
APPENDIX 4: WORKSHOP DESIGN TEST-PROJECT 89
APPENDIX 5: WORKSHOP DESIGN JAPAN 90
APPENDIX 6: WORKSHOP DESIGN USA 91
APPENDIX 7: A PRACTICAL APPROACH TO A SUSTAINABLE THEATRICAL PRODUCTION 94
APPENDIX 8: HOW TO IMPROVE THE ARTISTIC QUALITY OF THE VISUAL FRAMING OF THE GLOBAL SCIENCE OPERA PRODUCTION 95
APPENDIX 9: PRACTICAL GUIDELINES FOR MAKING ECOLOGICAL SUSTAINABLE COSTUMES 96
APPENDIX 10: AN OVERVIEW OF ARTS AND CRAFTS-EDUCATION IN JAPANESE SCHOOLS 97
APPENDIX 11: QUOTES 98

"Creativity is the most sustainable and renewable energy source on the planet. Let´s use it!"
Alison Tickell

"Earth is really just a large spaceship, and ruining the thing you live on doesn't really make sense, whatever your political ideology is."
Trygve Hallberg

Abbreviations

EDR	Educational Design Research
ESA	European Space Agency
GSO	Global Science Opera
IBSE	Inquiry-Based Science Education
ICT	Information and Communication Technology
SHUC	Stord Haugesund University College, the old college-name before the fusion with two other colleges and becoming HVL January 1st, 2017
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WASO	Write A Science Opera
WHC	Wise Humanizing Creativity
HVL	Western Norway University College of Applied Sciences

List of figures and photos

	page
Figure 1: Dreyfus & Dreyfus´ model of adult skill acquisitions	11
Figure 2: The 4-C model of Creativity	13
Figure 3: The Wise Humanizing Creativity wheel	15
Figure 4: Man above nature versus man in nature	17
Figure 5: Cradle-to-cradle	19
Figure 6: The Ecoscenography trajectory	21
Figure 7: The core values of the Global Science Opera initiative	23
Figure 8: overview of data-collection process	28
Photo 1: Building-blocks	30
Photo 2:The lighting-crew scientists from GHOU/GTTP	31
Photo 3: Constructing set and costumes at GHOU/GTTP	31
Photo 4: Japanese students assembling bamboo-set	33
Photo 5: acting the scene in front of the bamboo-set	33
Photo 6: The US lighting-group experiments	34
Photo 7: The US costume-group transforming old T-shirts	35
Photo 8: US students embodying the egg-tempera painting.	36
Figure 9: The EDR-process	37
Photo 9: The footprints of a creative process	43
Figure 10: Guidelines for a GSO Ecoscenography workshop	71
Figure 11: A practical approach to a sustainable theatrical production	72

All photos are taken by Janne Robberstad, unless otherwise stated

Creativity and Ecoscenography in the Global Science Opera

Introduction

Background for my choice of work/theme

There are many interesting fields worth studying, but from my perspective perhaps the most fascinating research takes place in the collaborative field of interdisciplinary work. What can be achieved when joining forces towards a greater goal? A varied field of interests and skills characterizes my own background. Trained as an arts and crafts teacher, I have work-experience as a teacher in several creative subjects, but also as a visual artist and a designer, working for theatres. The interest for a more sustainable approach to living has gradually evolved in line with the growing ecological challenges and the urgency of a radical transition of our way of life. Becoming a master-student and learning about the Global Science Opera (GSO) project, all the pieces of the puzzle fell into place. Conducting research here meant that I could put to use all my former training and experience; I could develop new skills for myself while contributing with building blocks of knowledge for others.

Literature and previous research in the field

This thesis operates across several fields of research, as it aims to implement one field (Ecoscenography) into another (GSO) by looking at the effect it has on a third (creativity). There is no prior research that includes these three areas together. However, in each of the respective fields, there is available research essential to this thesis. In this context, therefore, it is also interesting to look at what place the field of sustainability has in education. When searching for prior research, Google Scholar and Oria.no were of great help.

Creativity in education

Creativity is a field that has been the subject of philosophical studies and researched on for centuries. From divine intervention according to various religions via Freud´s psychoanalytic unconscious processes to the behaviorists´ conditions of originality (Craft, Gardner & Claxton, 2008 p.2). It has been explained as both a stroke of genius and madness. Systematic scientific study, however, started around the 1900s (Eysenck, 1995 p. 11-12; Craft, 2001 p.5).

Since the 1950s research on *personality* (research by MacKinnon, Simonton, i.a.), *cognition* (researched by Freud, Guilford, Gardner i.a.) and how to *stimulate creativity* were dominant (Craft, 2001 p.6). A fourth study-area surfacing in the 1980s was looking at creativity in social systems (researched by Amabile, Craft, i.a.) (ibid p.10).

Creativity in education has benefitted of several divergent theories, complemented by the broader perspective of creativity, focusing on collaboration and a supportive environment (Craft, Gardner & Claxton, 2008 p.2). Craft represents a gradual shift towards everyday creativity at home and at work (Craft, 2005). Seltzer & Bentley suggest that creativity can be learned (Craft, 2001 p.16), though little research confirms this conclusively. There is some interesting research suggesting that the teachers' attitude towards creativity is "contagious" for the students and a motivational factor when teaching creativity (ibid p. 18)
By recognizing the process of creativity, it may be easier to create and stimulate creativity in education. Attempts toward achieving this include Guildford´s "creative cycle", Balke´s importance of playfulness, or Craft´s possibility thinking to mention a few (ibid p. 18-22).

As wealth grew in Norway[1], people were less dependent on *making* the things they needed, they could just *buy* them. And as lack of practical experience of *making* in the general population decreased, the schools have been unable to compensate this loss of practical knowledge. Educational fields that traditionally promote creativity, like the practical aesthetic fields of arts and crafts have had a decrease in hours of education the past decades, compared to other subjects. However it is just as important to look at the content being taught, as the amount of hours: skills in quality craftsmanship are decreasing. This is mainly due to a lack of trained crafts-lecturers, again due to a lack of political will to prioritize strengthening these fields (regjeringen.no, 2008; Christophersen, Iversen & Tvedt, 2017, p. 10, Vavik et al, 2010).

Sustainability in education

Inspired by the global aspect of the GSO, I have mainly looked at international agreements regarding implementation of sustainability into education. Since the 1970s there has been an understanding recognizing the importance of a "sustainable" curriculum, as it would

[1] Examples from Norway may represent a larger culture or policy within education. However it is not necessarily representative for the rest of the world.

shape our future (Sinnes, 2015 p.17). In 2002 the UN declared the International Decade of Education for Sustainable Development (2005-2014), as a means to mobilize educational resources for a more sustainable future (en.unesco.org, 2017). The experience gained through this work, gave the basis for the UN´s new resolution: the 2030 Agenda for Sustainable Development. The sustainability threesome People, Planet and Prosperity is now extended to include Peace and Partnership (United Nations, 2015). The UN looks at all sides of sustainability on a global scale, but particularly mentions that:

> *By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.* (United Nations, 2015 §4.7)

In Norway, "The Future School"[2] is a document from the Ministry of Education and Research, stating that sustainability is one of three priority areas (Ludvigsen, 2015 p. 20). This document is influenced by the 21st century skills, promoted by UNESCO i.a., realizing that no one knows what jobs we are educating children for in the future, as these jobs do not even exist yet. Education necessarily needs to change in order to prepare students for this future by teaching them how to learn, training them in adapting to new circumstances, solving problems, being critical and creative in their thinking (Medel-Añonuevo, Ohsako & Mauch, 2001). This is achieved by in-depth learning, interdisciplinary collaboration and creativity (Ludvigsen, 2015). Sustainability and creativity are defined as two values or skills that exceed the school-subjects[3].

Support or influence?

While it is positive that major organizations like the EU and the World Bank support the 21st century-skills, it might be wise to consider the influence of a strong business-industry should have on education. Even though schools are working on commission to produce future

[2] my own translation

[3] In Norway, there is currently an ongoing discussion between the government on one side and the Union of Education Norway (Utdanningsforbundet.no) and the Ludvigsen-committee regarding whether these 21st century values (creativity and sustainability) should be taught in all subjects, or if they are to be combined with certain subjects which are defined as more creative than others, such as arts and crafts. Perhaps the competence constraints need to be expanded.

employees of our common society, the contractor and commissioner may not always value the same interests. Government and business sometimes have different agendas. Biesta (2015) raises a critical voice regarding societies demand for a pre-defined learning outcome, with a side order of predictability (Biesta, 2015 p.1-2).

The evolution of Ecoscenography

The concept of environmentally friendly theatre-design has developed in practice over the past decades, and, gradually research is catching up. The first guidebook on sustainability in performing arts was published in 1992, but never made a deep practical impact. Theatres were either not interested in sustainability or feeling "above" it (Abedayo in Beer, 2016 p.4). Peeters points to how reluctance among designers may be caused by a skepticism based on the notion that sustainability will conflict with the aesthetics (Peeters, 2012). Allen et al (2013) show how circumstances like a strict time schedule and tight budgets limit the possibilities a designer has to experiment (Allen et al, 2014 p.14).

However, due to a gradual increase in general public awareness regarding sustainability, the past decade has seen a growing interest in, and development of, the eco-theatrical scene.
A major work in Ecoscenography and the main source of research used in this thesis is material provided by Tanja Beer[4] from the University of Melbourne, Australia. Her 2016 doctoral dissertation, along with her other publications, have provided essential information on sustainable theatre-practice. In addition to Melbourne, two other universities also offer master-programs in sustainable theatre design: The University of the Arts Helsinki[5], Finland and York Université[6] in Toronto, Canada. No doubt, interesting new research will arrive from these centers in the future.

The development of Global Science Opera

The Global Science Opera, even though it is a new initiative that commenced in 2014, stands in a larger context of educational projects. The GSO is inspired by and builds on the previous

[4] Tanja Beer (PhD) Scenographer & Academic Fellow in Performance Design & Sustainability. Melbourne School of Design, University Of Melbourne
[5] Offers master-programs in Performance and Ecology. http://www.uniarts.fi/en/maecp
[6] Offers a master-program in Sustainability and Design, Theatre Production and Administration, and a master-program in Ecology and Contemporary Performance. http://www.uniarts.fi/en/maecp

interdisciplinary work of WASO[7]. It uses much of the same teaching material[8], hence research interesting for this thesis include both of these projects. The GSO was developed at Western Norway University of Applied Sciences[9] (HVL), together with the Galileo teacher training program[10] and Global hand on universe[11]. It is supported by the Norwegian Research Council´s iSCOPE project[12] and by the European Commission´s CREATIONS project[13] (globalscienceopera.com, 2017). Together, all these fields and projects have accumulated research regarding the implementation of creativity into science-education. An example is Craft et al (2016), whom have contributed with implementing creative strategies into science thinking, presenting WASO as one of three ways in which the CREAT-IT-project [14] promoted this, as an answer to the EU´s educational targets for the near future (Craft et al, 2016).
Volta Volta e Sousa, Ben-Horin, Ramos and Lopes found that students experienced how motivation seems to grow when creativity enters into interdisciplinary educational settings. (Volta e Sousa, Ben-Horin, Ramos, Lopes, 2016).

During the past years, the practice of GSO has exceeded the amount of empirically based research. Several research initiatives are currently underway regarding the GSO educational design, the interaction between art and science educators within its premises, and regarding the GSO's potential to engage students in science more than is the case today. Yet no systematic research has been conducted regarding the visual arts' role in the GSO, or regarding GSO's handling of the concept of sustainability. The current Masters thesis fills that gap.

[7] WASO = Write A Science Opera, A creative approach to science and art inquiry in schools http://prosjektsider.hsh.no/waso/the-training-course/
[8] This is elaborated upon on page 19?
[9] Western Norway University of Applied Sciences https://www.hvl.no/en/
[10] The Galileo Teacher Training Program is a global network of astronomers, educators, teachers and students reaching more than 100 nations. http://galileoteachers.org
[11] Global Hands-On Universe (GHOU) joins efforts from all around the world to train teachers on the use of modern tools and resources for science education and engage students in international scientific projects. http://handsonuniverse.org
[12] iSCOPE (integrating Science of Oceans, Physics and Education) aims to create of a suite of verifiably effective, innovative science pedagogies to make Norway a leader in the impact that marine biological research offers the global community. http://casecenter.no/projects/iscope/
[13] CREATIONS aims to improve the skills and engagement of young people in STEM (science, technology, engineering, mathematics). http://creations-project.eu/about/
[14] CREAT-IT = Implementing Creative Strategies into Science Teaching, an EU-funded project which aims to develop and support teacher skills in science education by integrating creative, cultural disciplines and social media tools in science courses, engaging students to participate in collaborative, project and case study based activities. http://www.creatit-project.eu

Research area and research question

At the intersection of the above-mentioned research-areas, lies the Global Science Opera. It is a relatively new project, which is still being developed and thus merits research. After reading the teaching material, I detected a need for evolving the scenography, both on a theoretical and a practical level. Wondering if it was possible to not only improve the opera artistically, but perhaps even adding a positive ethical addition, inspired the attempt to integrate Ecoscenography into the GSO. I believed it was possible to achieve, but didn´t know to what degree it could be done and how it would affect the students or the opera. I also wondered how it would affect the creative process itself. Would the ecological aspect constrain the students´ creativity, focusing on limitations? Or would it inspire them into a new level of innovation? Or would it not make much of a difference either way? After a time of deliberation, the research questions evolved:

> **In what ways can sustainable Ecoscenography principles be integrated into the process of creating visual frames of the Global Science Opera? And how can these principles affect the creative process?**

The empiric data collected through the fieldwork interventions give a ground for answering these questions. However, a new series of questions have arisen, and hopefully more research into the field can take place, perhaps to consolidate the answers.

Conceptual clarification and definitions

Sustainability

Sustainability is defined as the ability to maintain a certain level of something. It is often used in both economic and ecologic circumstances. In this thesis it is solely used in the context of *ecological* sustainability. First introduced into the ecological context by Brundtland in 1987 in the UN[15], referring to "meeting the needs of the present without compromising the well-being of future generations", later redefined to include all life on earth, not just humans (Brundtland, 1987).

[15] Report of the World Commission on Environment and Development: Our Common Future.

Creativity

When researching creativity, clarifying what is being assessed is of the essence: the creative process, the creative product[16] or both (Sawyer, 2011 p.11). One can of course assess the product in itself, and it may or may not speak about the process behind arriving at the result. In an educational setting, where novice-students are in the process of learning, this makes less sense than looking at the product as an integrated part of the process, enriching the understanding of this process. This thesis concentrates on the creative process and creativity in context, as recommended by WHC. The product is considered a part of and a measure of the process, acting as help in the creator´s development process. For the creator it is the goal with the process, and achieving a good result the creator can be proud of should not be underestimated.

For the inexperienced beginner the product may be the result of a creative process where the creator embodies a "conversation" with the material, creating collaboratively *with* the material, with trial and error, trial and triumph[17](Sawyer, 2011 p.183-186). Or it could be the result of a completely cognitive production, where no creativity took place. In either case, the finished product may be a very different object for the creator than for the observer trying to understand or assess the creative process behind it. In this study the product has not been assessed on its own on an aesthetic basis.

Scenography

Scenography is a collective term referring to all sides of creating a performance environment; the original Greek meaning is "visual dramaturgy" (Howard, 2009; Beer, 2016, p. 14). In this thesis it is mainly used to describe the set, costumes and lights. But it may include other physical effects on stage, like hair, make-up and props. It may also include sensatory effects like scent- or sound-design, other structural and space-designs, not only on stage, but also in or outside the theatre. The word scenography is broader in its definition than theatre-design, where the latter would provide a backdrop for the show, the first would be

[16] Sawyer presents the Four P framework, a division of creativity research, proposed by Mel Rhodes in 1961: Product, Person, Process, Press (outside pressure affecting the person or process, like social or cultural setting)

[17] For a trained creator much of the creative process can take place in the mind, leaving a more efficient production-period with less trial and error, as much deliberation is done on a mental level.

part of the whole, contributing to the complete experience of the performance (Beer, 2016 p.14).

Eco-design and Ecoscenography

Ecoscenography is a small part of eco-design. In the fieldwork-courses we are using Ecoscenography when creating the visuals to back up a GSO performance. When the word eco-design sometimes is used, it is to imply the larger picture, how the basic principles can apply to other arenas in life, not just on the stage. The phrase *sustainable design* also indicates a larger field of design than that of use in the theatre.

Thesis structure

The methodology of Educational Design Research was chosen to guide this work.
In the *Research-design and Methodology-chapter* the methodology of Educational Design Research (EDR) is presented. The chapter also presents the fieldwork, the informants and how the data was collected and analyzed.

The *Analysis-results and Findings* chapter is structured around the theories of WHC and Ecoscenography. By adding sub-chapters looking specifically at the educational framework in which the research took place, the Global Science Opera (GSO), additional information contributing to the answers might be found. Each of these three areas provides a number of sub-chapters, presenting a core value of the theories or initiative. This chapter contains a large amount of quotes. There are two reasons for this: there are a large number of accurately descriptive, eloquent quotes and a wish for transparency and credibility in presenting the results (Lincoln & Guba, 1985 s. 36-38).

The *Discussions and Reflections* chapter looks at common denominators and crossing points between the theories. It moves on to see if and what impact the GSO Ecoscenography has in an educational setting, minding the challenges of potential implementations. It also casts a glance into the future, recognizing areas of further research needed.

Finally the *Conclusions* chapter looks at the practical and theoretical contributions, according to EDR, provided through the research presented in this thesis.

Theoretical foundation

As mentioned, the aim of the thesis is to look at the students´ creative learning processes when they are working with sustainable scenography within the educational framework of the GSO-project. In recent decades there has been a great amount of research in creativity, including in education. Until the beginning of this century, less research was done regarding development and assessment of students´ creativity (Craft, 2001 p. 25). A complete review of this lies beyond the capacities of this thesis. A number of philosophical and academic principles connected to creativity and sustainability, which are relevant to my work, are presented below. The main theory I used in this thesis regarding creativity in education is WHC (Chappell, Craft, Rolfe & Jobbins, 2012). Before detailing that theoretical approach, I hereby refer to several other relevant approaches to creativity as a background.

Theories of Creativity

Creativity is a word of boundless limits, holding an infinite number of ideas. When defining creativity, Keith Sawyer (2011) separates two major traditions of research: the individualist approach and the sociocultural approach. The first focuses on a single persons involvement with creative thought or behavior: Creativity is a new mental combination that is expressed in the world (Sawyer, 2011 p.7). This requires an original idea for the creator, which is a combination of other previous thoughts and ideas, and that is shared with someone else.

The second studies how people work creatively together in a social or cultural setting: Creativity is the generation of a product that is judged to be novel and also appropriate, useful, or valuable by a suitably knowledgeable group (ibid. p. 8). This is connected to how new ideas matter for a larger congregation than just it´s originator. Truly original ideas are often the result of a collaborative effort. They also often follow an established structure, being appropriate; being is socially valuable to a community (ibid. p. 8-10).

Looking at creativity from an educational point of view, Sir Ken Robinson defends a widely recognized socio-psychological or democratic approach, claiming everyone can be creative (Robinson, 2001 p.29). He defines creativity as “the process of having original ideas that have value” (The Brainwaves Video Anthology, 2014). By this he means creativity is not an event, but rather indeed a process of trial and error. The idea must be original, at least to you, perhaps

your peer-group, and sometimes even to the whole world. Creativity is not a random process, but rather a continuous evaluation-process of making choices, which gives it value. All fields that require human intelligence require creativity, - it is not limited to being artistic. In arts & crafts education, for example, one of the main goals is to nourish and help develop and train the skill of creativity in students[18]. To help in this teaching-process, knowledge about creativity is essential, what it is, how it works, how to make it thrive.

Skill levels

Dreyfus and Dreyfus introduced in 1986 the five-stage model of adult skill acquisition (Dreyfus, 2004 p. 177). The model shows the different stages of acquiring new knowledge, and what characterizes these stages.

Figure 1: Illustration based on Dreyfus & Dreyfus´ model of adult skill acquisitions, by Janne Robberstad, 2017

The *novice* learns the mechanical rules and how to operate them. The *advanced beginner* develops an aspiring understanding through real-life experience. The *competent* extends the experience and increases the understanding, which in turn permits plan making. Emotional

[18] At the same time, teachers in public schools are asked to assess their students´ skills and give grades to these. The constant "threat" of being evaluated may restrict the creative process, which in itself requires risk-taking, and daring to think outside-of-the-box. The majority of my own personal teaching-experience is from the Norwegian folk high school system, where education is based on inner motivation. There are no grades, but quite a bit of creativity.

engagement is essential for evolvement from here on. The *proficient* has assimilated experience, which helps him clearly see, but still not enough experience to automatically respond into action without consulting the rules. The *expert* has embedded experience that leads to immediate, involved and intuitive response (Dreyfus, 2004 p. 177-180). Dreyfus´ theory of skill-acquisition may say something about learning creativity, if it is considered as a skill that can be trained, however it is not a tool to evaluate the creative process.

Stages of Creativity: The four C´s

Prof. Anna Craft believed creativity *could* be trained, and developed a theory where she took the theory of steps of learning into an educational setting. Her theory of Possibility Thinking inspired The Global Science Opera methodology (Chappell & Craft, 2014;Craft, Cremin, Burnard, Dragovic, & Chappell, 2013). Stimulating the creativity in young children by asking the question ”What if?”, her aim was to look at the creative process, across the different levels of generative activity (ibid. p.2). Noticing there are different types and levels of creativity, she separated and defined a gradation of creativity: little-c and Big-C. Little-c is connected to the individualist approach to creativity. It refers to a ubiquitous, interpersonal creativity needed and used in schools and in everyday-life, calling it the ability to cope effectively with changing life in the 21st century (ibid p.2; Banaji, Burn & Buckingham, 2006 p. 29; Sawyer, 2011 p. 7-10). Big-C is connected to the sociocultural approach. It refers to an eminent, mature, everlasting, genuine creativity, which is recognizable by totally unique ideas, generated by a genius (Craft, Cremin, Burnard, Dragovic, & Chappell, 2013; Beghetto & Kaufmann, 2007; Sawyer, 2011 p. 7-10).

Beghetto and Kaufman promoted the need for dividing everyday creativity into mini-c and little-c, as a useful tool to separate the beginners and the advanced. Just because something is not new to the world, does not devalue the experience for the first-timer. Everyone starts their creative journey within themselves and develops from there (Beghetto & Kaufmann, 2007 p. 76). Later Beghetto & Kaufman added Pro-c, which they define as *“the developmental and effortful progression beyond little-c that represents professional-level expertise in any creative area”* (Kaufman & Beghetto, 2009 p. 1). Craft´s idea of the four-c´s is important in the main theory, which I am using in this thesis, “Wise Humanizing Creativity” as democratic and

contextual creativity. Furthermore it is interesting when observing the different levels of creativity combined with skill-levels in other areas of the students´ activities (Gardner, 2011).

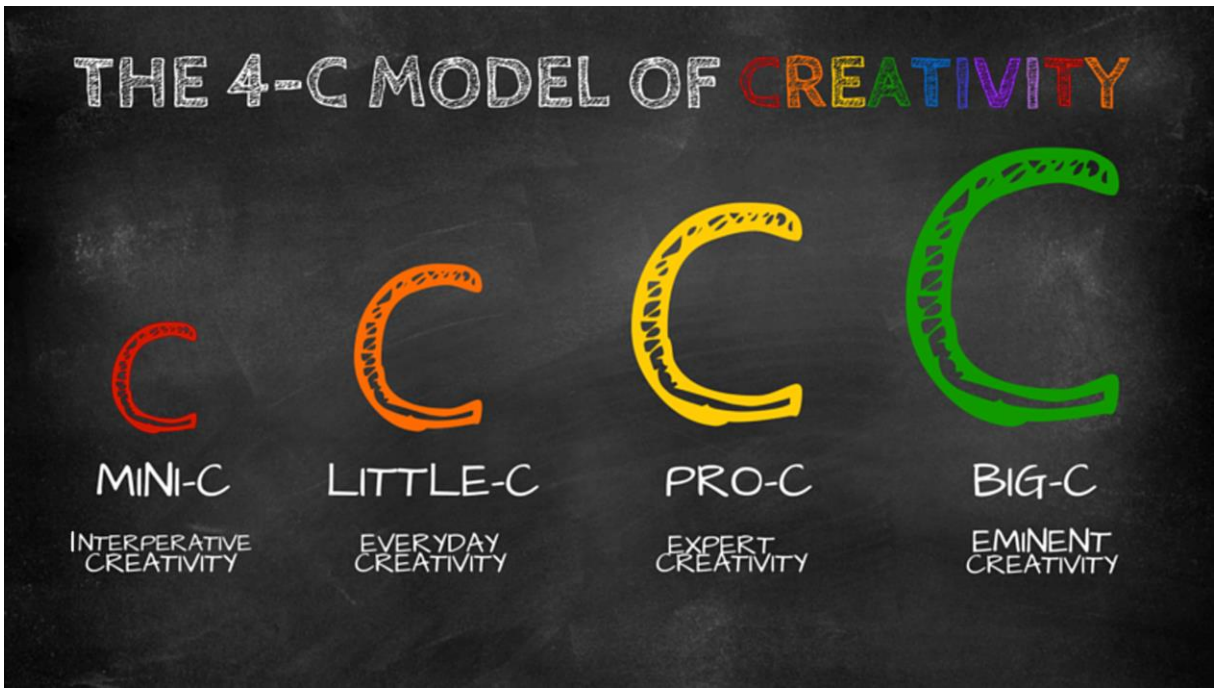

Figure 2: The 4-C model of Creativity, illustration[19] by @JessMarranco

The theory of Wise Humanizing Creativity

Wise Humanizing Creativity (WHC), first introduced by Craft, observes creativity´s fundamental humanizing potential (Sternberg in Chappell, Pender, Swinford & Ford, 2016 p 254). WHC is the creative development of ideas and the people involved and is recognized by it´s five themes (Chappell, Craft, Rolfe & Jobbins, 2012 p. 26):

The core concept of (1) **"making and being made"** is a reciprocal relationship between a creation and it´s creator(s) (ibid. p 258). One can experience personal changes when creating, by expressing and developing ones own voice, either by one self or with others, and by actively using the imagination to embody ideas. Ultimately engaging in the creative process is shaping your identity. Embodying the creative process will influence your identity through a "journey of becoming" (Chappell, Craft, Rolfe & Jobbins, 2012 p.1).

In this "journey", (2) **new ideas that matter** will emerge through exploration, along with an understanding of their consequences and value for the community. It will also appreciate

[19] Found at https://twitter.com/hubspot/status/586385878638919680

respect for other people's ideas and values. Creativity can be *"humanizing when it is carried out with ethical consideration as part of creative value judgments in relation to what matters to that particular community"* (Sternberg in Chappell, Pender, Swinford & Ford, 2016 p 258).

(3) **Working on your own or with others**, asking questions and debating between ideas, may lead to a group identity and ownership. The creative process is a dialogue between an inner individual, contributive process and an active collaborative effort with a community (ibid).

(4) **Immersing in creating**, entering the creative process with your whole being - using all your senses, getting into the creative flow, taking risks: it may lead to surprising new ideas (ibid). This requires support from a safe and encouraging environment[20].

(5) Finally it is the confidence **to take and to share control**, by initiating ideas or responding to others, understanding rules and making decisions (ibid, p.258; Chappell & Hathaway, 2015 p. 1-12). Helping the developing self-esteem in students by inviting them into partnership and inclusive leadership.

WHC democratically promotes that everyone can be creative in his or her everyday lives (Chappell, Craft, Rolfe & Jobbins, 2012 p. 3). It claims that creativity is contextual and should always be appreciated thereby, considered from the maker´s level of creativity, be it mini-c, little-c or even pro-c-levels.

Craft reminds us that creativity can be used for good or evil, hence it is important to induce creativity with wisdom. Wisdom is balancing various self-interests with the interests of others and other aspects in life, such as the environment (Sternberg, 2003 p.152; Claxton, Craft & Gardner, 2008 p.29; Craft, 2008 p. 8). This leads to the humanizing aspect: to use creativity for a greater common good.
WHC provides a structure of behavior to use in observing the workshop-participants. I chose WHC as a theoretical approach for three main reasons. It is a good way to recognize, observe and analyze the structures of creativity. Also the GSO´s theoretical foundation is based on

[20] The supportive safety in en educational setting may be compromised if the students feel that they are performing under a constant state of evaluation.

WHC[21]. In addition, the wisdom-induced theory can easily related to the wisdom-induced practice of ecology.

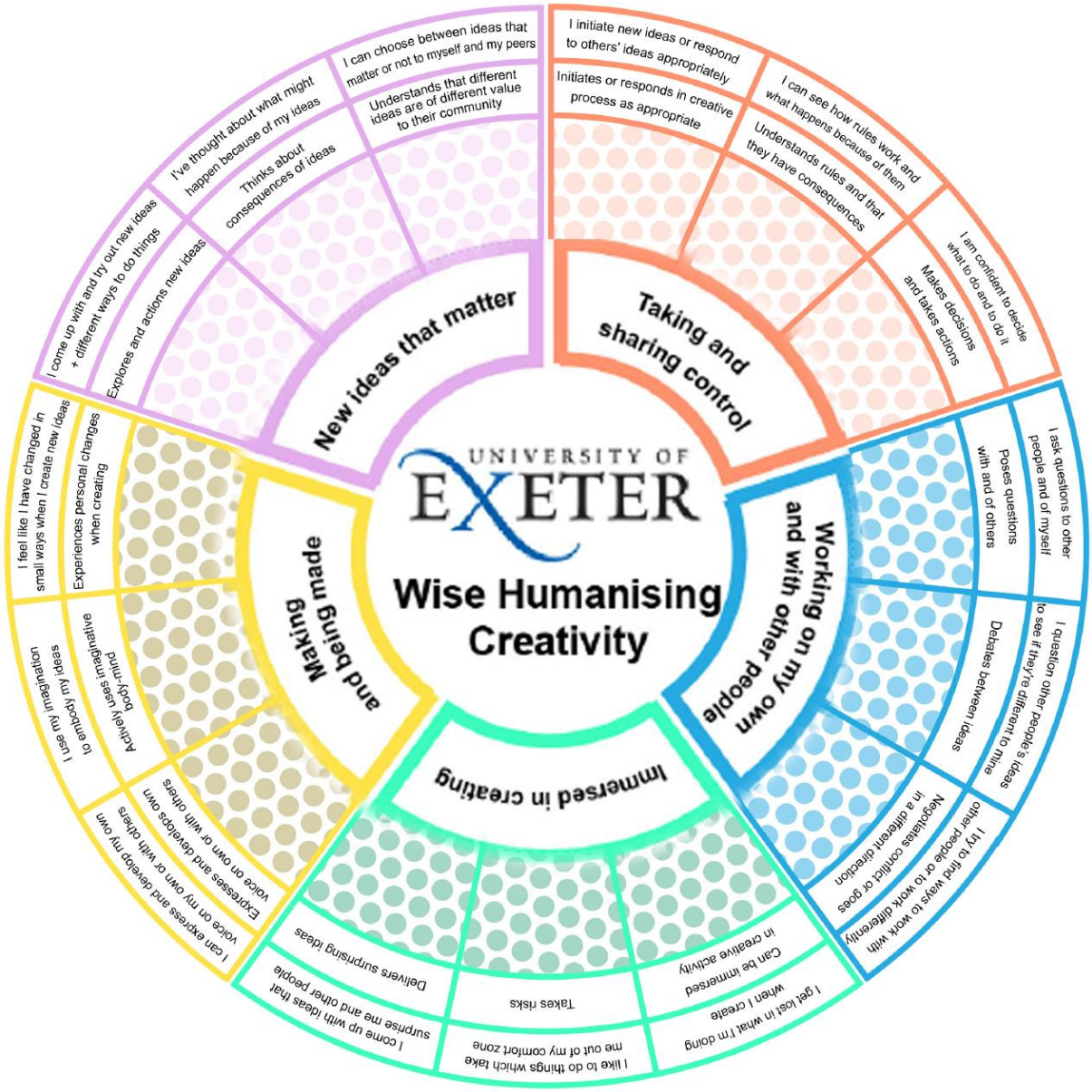

Figure 3: The Wise Humanizing Creativity wheel, K. Chappell, 2016 (slightly altered to make it more readable)

[21] As well as Possibility Thinking

Ecoscenography – theories of holistic sustainability

Ecoscenography derives from Deep Ecology and includes elements of eco-design.

The historical background

Our western view of and valuation of the planet on which we live is deeply influenced by a mechanistic perception of values. Gradually it has been shaped through the last 500 years, reinforcing industrialism, ground through commercialism. The latter views the world as a large piece of machinery, where everything can be used for human benefit – it can be sold, bought, built, torn down and fixed again. This view advocates that living and mechanical systems can be approached in the same way- as a collection of parts that can be studied and repaired separately. Humans rule nature, and nature can be useful in producing things that will improve our day as a human being. This has resulted in a great deal of technological development and an economy that largely ignores growth limit (Hes & DuPlessis, 2014, p.23-27).

What is Deep ecology?

Deep ecology brings together spirituality, thought and action in an ecological philosophy (Johnstone, 2017). Presented by Arne Næss in the 1970s, it advocates a holistic view on how everything is interconnected. All life is part of a bigger whole and has equal worth and a right to thrive. Man is not separate from nature, but a part of nature, in a tightly woven relationship. In fact, we *are* our own eco-system, with more bacteria living on and in us, than we have DNA-cells (Hes & DuPlessis, 2014, p. 28). Man is not the ruler of nature, but a piece in the big puzzle called life on Earth; hence he is not free to exploit or suppress other life-forms for their potential usefulness for him. Diversity of non-human life creates a healthy ecological wealth. However our species is continuously growing, polluting, over-consuming and depleting natural resources. We should seek a high life-quality rather than a high life-standard (Næss in Drengson & Inoue, 1995, p. 3-9; Næss & Sessions in Drengson & Inoue, 1995 p. 49-53). Meaning we should focus on creating a happy life for ourselves and those around us, rich in experience and joy, rather than aiming for an excessive life-style of material and monetary wealth.

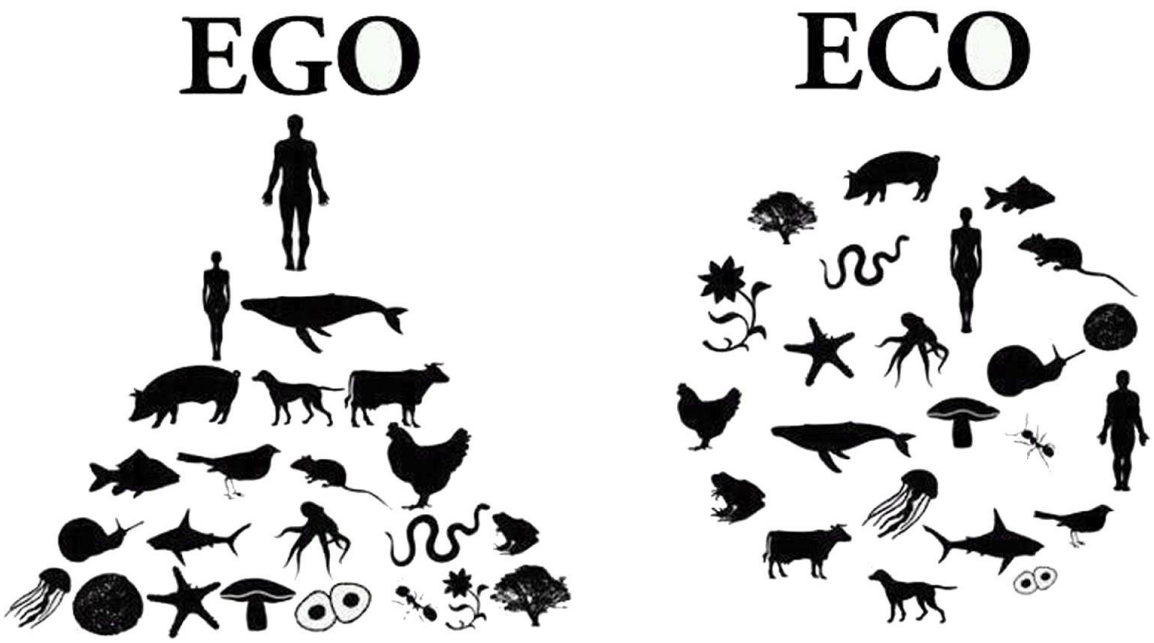

Figure 4: Man above nature versus man in nature (illustration from EcoHustler[22], no known copyright)

According to deep ecology a fundamental political change needs to take place - ideologically, economically and technologically (Næss & Sessions in Drengson & Inoue, 1995 p. 50). Global collaboration is needed to reach this greater goal. For example, climate change is ignorant of national boarders, pollution doesn´t carry a passport. Local and regional differences should influence policy, but the global society in general, and the rich (over-) developed countries especially are obliged to take responsibility (ibid. p.49-53). Change is the one constant, inevitable and necessary for development, everything is in one endless "process of becoming" (Hes & Du Plessis, 2014, p.29-30).

A self-sufficient society is more sustainable as it will use fewer resources and maximize the outcome with less bureaucracy and flatter democracy. This in turn requires a change of world-views from a mechanistic to a holistic, ecological view (Naess & Rotheberg, 1990; Næss & Sessions in Drengson & Inoue, 1995 p. 49-53). Finally the deep ecology platform principles appeals to commit to an active life-style change, to practice what one preaches (ibid. p. 49-50). Deep ecology and Næss´ philosophy has inspired scientists, engineers, environmentalists and others for the past 4-5 decades. Among these are a generation of designers.

[22] http://www.ecohustler.co.uk/2011/06/18/from-ego-to-eco-a-new-sense-of-self/

What is Eco-design?

Eco-design is a common term describing design that takes into account the whole life-cycle of a product, considering environmental consequences from material resource-extraction, production, use, to the after-life. Inspired by nature itself, it seeks to eliminate the concept of waste. Eco-designers attempt to make the things we need with the thought in mind that nothing ever goes away (McDonough & Braungart, 2010).

Recognizing today´s wasteful practice of use-and-discard, the first step is to limit our consumption (eco-efficiency)[23]. But eco-design takes this one step further, positing that every product should also have a positive environmental outcome[24] (Beer, 2016 p.47).
This is achieved by making products as clean as possible: materials, production, energy-use, short travel, easy to disassemble and recycle, healthy to use and finally degradable. High-quality materials and craftsmanship makes a product last longer and reduces waste. It is also essential to keep natural and technical materials apart, as they contaminate each other's metabolisms when degrading (McDonough & Braungart, 2010). Considering the product´s complete life cycle at the design-stage, makes it easier to make a genuinely good product, not just a better version of a bad one (ibid.).

The Cradle-to-Cradle-model shows the ecological concept of complete and healthy life cycles on man-made technical and biological degradable materials, and how they should be produced, used, dismantled and recycled, time and again.

[23] First introduced by the World Business Council for Sustainable Development (WBCSD) in 1992
[24] As a consequence of development already exceeding the earth´s ecological carrying capacity (Birkeland in Beer, 2016 p. 48)

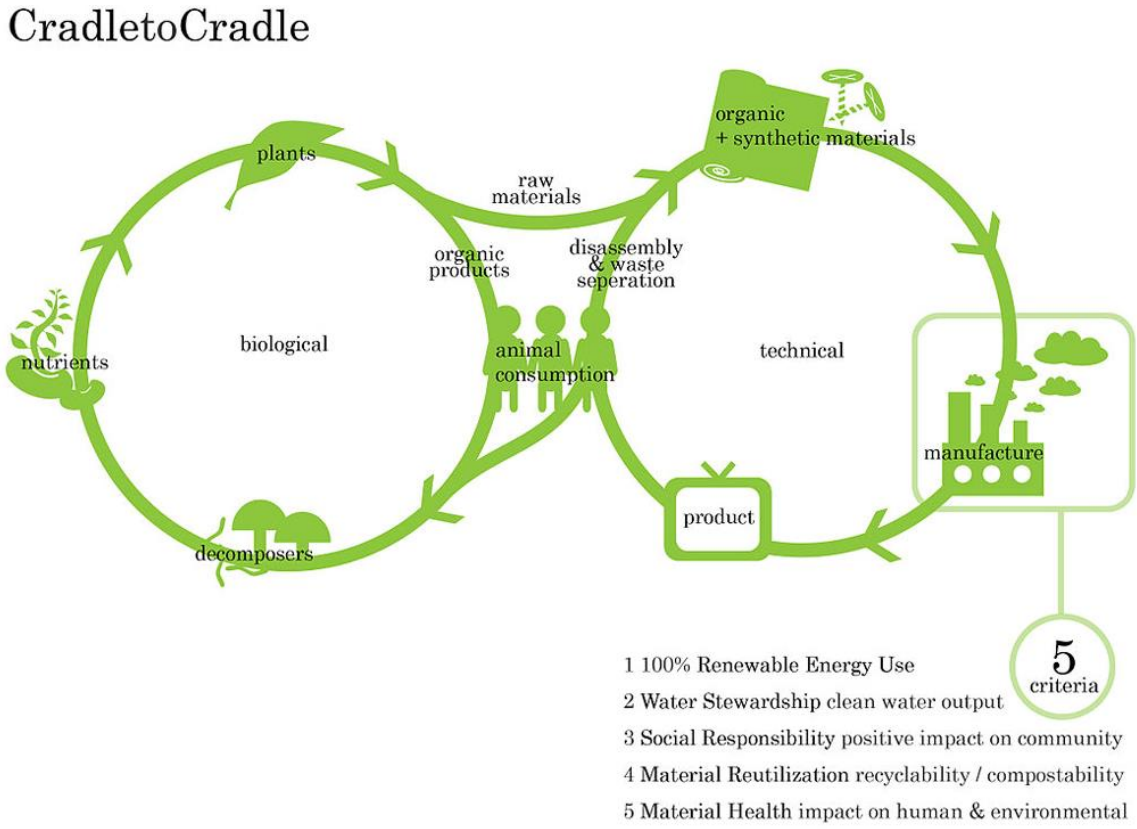

Figure 5: Cradle to cradle, the life cycles of biological and technical nutrients[25], Copyright: WikimediaCommons.org

There have been several attempts toward establishing a foundation for sustainable design. Datscehpski presents a set of principles:

- The materials used should be cyclic, which means, they should be grown, recyclable materials, which finally deteriorate back to nature.
- All energy used in production should be renewable, be it solar, wind, water or waves.
- It should be safe, as in non-toxic, both to humans and nature.
- It should also be efficient, using the least amount of materials and energy.
- And finally, it should be social, good for people, for consumers and workers. A sustainable production should be a win-win-win situation. Where we optimize the benefits to the economy, to society and to the environment (Open University, 2009).

[25] https://commons.wikimedia.org/wiki/File:Biological_and_technical_nutrients_(C2C).jpg

What is Ecoscenography?

Ecoscenography is an environmentally friendly approach to theatre design, pioneered by Tanja Beer. Rooted in Næss´ deep ecology philosophy, and inspired from eco-designers in all fields of life, Beer has taken sustainability into the theatre. Her five guiding principles present a way of thinking about scenography that encompasses both ecological and creative potential (Beer, 2016 p.170).

Beer presents five guiding eco-principles (Beer, 2016 p.171):

1. Embrace ecological design as a starting point and opportunity. The eco-creative process is recognized by thorough planning, designing with several life cycles in mind, giving special attention to materiality and processes. This "reinvention" of the world is dependent on innovative creativity (ibid. p.172-175).

2. Allow opportunities for serendipitous and place-based responses. Keeping an open mind and utilizing local resources, both human and materialistic, may lead to unique creative solutions, including opportunities for trans-disciplinary practice and community engagement (ibid p.177).

3. Acknowledge ecological complexity in overcoming sustainability assumptions and challenges. Considering a broader socio-political ecosystem, which relates to contributive practice will challenge preconceived ideas. It also requires an education in eco-literacy, sustainable materials and processes (ibid. p.178-179).

4. Scenographers are change-agents that can empower and catalyze ecological collaboration. "Practice what you preach" through sharing, engaging and collaborating with others. Taking a leadership-role in building awareness of sustainable issues, even considering using the stage as a platform to showcase ecological potential (ibid. p.180-182)

5. Go beyond the transient in pursuit of positive social and environmental contributions. Engage with "the world beyond theatre" by inviting the audience or community to participate in creating the Ecoscenography (ibid. p.182-183).

The principles may provide a basis for a pedagogical framework, but are not intended as a sustainability checklist (ibid. p. 170).

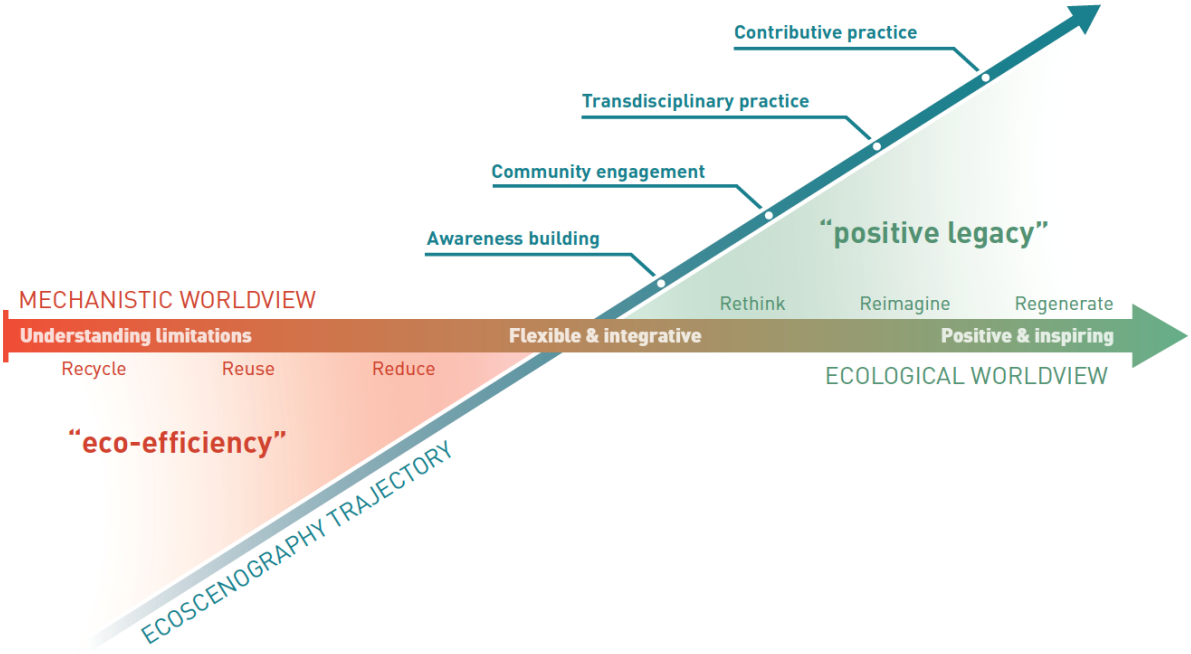

Figure 6: The Ecoscenography framework, Tanja Beer, 2016

The figure above represents Beers Ecoscenography framework-model, showing the way "from limitation to liberation". It presents the gradual evolvement in ecological thinking and practice and how they interconnect.

The model shows how the eco-efficiency -"motto" of re-duce, re-use, re-cycle based on a mechanistic worldview focusing on reduction is replaced (Hes & DuPlessis, 2014 p.23-25; Beer, 2016 p.23). Sustainable innovation is an ecological worldview that suggests a more positive and inspiring legacy than eco-efficiency. The new motto is re-think, re-imagine and re-generate. The focus is on the possibilities instead of restrictions. It achieves a positive legacy by building awareness, engaging the community, and practicing trans-disciplinary and practical contribution through an ecological worldview (Beer, 2016 p.59).

Beer´s eco-scenographic framework-model and her guiding principles will serve as a basis for my fieldwork.

What is the Global Science Opera?

> *"The GSO vision is to create annual Global Science Opera productions during which a global community will explore interwoven science, art and technology within a creative and democratic inquiry process"* (globalscienceopera.com, 2016).

GSO is an international collaboration between the fields of science, arts, education and ICT[26]. The goal is to create a meeting-point that stimulates the curiosity common to science and arts. Students from elementary to university, scientists, artists and teachers collaborate in exploring a scientific topic before immersing themselves into the opera production-process of theatre, dance, music and design. By merging the creative processes from the arts-fields with the research from science, a fusion arises: the Global Science Opera.

The method is basically democratic in allowing all students to speak their ideas, and collectively choosing which way to apply them. It is a co-operation in research and practice across cultural borders. Schools from different countries participate in both local and international implementations. The scenes created around the world are assembled, and the final opera premieres through real-time live streaming onto the worldwide stage of the internet (globalscienceopera.com, 2016; Ben-Horin, 2017 p. 3). Initiated through collaboration and brought to life at HVL in 2014, the GSO shares much of its methodology with the similar interdisciplinary work of Write A Science Opera (WASO)[27]. WASO in turn builds on the Write An Opera method, originally developed at the Metropolitan Opera in New York, before further developed by the Royal Opera House in London (Ben-Horin, 2014 p.5). GSO is a new initiative, using existing theories like WHC. There is no GSO-theory per se today, but this thesis may contribute to a part of this development.

Through the practical process of actually making an opera, the students learn hands-on artistic skills on how to compose and play, to choreograph and dance, to direct and act, to design and make scenography. First and foremost the GSO promotes creativity, through process-driven work. Students experience how scientific research unfolds through an

[26] Information and Communication Technology
[27] WASO = Write A Science Opera, A creative approach to science and art inquiry in schools http://prosjektsider.hsh.no/waso/the-training-course/

introduction to inquiry-based science education (IBSE). It is designed especially to increase students´ interest in science and mathematics[28].

The GSO teaching-material is intended to be adjustable and accommodate local variables like age, language, geographical and cultural differences, and adaptable to different scientific themes. The challenge is to jointly implement the methods of Ecoscenography and GSO with a sustainable and robust design adaptable to all these variables on a global scale, systematic evaluate the outcomes and conduct research that may be helpful in applying it (Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006 p. 16). Below is a model attempting to visualize the core values of the GSO.

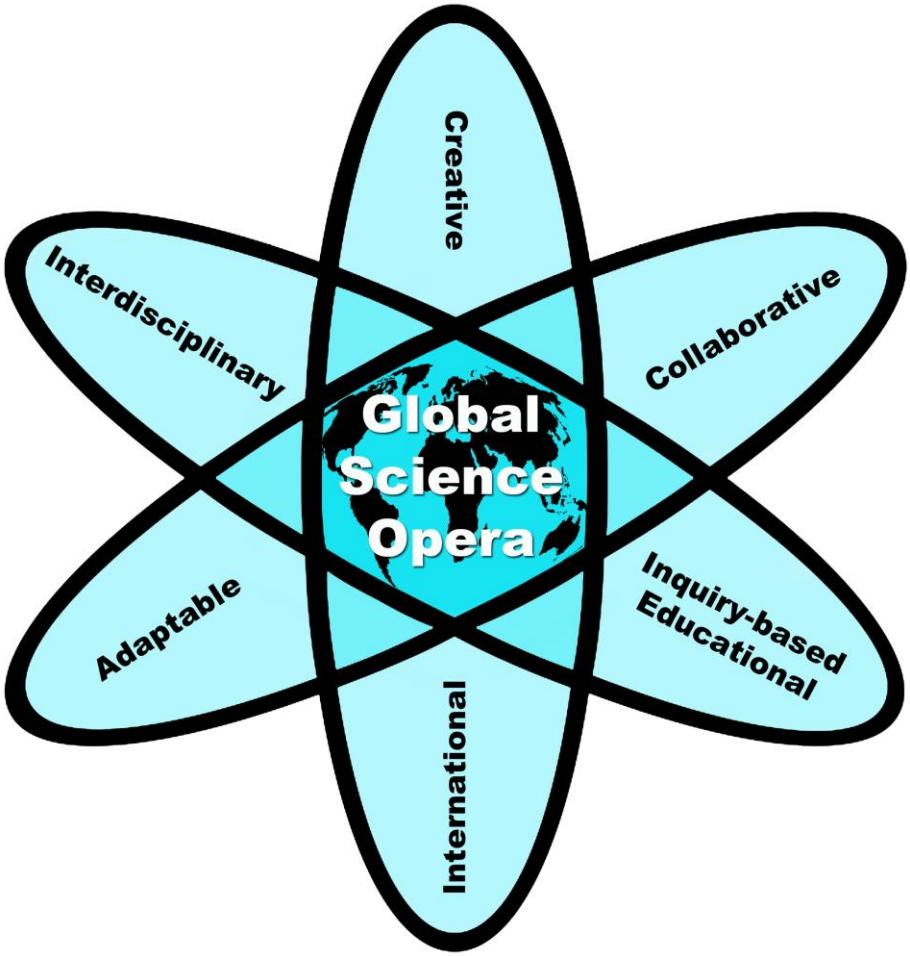

Figure 7: The core values of the Global Science Opera initiative, Janne Robberstad, 2017

[28] . This study does not provide scope to fully explain the extent of IBSE. More information can be found here: Rocard, M. (2007). Science Education Now: A Renewed Pedagogy for the Future of Europe (pp. 20). Brussel: High Level Group on Science Education, Directorate General for Research. *Science, Economy and Science, European Commission*. http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf

Research Design and Methodology

All research is dependent upon the common understanding of the methodology on which the research has been designed. This chapter presents the methodology and methods utilized in working with this thesis. This includes the practical approach of designing the workshops and the more theoretical approach of designing the written thesis. The chapter also looks at some of the pros and cons of the methods and explains why they were chosen.

Methodological theory

Qualitative research and interpretation

As mentioned, this thesis investigates how creativity unfolds within the implementation of two relatively new fields through practical, creative workshops in an educational setting. With no prior research directly focused on these areas together, an in-depth qualitative research will help to better understand this introduction (Bogdan & Biklen, 2007). This process is guided by observing the different circumstances in the interventions, looking for similarities and differences. This understanding will be founded in my interpretation of the empirical data, which in turn is influenced by my own socio-cultural background, my beliefs and lived-life experience (Kinsella, 2006). I have chosen Educational Design Research as an approach to the previously described research-area.

Educational Design Research

Educational Design Research (EDR) is a genre of research characterized by two equal contributive goals. The first is to actively seek solutions to educational problems through interventions in cooperation with stakeholders and to make a positive change in the real world (McKenney & Reeves, 2013, p. 7-31). The second is to acquire knowledge or theoretical insights and provide a fundamental scientific understanding which in turn results in developing new theory available and helpful to others in similar situations (ibid). EDR seeks to build a bridge over the gap between theory and practice by merging the best of both traditions, through a continuing process of gradual improvement through iterative operations. Knowledge and experience gained in one intervention recommends the improvements in design for the next intervention.

There are several ways to conduct EDR. The core process to be employed has four steps. (1) Analyze and explore, (2) design and construct, (3) evaluate and reflect, and finally (4) implementation and spreading of information. In the process, one might go back and forwards several times, gradually improving the design and fieldwork exploration (McKenney & Reeves, 2013, p. 76-81; Open Universiteit, 2013)).

Attempting to implement the new core-value of sustainability into an existing project like the GSO, requires iterative investigation, and EDR represents a good way of guiding this investigation. This thesis thus describes a purposefully sequential research process during which a small, iterative series of pilot studies were conducted. After evaluating the results at each step, the specifics are modified from one setting to the next depending on the findings. For this research a test-project in Norway and two workshops, in Japan and the USA, have been conducted and have provided substantial empirical data.

EDR Challenges

The researcher has several roles – acting as a designer, developer, observer, facilitator, and analyzer – roles that may conflict (DesignBasedResearch, 2011). Accordingly the researcher must be aware of these sources of bias, particularly as one is not only conducting, but also evaluating the process. Filming the workshops enables participation as workshop-leader and subsequent iterative observation and evaluation. Multiple observers were present in both workshops, supplying valuable information on their observations.

The GSO project and the Ecoscenography workshops are interventions into the regular school-schedule. Such intrusions into educational situations require engaged collaboration with teachers and perhaps other stakeholders. In Japan, the 3-day workshop was a combination of a theatre- and an Ecoscenography workshop. By the end of the course we had the communally created theatre-scene[29] acted in front of the sustainable scenographic set. In the US, the students met once a week during a year to work with the opera, and the Ecoscenography workshop was a 4 hours intervention halfway through the school year.

[29] Scene 2 in the 2016 opera ”Ghost Particles”

The GSO-methodology

All GSO workshops are inquiry-based science educational, with equal emphasis of science and arts. The creative process is essential, cooperative and democratic. The collaboration is international and is respectful of cultures and is adaptable to local variables.

Methodological practical application

The practical EDR-contribution is to design a good basic method for an Ecoscenography workshop, incorporating the core values of the GSO methodology[30].

The Ecoscenography workshop

A short test-project[31] at HVL[32] advised the design of a common introduction to the field of Ecoscenography: a presentation explaining the subjects´ complexity and simultaneously inspiring the creativity. The implementation of the workshop in Japan highlighted the importance of clarifying the core elements and the significance of applying the participators creations on stage. The workshop in the USA demonstrated the benefit of tightening the structure of the initial lectures and starting the hands-on creative process earlier, but still supplying all the necessary guidance.

Methodological theoretical application

The knowledge acquired through this research, presented in this thesis, is freely available to anyone interested in working with sustainability in the GSO, or similar educational interdisciplinary projects. The results will also contribute to the Norwegian Research Council´s newly established project, "Integrating Science in Oceans, Physics and Pedagogy (iSCOPE)" in which Western Norway University of Applied Sciences is a partner (BioCeed, 2016).

[30] WASO is a local self-determined version of a science-themed opera, GSO is the international collaboration.
[31] A 1 hour micro-workshop took place at Global Hands On Universe/ Galileo Teacher Training Program-conference, August 2016
[32] Western Norway University College of Applied Sciences, Stord, Norway

Data collection and approach to analysis

The data has been collected in Norway, Japan[33] and USA in the form of questionnaires, formal and informal interviews and observations made by others and myself. This was transcribed before being coded and analyzed. The codes were applied based on two sources. One was core themes of the WHC, Ecoscenography and GSO. The second was based on interesting findings that appeared and emerged from the data as I was analyzing it. While going through the data, interesting findings appeared that were outside the original codes, and new codes were added. The organic process of EDR, going back and forth several times, gradually changing and improving is accurately descriptive of this process.

A short time before delivering this thesis, the facilitating teacher in Japan kindly shared his quantitative research results. He asked his students the same questions before and after the workshop, making it possible to compare potential effects of the workshop, and in which areas the students felt they had an outcome in learning or interests. The results reveal interesting data which is potentially relevant, but there is not enough scope to bring it together methodically with the qualitative research. However they add much value to the field of this study, and I have attached them in appendix #1.

The samples of informants

The data collected in this research comes from three main sources: the participants, the observers and the external experts. 40 participating students answered a structured written interview with open-ended questions[34]: 26 from Japan, 14 from the USA (Bertaux, 1981). The US-students also participated in a filmed, oral interview the day following the workshop. All students were in the age between 14 and 18, attending middle-high and high school.

The nine observers were a combination of teachers, scientists, translators and facilitators, eight of whom answered a written questionnaire[35]. One observer shared her observations through a filmed interview. Informants/observers represent the fields of science and arts, education, administration and research. Before the workshops took place, they were asked

[33] During data analysis it became obvious that some challenges do exist with regards to interpretation of the data, which had been translated from Japanese to English. I have chosen to bring the data here as it was translated.

[34] Appendix # 2 show the questions the students were asked

[35] Appendix # 3 show the questions the observers were asked

to pay special attention to situations where creativity took place and if interesting questions regarding creativity, sustainability or their own field of expertize appeared. In the US, three of the observers also had roles as teacher-assistants, helping the groups artistically in the respective fields of set painting, lights and costumes. The data also includes my own reviews as a participative observer (Fangen, 2010). The multitude of data collection methods, ensured overlapping and a manifold of expressions. The external experts are Tanja Beer, eco-scenographer, and Dr. Bernard Foing, ESA rocket scientist and astrophysicist, whom have also either been interviewed on film or has shared knowledge through personal written communication.

Country	test-project **Norway**	intervention 1 **Japan**	intervention 2 **USA**
date	August 2016 .	October 2016	January 2017
age	ca.25-65	15-17	14-18
number of participants	13	26	20
participants structured written interview, open-ended questions		26	14
participants oral interview	feedback given in plenary		14
filmed observation of participants	filmed feedback session	most of the workshop	part the workshop, most of the evaluation
observers structured interview, open-ended questions		2	7
observers filmed oral interview			1
participants questionnaires, before and after workshop		26	

Figure 8: overview of data-collection process; blue notes are attached in appendix # 1

The fieldwork (iterations)

The fieldwork consisted of two iterations. This was preceded by a small test-project that gave me valuable feedback on which to build the workshop-design. The GSO-project operates in 30 countries, and its learning material needs to be applicable and adaptable to all of them. I believe it is a strength for this research that the fieldwork took place on three different continents, which allowed for some cross-cultural comparison. Japan was chosen because of its rare combination of a long aesthetical tradition combined with its long history of technological innovation. In contrast, the USA is perhaps one of the most commercialized consumer-based countries in the world, also making it very interesting to see how eco-design would be welcomed here.

The groups in Japan and USA were selected on the bases of already being participants in the GSO. Prior to the workshops, the local facilitators/GSO-contacts/teachers had attended the test-project at HVL. In the aftermath, e-mail contact was established in order to plan and inform about the workshops.

The content of the workshop was based on the principles of Ecoscenography and GSO, and designed by the workshop-leader. The privilege of conducting research allows one to define the structure of the fieldwork, in this case how to build a practical framework for a workshop, which will serve and enrich the GSO. The choice of focusing on set, costumes and lighting were taken, as they are essential in making any staged show. Make-up, hair, props and PR are in this context less vital, and have therefore been excluded in this round.

The test-project

During the GHOU[36]/GTTP[37]-conference at HVL[38] in August 2016, I conducted a 35 minute micro-workshop in GSO Ecoscenography. Thirteen adult participants from 5 continents, mainly educators and scientists, participated in three group activities: set-, costume- and lighting-design. Participants were presented with renewable "building blocks"[39] of natural materials, which could be varied in endless combinations (Sawyer, 2011 p. 297).

Photo1: Bamboo as building-blocks for the set and natural fabrics for draping costumes, used in the test-project and in Japan

The tools and equipment were kept low-fi to advocate against the need for advanced, expensive technical equipment. This test-project showed the importance of a structured and visual presentation to the field of Ecoscenography, explaining the complexity and inspiring the creativity. The participants highlighted how the GSO-project engages people with different learning styles and interests through its many entry-points. Direct feedback demonstrated the integration of sustainability as a new factor into the GSO-project. One astrophysicist said:

> *"We were amazed how well the bamboo-structures worked, how quickly they came up, recyclable, you can use them in the next opera. Somehow getting a structure like that, it´s both metaphorical and literal in it´s power, doing things like that."*

[36] Global Hands-On Universe (GHOU) joins efforts from all around the world to train teachers on the use of modern tools and resources for science education and engage students in international scientific projects. http://handsonuniverse.org

[37] The Galileo Teacher Training Program is a global network of astronomers, educators, teachers and students reaching more than 100 nations. http://galileoteachers.org

[38] Western Norway University College of Applied Sciences, Stord, Norway

[39] Inspired by LEGO blocks, that can be made into almost anything. The LEGO company also has an internal policy of creative sessions for their employees which they have "exported" to other companies as consultants.

Photo 2: The lighting-crew scientists from GHOU/GTTP experimenting with overhead projectors and colored filters

Photo 3: Constructing the Proxima B-landscape with bamboo building blocks, and draping the sun´s costume at the GHOU/GTTP-conference

Japan – the first iteration

The first real workshop took place in a large high school near Tokyo, Japan in October 2016. It was a three-day workshop conducted over a weekend. The 26 students, aged 16-18, were involved in either a drama-group or a music-group. Their science-teacher and a visiting astrophysicist, who verified the accuracy of the science, accompanied the group. In addition, a teacher/translator and a music-teacher were present most of the time.

After a general introduction to the GSO, day one was a four-hour theatre-workshop, where the students collectively created a two-minute scene for the "Ghost Particles"-opera[40] 2016, based on the WASO/GSO-methodology. Day two was a five-hour Ecoscenography workshop. The first part of the day, participants were divided into two groups: lighting and set. The lighting-group experimented with smaller low-fi equipment[41] as well as professional theatre-lamps in the drama-room. The set-group designed an abstract outdoor-scenery with bamboo-sticks and washi-tape[42]. By taping the sticks together in triangles, they built shapes that could be assembled in different configurations. Regrouping into four new groups, the students experimented with different approaches to costume-design[43] in order to test which approach was preferable. Finally, on day three, we put it all together, filmed the scene for the GSO-opera and conducted an evaluation-session.

An informative Power-point presentation had been prepared for the students, introducing the GSO and Ecoscenography. Because of students' limited knowledge of English and their modesty, translating the entire workshop was necessary. This immediately demonstrated the importance of clarifying the essential core of the contents. Ecoscenography is a complex field that includes several areas of expertize, even thought the prime message is relatively easy to understand. Making an informative and inspiring introduction might stimulate the

[40] The science-theme for the 2016 GSO-opera was named "Ghost Particles", inspired by CERN´s work on particle physics, Higgs boson, photons and neutrinos.

[41] Easy-accessible equipment at schools: overhead-projectors, flashlights, mirrors, colored filters, prisms, water and inks

[42] Bamboo is a short-travelled, natural and locally grown material. Washi is an easily removable paper-tape, which simplifies the de-construction. The bamboo-sticks are space-efficient, can easily be stored and reused again and again, as building blocks in ever new constructions.

[43] The groups had a) 5 meters of woven cotton fabric to drape b) 5 fabric-pieces of 140x25cm to assemble into a garment c) origami-inspired folding of washi-paper and d) cutting and taping washi-paper to shape a garment

students to further investigate the subject. The feedback also identified the importance of applying the participators creations on stage[44].

Photo 4: Japanese students assembling bamboo-set, photo: my Japanese teacher-colleague[45]

Photo 5: "Joao" meets "Little girl", acting the scene in front of the bamboo-set

[44] Unfortunately none of the costumes the groups made were used in the filmed scene.
[45] The agreement with The Data Protection Official for Research, Norwegian Centre for Research Data, prevents me from revealing his name and giving him proper credit, in order to protect the identity of his students.

USA – the second iteration

In January 2017, the second intervention took place in a high school near San Francisco, USA. Twenty students, aged 14-18, all members of the school´s science-club, participated in a four hour Ecoscenography workshop. The science-club met every Tuesday, and was already working on their contribution for the 2017-opera "Moon Village"[46]. The project-introduction took an hour. Then the students divided themselves into three groups, working respectively with set-, costume- and lighting-design. The set-group made their own egg-tempera-paint before starting to paint a big backdrop for the set. The costume-group sub-divided in two groups, where some of them learned to crochet old cut-apart T-shorts. The second group made a solar-paneled "protective poncho". The lighting-group struggled with a scarcity of equipment to work with, but being a resourceful group, they used a video-projector as their main lighting-source, constructing a site for experimenting.

Photo 6: The US lighting-group experiments with a video-projector and ink in water

For the practical workshops, I had help from three fellow master-students, who were participating a nearby conference. I had prepared the activities and tasks at hand, and the helpers were informed and had prepared to be a creative resource for their respectively

[46] The science –theme for the 2017 GSO-opera is "Moon Village", inspired by ESAs vision of building a permanent space station on the moon.

group-activities. This served two purposes: 1. To see how the Ecoscenography material was "teachable" for other teachers and 2. To allow me to be an outside-observer.

In addition to myself, other observers include an astrophysicist who leads the science-club and four Norwegian observers interested in IBSE interdisciplinary work. Coming back the next day for the evaluation allowed more time for practical work in the course.

The workshop in the USA yielded information on the introductory-lecture. This demonstrated that the hands-on creative process should start earlier in the course, but not at the expense providing adequate introductory material. Unfortunately, not all participating students could attend the next day´s evaluation-session.

Photo 7: The US costume-group transforming old T-shirts into crochet costumes

The Ecoscenography principles inspired choosing the materials the students worked with, local ecological resources, bamboo in Japan and the egg-tempera pigmented with soil[47] in the USA. The assignments in costume in Japan were focused on how to exploit the fabric best, in the US the focus was more on how to reuse and recycle. The lighting-groups had the same assignments, but access to different equipment and working with different scientific themes, led to different creative expressions. Ideally students would be involved in this choice-process, but time did not allow for it.

[47] The most basic form of organic paint: eggs mixed with soil. We had a recipe as a starting-point: 50% egg-yolk 50% natural pigments. The students used the soil outside the classroom as a pigment, in addition to a batch of paprika-powder. Also they experimented with using both yolk and white, even the egg-shells (to add texture)

The groups in Japan were decided randomly by numbers, in the US, the students decided themselves which group they wanted to attend. The activities took place at their respective schools.

Both workshops were independent introductory courses. In Japan the students produced set and lights used in the filming of their scene the next day. In the US none of the products were finished during the workshop, and would be continued to be worked on. Their premiere was not until 11 months later, so they have the time on their own to finish and develop the results.

Photo 8: US students embodying the egg-tempera painting

The two workshops in Japan and the US were separate in time and had different practical student-assignments. The Japanese intervention influenced the design of the US-intervention. The US intervention resulted significant more data being acquired. This is mainly due to the addition of oral interviews and more observers in the US.

Diagram of the EDR process

The illustration below illustrates my educational design process, albeit symbolically.

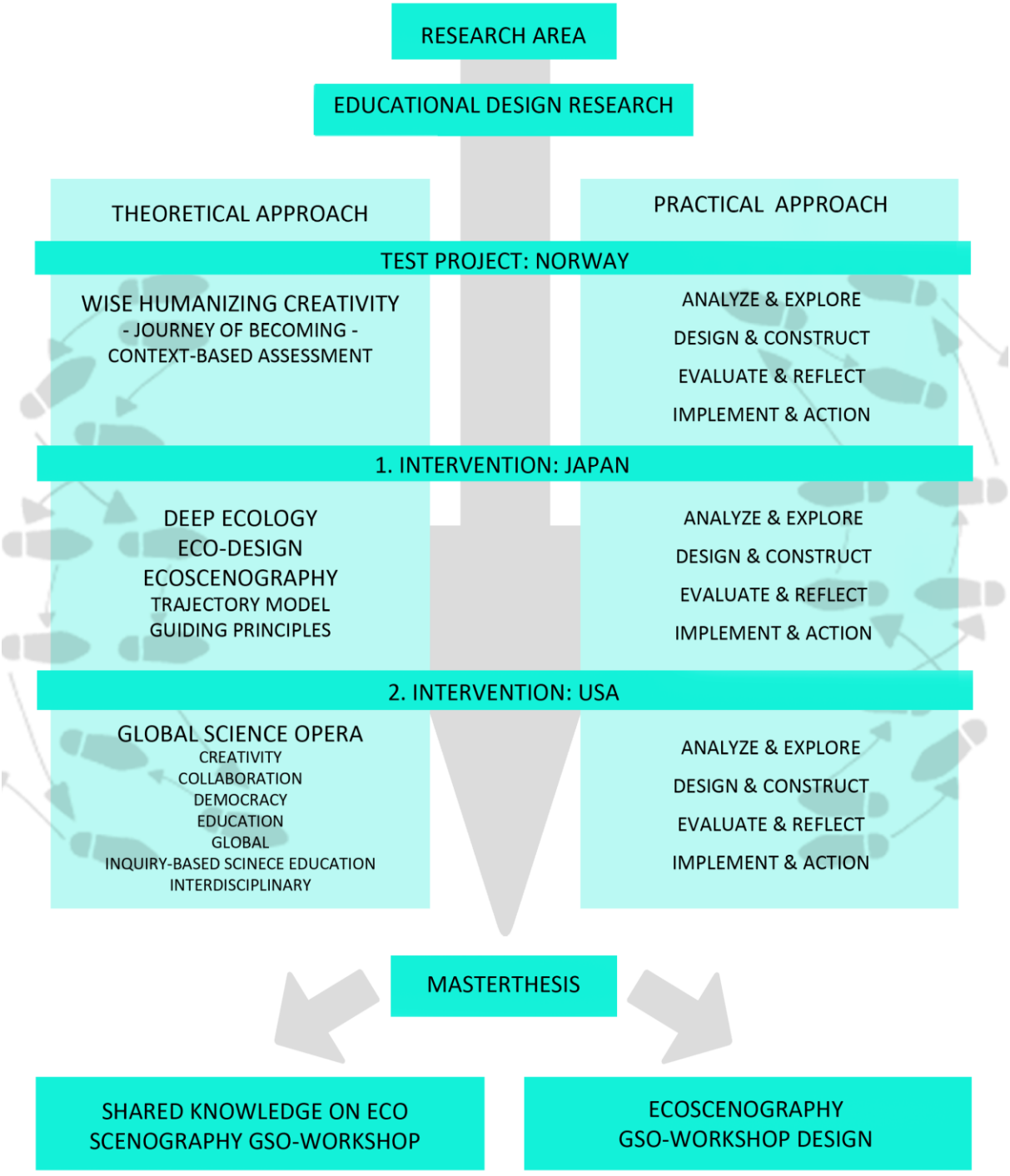

Figure 9: A symbolic model to illustrate the EDR-dance: going back and forth between the core steps of educational design process

Data Analysis

Coding

In order to analyze the collected data, it needed to be coded for classification or identification of behavior I was looking for. Examining the written records, it was possible to identify observable behavioral items that could be assigned to 98 different categories. The categories can be assigned to major elements of this study, namely WHC, Ecoscenography, and the GSO.

The data analysis software, "HyperResearch", facilitated this study. It is a commercially available software tool that will permit systematic evaluation of the observational data. It enables coding and retrieval of source material, (be it text, photos, audio or video) theory building, and data-analyses (researchware.com, 2016). It is an easy-to-operate tool that proved helpful when trying to keep track of a large amount of data. The researcher is free to define the codes, and when and how to apply them according to her own interpretation. Whenever relevant information appears in the data, it was marked by a code. When sorting for findings, it was easy to find all data connected to this particular informational topic. Patterns or themes can be seen by comparing and continuously revisiting all the coded data, be it repetition or something unusual.

After identifying the core values of Wise Humanizing Creativity, Ecoscenography and the GSO, Hyper Research helped me organize the coding of all these findings. As an example, WHC is a theory of explaining, articulating or describing creativity in education. By specifying features or concepts which are typical of WHC theory, it is possible to identify signs of behavior that may contribute in understanding and analyzing the creative process: students asking questions, collaborating or expressing experiences that made them feel different are all signs of creativity according to WHC. When coding the data, other interesting themes emerged in the material, and I assigned additional codes for these. For instance, when coding the data from Japan, "Communication" presented itself as a code. This code included translation-issues, language-barrier, miscommunication and the importance of clarifying the message.

A clarification regarding the coding of Ecoscenography

As mentioned, Beer´s overview of the gradual evolution of the human ecological consciousness is described in her Ecoscenography framework-model. It represents both modes of thinking and of practice, moving from eco-efficiency towards a positive legacy. The framework-model is a good tool for researching an Ecoscenography practice over time. Her Ecoscenography principles build on this model, showing how the gradual ecological "awakening" can be put into practice. Since the workshops were designed for shorter educational interventions, where the participants hardly had the possibility to move beyond the novice-level of "building awareness", the analytical tools will follow the principles rather than the model. To the degree that students move further along the trajectory, it will be picked up when looking at the principles. This choice will be elaborated upon in the discussion.

Ethical considerations (consent and approval)

All participants and their parents have received information about the research, and have signed forms of consent. All participants and observers are anonymous, except the experts. All data will be destroyed after the research is concluded. The Data Protection Official for Research, Norwegian Centre for Research Data has ethically approved the collection of data for this thesis.

Analysis-results and findings

The findings are presented in three main sections. These sections relate to the three areas of the theoretical framework: WHC, Ecoscenography and GSO.

Findings connected to Wise Humanizing Creativity

Chappell et al five indications that help identifying a creative process, also allowed me to identify relevant findings categorized into these themes (Chappell, Craft, Rolfe & Jobbins, 2012). In many real-life situations, these tend to overlap each other.

1. Making and being made

Making and being made emerged as a clear tendency in the data (Chappell & Hathaway, 2015 p. 1-12). It might be difficult to recognize the developing of one´s own expression, embodying ideas, and noticing *changes* in oneself through self-reflection, however some students did just that. As a Japanese student expressed it:

> *"I noticed I can [do] anything that I didn't know I could".*

A fellow student reported the positive experience of feeling achievement by being part of something bigger than him self, referring to the global aspect of the GSO. Another example from Japan is a student who expressed how the creative process challenged her to overcome her shyness in cooperating with other students.

A US-student indicated that the process made her more open-minded to ideas, explaining how by connecting science to art, she got a new appreciation for science.

> *"It makes me more open-minded to ideas, because when you live in certain societies like ours, they give you some ideas that you´re supposed to keep about science, like "Oh, it´s just to figure out stuff and nothing else". But then you think, "Oh, if I apply this scientific thing to something I like, like music or art or anything in general". It makes me like think more."*

A Japanese student sums it up in her definition of what the creative process is:

> *"To grow up myself."*

2. New ideas that matter

The theme of new ideas that matter emerged as a major tendency, mainly with regard to Ecoscenography (Chappell & Hathaway, 2015). Both in Japan and in the US, students welcomed the general idea of sustainability, realizing its consequences for the environment.

In Japan the idea of using bamboo-sticks as constantly re-designable set-pieces, was commented in positive terms:

> *"To make something that we can use again and remake [as] other things".*
> *"It's new to reuse and create by using something that we always throw away when we [have] use [it] once."*

In the US, students used their imagination when deciding which properties a costume should have to make it functional for moon-wear. And at the same time reflecting over the materials they were using here and now:

> *"It´s something that isn´t renewable, but it´s reusable, so… we can avoid pollution by using plastic and other materials that we can normally use"*

A fellow US-student is open to expanding her horizon regarding artistic supplies:

> *"It was like a new experience, because I´ve always used like store-bought paint, but like learning to make our own paint using stuff you can find outside and stuff you can buy… it´s just really cool, you know. I might use it again, you know for future projects."*

3. Working on ones own and with other people

Asking questions and collaboration with others are integral parts of the workshop, overlapping with the GSO´s core values (Chappell & Hathaway, 2015). The artistic expression is closely connected to inquiry-based science education and collaboration becomes the applicable implementation. The data shows clear evidence of students appreciating the collaboration, how it made the different ideas fulfill each other, and how questions drove the process forward. As one US student so eloquently puts it:

> "*You can´t discover something new if you don´t ask the question "What if?"."*

This US student explained how his group processes the different ideas into a greater whole:

> *"I think everyone like had their own creativity depending on which station they were in, we all had an idea of what our scenery would be and like how we would interact with it, and that like just by having everyone´s imagination with the set of tools that they have like … since we all came up like (with) very different ideas and very like… outside the box ideas, and if we were to bring that together, and then I think it would be a very like great project overall."*

A fellow student debated between his ideas based on knowledge and imagination, and how they are influenced by others´ ideas:

> *"I tried to use what I know and things that I just imagined in the work we were doing. I liked using my creative thoughts and adding to others ideas and them adding to mine."*

A few students felt they had little to contribute with in the collaborative work, but the majority expressed a positive attitude towards the cooperative work.

> *"My whole groups creative process in this workshop was explored equally. We all had fun creating paint from organic materials and mixing paints to make shapes and images for the background."*

Working in cooperation with others may lead to conflicts, but no disputes were observed, not denying any possible occurrence.

4. Immersed in creativity

The data showed many examples of students being immersed in creative activity and taking risks outside their comfort-zone (Chappell & Hathaway, 2015). They were all positive towards the experience it represents, implying engagement among the participants (Volta e Sousa, Ben-Horin, Ramos, Lopes, 2016). One of the observers in the US shared his perception:

> *"I think the type of open-ended creativity is something the students often do not get a chance to express in normal settings, so it normally lies dormant."*

The students seemed to support his statement, expressing engagement and joy. A girl in the costume-group enjoyed learning to crochet:

> *"I'm surprised at how fast I was able to learn a new skill and I'm glad I was able to learn. I caught on quickly and I enjoy having learned a new creative skill and being able to apply it to the opera."*

The set-group in the US truly embodied the creative process when they put the paintbrushes aside and started painting with their hands. They unanimously appreciated this immersing in the act of creation:

> *"I enjoyed everything, even the egg all over my hands. I loved the fact that we got to explore ideas in our heads and express them on paper, or through colors or costumes, even when there was a very prominent scientific undertone to the mission."*

Yet another US-student expressed a sense of liberation through the painting:

> *"Through this workshop, I was able to explore and freely express my own creative process. For instance, I was able to simply paint anything. I loved how there was no limitations, my instructions was just to paint. Despite the broadness of the instruction, it allowed me to just paint; ultimately helping me paint whatever is on my mind or what feels right."*

This US-student lost herself in learning a new technique to the degree that *what* she is making is of secondary importance:

> *"I learned how to crochet T-shirts. This was a T-shirt, and now I don´t know what it is, but it is something new."*

5. Taking and sharing control

There was less feedback in the data on this topic, not because students weren´t taking and sharing control, but perhaps because it seemed to be a seamless, organic operation (Chappell & Hathaway, 2015). The GSO-method is collaborative and democratic in it´s base, and students had to share control through the workshops. This is closely related to "working on ones own and with other people". In any collaboration there is somebody taking and somebody sharing control. In regard to understanding rules and their consequences, this was easiest to observe on an intellectual level.

> *"I learned some things about what I can change and what causes the things that happen in the environment."*

Or this expression of wanting to learn more so one can put into practice:

> *"I want to know and put into practice how to make sets from the past."*

Independent of the GSO, *after* the workshop-day was finished in Japan, the music-group and the drama-group both had a leader that took control. They gathered their respective groups around them and reminded them of what needed to be done by the next day.

Photo 9: Footprints indicating an embodied creative process

Findings connected to Ecoscenography

The sub-chapters below look at the first step on the Ecoscenography trajectory and then move on to see if and how the Ecoscenography principles have influenced the participants during the workshop. The data showed a clear tendency of students´ engagement and willingness to learn more, both practical and theoretical knowledge about sustainability (Green, 2016). There was an almost unanimous concern for the environment. It also revealed that most of the students still had a mechanistic worldview, when referring to eco-design; most of their replies indicated that they thought of "eco-efficiency". However, there are also signs showing that students were embracing the possibilities of the ecological worldview.

Building awareness

Most students had heard of sustainability and were aware of climate change, but the data shows that this might have been the first time some of the students heard of eco-design. For some it might also have been the first time they became aware of its implications in their own lives and new ways of how they can contribute actively through a hands-on approach in a creative context.

A US-student revealed:

> *"I wasn´t really thinking that much about the earth or like how people use materials at all, but after seeing that presentation and learning more about recycling and we´re using specific objects, I realize that we´re doing more harm to the earth and I believe that doing stuff like this will actually help us a lot. Not just for the play, but for the earth itself."*

Almost all of the forty students said that they had learned something new about sustainability, while only two were hesitant in their replies.

1. Embracing ecological design as a creative starting point and opportunity

The data shows that all students met the eco-creative challenge of reinventing a sustainable world with an open and positive attitude. A Japanese student expressed, after building a set with bamboo "building-blocks":

> *"We can make a unique space using simple set."*

Only one Japanese student expressed a wish to have used other materials, not stating weather they should be eco-friendly or not. A US-student reflected over the merging of science and art through working with Ecoscenography:

> *"I'd never really thought about using eco-friendly things and recycle to build all of these things for sets. It manages to merge together scientific aspects and creative aspects, since for a very long time they've been considered to be mutually exclusive."*

A co-student contemplated the transferable value of "fake"-designing for the moon-opera versus real-life action on earth:

> *"And along the way, I´ve just learned so much about reusing, and creating new things of what´s already existing. Things that I didn´t know could be reused. So I think that it´s a lot broader than just space[48], because it´s right here, in here literarily, that we´re learning all about what we can do with what we have and what we can change about what we do."*

One of the more artistic students reflected over her own artistic process:

> *"After doing the workshop, I've realized how non-eco friendly my process is. I always get brand new equipment, materials, etc. rather than using what I already have and making it adaptable to any changes."*

In professional theatres, the lighting-department may seem relentless in their claim for new and advanced technical equipment. But this US lighting-group student discovered there are other options:

> *"I learned that there is always a way to make it instead of having to go buy. For example, we made good lighting instead of having to go get some professional ones."*

2. Allow opportunities for serendipitous and place-based responses

The utilization and the quest for local resources were mainly pre-organized by the workshop-leader. However there are empiric signs of students reflecting on place-based materials. Inspired by the Moon Village-project, the set-group in the US made their paint with a very local ingredient. Two feet outside the classroom they gathered soil to mix into the egg-tempera paint:

> *"I learned about the connection between art and ecology. For example, I was able to learn how to create colors through natural entities. I was able to create the grey color with dirt and egg."*

A fellow student took it one step further, including mindfulness:

> *"The Global Project helped me become more aware of the usefulness of my environment. I learned that with creativity, we are able to connect the world around us and our minds".*

A definite local resource is people. And no one is closer than the maker himself. The data presents comments regarding students´ realization and appreciation of the opportunity of making something themselves from scratch, rather than just buying it:

[48] Student referring to the scientific theme of space/ astrophysics

> *"I learned more about how to make use of the environment and do more DIY's rather than buying everything."*

3. Acknowledge ecological complexity in overcoming sustainability assumptions and challenges

As previously mentioned, Ecoscenography is no small subject; it can be applied to every step of the theatrical life cycle, from idea to after curtain-fall (figure 11, p.72). Achieving a 100% eco-friendly production-process may require an extensive educational process, though Beer suggests that even with a small amount of eco-knowledge one can improve the production´s carbon footprint greatly (Beer, 2016). Through a short introduction, the GSO Ecoscenography workshop could only present a superficial introduction to the vast area of eco-design. The data shows how this introduction was received.

One of the observers shared how she believed that learning practical techniques and principles of eco-design in a playful way, may inspire a transition of knowledge into the students daily-life:

> *"They learn about sustainability in different ways at school and in other places. I think that the GSO Ecoscenography workshop makes sustainability into something creative and fun, and is a very concrete way of learning about how to work and do little things in ones everyday-life to promote a sustainable way of life in general."*

Many students shared what they had learned and expressed a curiosity, wishing to learn more, be it in-depth learning on Ecoscenography or other fields of eco-design. Materials were often a topic of wonder and questions.

> *"I'd like to know how to combine man-made and natural materials together in a safe way that makes both of them easy and safe to reuse."*

4. Scenographers are change-agents that can empower and catalyze ecological collaboration

The data also confirms how for some of the students, the workshop sparked a wish to take action in bringing their newfound knowledge with them to other projects or into their own lives. In the US, one girl expressed a wish to teach the drama-class the basics of Ecoscenography and encourage them to reuse the materials used in the opera. Another girl wanted to bring her newfound knowledge with her to her church-group, which stages plays. Yet another couple of students informed about an "Eco-crew" at their school: actively

collecting, sorting and recycling trash and arranging events to spread awareness about the environment, suggesting a collaboration with them. Their teacher confirmed this engagement:

> *"Furthermore, they like ideas of GSO's, and how they can contribute to the world, so they are very, very engaged."*

5. Go beyond the transient in pursuit of positive social and environmental contributions

A theatrical production is limited in time, as is a GSO project. However, it is possible to use this as an entry-point into social collaboration, perhaps engaging others outside the immediate circle. The data shows how the Ecoscenography workshop may contribute to both addressing sustainability in a wider arena as well as a practical approach for collaboration with the local community.

One of the US-observers shared his thoughts on how addressing ecological problems through an Ecoscenography workshop, may help against a pessimistic resignation. If properly founded in facts, this knowledge is transferrable to other fields outside the theatre and education.

> *"Sustainability is one of the core problems of humanity and science today. Learning about not only the issues, but also playful solutions might help with what I consider to be a growing sense of cynicism and sense that there is nothing to do about it. But it is important that these things are taught and approached in a scientific fact-based way, as many possible solutions are viewed with skepticism, not only because they have their own problems (like my field, aquaculture), but also because they are new."*

This pessimism of "there´s nothing I can do" is a serious issue (Hes & DuPlessis). It can prevent a common action, where every contribution is necessary. One US-student said:

> *"I would like to learn more on how to prevent any eco-related disasters."*

The will to do something is strong, and so is the wording revealing the fear.

On the other hand, in a conversation with two of the costume-girls who just learned how to crochet, a teacher-assistant learned that both their Grandmothers knew how to crochet. She suggested they should ask their Grandmothers to join them in crocheting, making it a common interest meeting-point. She explained how they agreed to this smiling; they would get help in finishing the costumes *and* they would spend quality-time with their relatives. The teacher-assistant / observer shared more through an interview:

> *" And that´s kind of one thing that I hope the GSO can, that even though we are talking of these universal scientific truths, how can we also pull it down locally? So that the kids can like,*

> *you were saying, how can they get involved locally with maybe things they can use in in set design. (…)I think those processes that happened today and the discussions that happened around the processes and the magic between human beings is really interesting.*
> *We need to stop telling these kids about these far-off goals that they´ll never be able to achieve until they´re 60, and start giving them resources and an understanding of the world and the globe and the environment that they can impact locally. (…) That they can actually do themselves here and now."*

This final step on the Ecoscenography trajectory is the one closest to Næss´ belief in the personal embracement and involvement in deep ecology. One US student shared how part of the introduction had moved her, and how she related it to her own spiritual life:

> *"I was interested in the part (…) about how people don´t consider themselves in nature. And that really kind of like interested me because that´s true and it kind of is saddening cause I guess you could say that when there were cavemen they probably considered themselves a part of nature, but you know we came up with technology and all this kind of stuff that kind of doesn´t make us rely on it anymore and I think that´s why we don´t consider ourselves part of nature anymore cause we´re so reliant on our own man-made stuff. (…) that really made me think a lot, and like even reflect on myself and lately I´ve been trying to get back to understanding myself, because I´m pretty spiritual. So, I´m like, if something is going wrong like in myself and I feel it, then I feel like I get back to nature or something like that, so I don´t know, that´s kind of personal to me as well."*

In general, it appears as if the students were happy to be given concrete tools of eco-design that they could utilize in their own lives. Tanja Beer shares her own experience when working with children:

> *"Many [students] are worried about their future and are desperate to have their voices heard and contribute to the wider world, beyond the school walls."*

Findings connected to Global Science Opera

The GSO methodology influenced how the workshops were designed. As presented below, the research-data shows to what degree this has been the case.

1. Creativity

Creativity is in many ways the glue that holds the GSO project together, combining new territories in education. But creativity also stands it´s own ground, as the data confirms. As this observer from the US workshop shared:

> *"It can be an eye-opener to what creativity can be, if the project is presented in a way that opens up for a creative process. People can learn that creativity can take place in new and surprising places, compared to what many people assume."*

One observer during the US workshop said that creativity in the GSO might serve as a means of addressing critical, real-life issues and perhaps as an alternative to a more passive life-style:

> *"…fellowship for a greater purpose. To feel that one can use art to communicate about serious and pressing matters, in this time and day where people are very interested in just being entertained."*

Reinforcing the collective creative exploration, one US workshop assistant shared her thoughts about involving herself in the learning process:

> *"It was a fun way to explore the topic we were given; how to use light in an opera-scene to stage lighting to allude being on the moon. The children and I had to explore the equipment we had available to us in many different ways, to see how to best solve our task."*

A US student explained the difference between the way science and art is taught in school, and how she experienced the structures used to encourage different *kinds* of creativities:

> *"[In] Science (…) we´re able to do labs with experiments, but with arts, because it´s not focused on as much as science or math, we don´t really get the opportunity at all to express creatively in that sense. But I think the two are similar, because you are given a set of tools, literarily and figuratively, and it´s up to your own creativity and your own personal meaning behind what you´re doing, to do something new. Because anyone can play the same song, but it takes creativity to* make *a new song. But you´re still using the same tools. Two people could have a guitar, and they could know the same song. One of them could keep playing the same song over and over and the other experiment and do their own. And I think the same goes for science. Anyone could learn calculations and how to do things, but it takes creativity to do something new. And to put those… to put what you learn to use and actually apply it in the real world, you have to have creativity so that you can actually have the idea to do it."*

2. Collaboration

The GSO-design is based upon creative collaboration, both on micro- and macro-levels[49], among students, and between students and teachers/experts. The data shows a clear tendency towards an appreciation of this, with students commenting the benefits of cooperation. As a Japanese student expressed it:

> "*It's fun to make something with everybody all."*

The majority of students expressed a positive attitude towards working collaboratively, represented by this US student:

> *"My whole groups´ creative process in this workshop was explored equally. We all had fun creating paint from organic materials and mixing paints to make shapes and images for the background."*

Collaboration is not just among students, but between experts and students as well. Several students mention enjoying learning new things from different teachers. Below is an excerpt of an interview with two costume-group students in the US, following an exchange of ideas between them, their tutoring scientist and the workshop leader. In only a couple of minutes a conversation led to three stages of recycling, making a complete little eco-system in their imagined costume:

> *Jenny: For example, within the imagination, when we used the water-bottles, we were just gonna use them for protection, but when one of the advisors came over to us and explained that it could be used as a type of solar-panel, like a clear solar-panel, it was like a cool idea, and we thought "Oh, that´s cool!" and yeah.*
> *Kenny: Well, right now we are putting the pads on the shoulders for protection, and it will be solar-panels, so the suit will have power while you walk around outside. It´s the outside-suit. Cause then you have power for… ehm..*
> *Jenny: life-support! Communication…*
> *Kenny: … turning water into oxygen. And remaking urine into water.*
> *Workshop-leader: And how are you making water into oxygen?*
> *Jenny: It´s chemical stuff… I don´t know what it´s called*
> *Workshop-leader: Mr. Scientist said something about splitting molecules in water into oxygen- and hydrogen-atoms?*
> *Jenny: We´re using the oxygen for breathing for the human that is inside this beautiful poncho [suit]! And we use the hydrogen maybe for transportation, like little rocket-boosters on the suit so you can travel faster across the moon. It´s already easy to go somewhere because if you jump up you fly a little bit before you come right down. So maybe it will just be faster way to move around the little base-area.*

The tutoring scientist revealed part of his own teaching-strategy, supplying the students with useful scientific facts:

[49] Micro-level collaboration refers to cooperation in the classroom, macro-level collaboration referring to global cooperation

> *"I tried to let the students be the creators, although sometimes I pitched an idea or two, particularly if the science was on my side".*

3. Democracy

The GSO design is democratic in that everybody's voices are heard, decisions are taken collectively, often by vote. GSO is also democratic in its attitude towards creativity. This means that everyone is fundamentally creative and has the capacity for creativity. The GSO approach salutes collaboration, taking care of all its contributors. Students commented on this in the data, even though it did not emerge as a main theme.

> "*I enjoyed the freedom of expression! We created an abstract set background, but it originated from everyone's emotions and creativity."*

> *"I think it´s something that kind of brings people together. Because it can be individual but at the same time it could bring people together to create. Something new, innovative."*

4. Education

The GSO is rooted in education and the educational perspective is fundamental in all aspects of the initiative. When I choose to add *Education* as it´s own sub-chapter, it is because the data shows some of GSO´s significant potential as an interventional educational project, as well as presenting some of it´s challenges.

The educational curriculum varies from country to country, but there are similar goals, presented by the UN as 21st century-skills (Medel-Añonuevo, Ohsako, & Mauch, 2001). GSO Moon-Village collaborator at ESA, expert astrophysicist Dr. Bernard Foing, explains that we do not know exactly what job-skills are needed in the future[50]:

> *"We have come to a stage where we should specialize in non-specializing".*

He continues in underlining the importance of learning several skills, both scientific and humanistic, and he believes the skill of creativity is valuable in order to be adaptable to whatever skills are needed in the future. When asked how a ten-year-old today should educate him- or herself in order to live and work on the moon in the future, he shares:

> *"So it´s good to know some science and some technology, because you will need to operate some of the tools we have, robotic tools. But it´s good also to develop international skills, because the people there will be coming from various countries, so learn a few languages and be willing to learn more, already start to travel on earth to know some of your future peers,*

[50] Bernard Foing in filmed interview of March 28th, 2017.

> *that will be on the moon village. It is also important to be open and adapt and be open to innovation because there not everything is predefined. Clearly you need a bit of discipline because there are some safety-issues (…). Also to be in good health, so practice some sport. To have a balanced education, so between technical topics, human topics, sport topics, to be also socially varied interested that you are going to perform some tasks that will serve the rest of the population. Now we will have some diversity as well, so a bit of thinking out of the box."*

All the students reported learning something, albeit different things. When asking the students if they had learned more science, three answers show the scale of their educational science-outcome:

> *"I feel as if I have learned more about science through the Global Science Opera because the project is beyond what I'm learning at school."*
>
> *"I feel that I have learned some science or maybe re-learned some science that I may have looked at in the past."*
>
> *"I don't exactly feel like learned very much more science since this is more a creative project and didn't require much research."*

It is important in the GSO that the creative process is grounded in scientific facts and artistic skills, as one US-student expressed:

> *"Creativity is an expression of imagination mixed in with what you learn*."

When the time for a project is limited and where there is an expectancy of an artistic outcome, there might be more focus on the finished product, in this case the artistic expression being staged/filmed, than on the educational outcome. Embracing both science AND art, the educational process in both fields should be lovingly taken care of.
However, as one observer recognizes, it does:

> "*…depend on good educators to steer students in a productive direction*".

As a Japanese teacher points out, not a lot of teachers know the GSO-method. According to one of the informants there is another challenge as well: since it is a time-consuming project, teachers need to be passionate about it in order to put in the extra effort required of a successful process. In teaching eco design, Tanja Beer also worries about teachers focusing on limitations rather than the opportunities, fearing their attitude will influence their students. Still, she believes:

> *"There are really only positive aspects to be gained from implementing ecological thinking and design into the school education".*

5. Global

The empirical data shows that the global aspect actually considers three different prospects: participating in a global collaboration with other countries, being their own country's representatives and finally it refers to the world-wide audience who will see the result of their creative effort. There is also the perspective of global cooperation as active peace-work:

> *"I feel like the world is united."*

The first aspect was only mentioned as a positive, the second and third perceived by several participants as a pressure-factor. For a few this was negative, but a clear majority found this motivating and a reason to make an extra effort.

> *"I think it does add a little more pressure. Because a lot more people are going to be seeing it. But at the same time, it really does gives us an opportunity to show what we know and to show how we can use what we know. So I think it´s a really good opportunity for us, just to share with everyone and hopefully inspire them in their creative process and into doing something similar."*

One US-student was motivated into extra effort to *"give the world a good and right education on the moon".* A single student is in minority when expressing a feeling of how a global audience required that she altered the expression into something she didn´t necessarily enjoy:

> *"The 'global project' changed a lot about my creative thinking. I feel more pressured to do something others would like rather than something my community, school, or I would enjoy. It also made me more self conscious about the scenario. I'm not fond of being on camera because I'm more of a backstage person."*

One US-student reflected on how different cultures can bring different things to the finished product, contributing into a richer final result:

> *"It made me think of different cultures and the way other people may think. I didn't think about the fact that there are other cultures that can play into the opera and how different cultures can come up with different ideas. A global project could mean that people all over the world can see and contribute to this project in many different ways."*

6. Inquiry-Based Science Education

The data provides several examples of students learning through asking questions and exploring their way to the answers. In the US, the set-group had an interesting session wondering about the practicalities of living on the moon. One of the ingredients in the set-paint was paprika, which gave a scent of "Mexican food" according to a student. This sparked a discussion about how the moon would smell:

> *"[The moon has] like a sulfur-ish smell to it, but we wouldn´t really know, because (…) we haven´t been on the moon, so we wouldn´t know. But also, wouldn´t it also be because of the atmosphere? And that like smell couldn´t really travel (if there is) no atmosphere? Right? Like learning about waves. We would like (…) guess that we wouldn´t smell anything because there is like no atmosphere, but if there were it´d probably smell like sulfur."*

The discussion continued with questions of how gravity affects humans in space. How the lack of gravity affects the bone-structure of astronauts, and how it would affect potential babies being born on the moon.

> *"…it worried us about people being born there. I know when people are in space for a while; a lot of the astronauts develop… eh… I think it´s osteoporosis or something like that. When the bones start to break down, because they´re not used to gravity any more. So like if children were born there, and they were to come back to earth, would their bodies be able to handle it? If they were like born and raised there an entire life? Or even like a year their bodies develop under no gravity. Nothing, none of the organs or anything actually double up under normal gravity?"*

The conversation continued with the students educating each other, contributing with knowledge in both medicine and space-history:

> *"There´s this one astronaut, I think her name is like May Johnson? Jameson? The first, black, female astronaut. Like she did an experiment in space, cause you know that astronauts can develop like osteoporosis, so she tried to develop like a spacesuit which could hold off the disability a bit longer."*

The US students were all part of the science-club; hence the interest in and knowledge of science, as shown above, was most likely larger than that of the average student body. In Japan the students were all either in the drama- or band-group, and therefore probably closer to this average in the population with regards to attitude towards science.

7. Interdisciplinary

The GSO promotes the educational collaboration between science and arts, insisting on their equal worth and place in the project. Both subjects are driven by curiosity, combining them may encourage innovation. By using art as a means to communicate science, and by allowing science to encourage imagination, it may open up new doors for both subjects. Data shows signs of both observers and students realizing this. As GSO coordinator Ben-Horin explained:

> *"When we ask questions in both science and art, and use one world in order to respond to questions from another world, we are opening up a space in which learners immediately see many possibilities. Acknowledging those possibilities, and generating them, is a way in which GSO promotes creativity."*

The benefits of this interdisciplinary collaboration is noticed by two observers:

> *"It promotes creativity in relationship to science, which I believe is a sorely needed combination in a world where there is so much that needs rethinking."*

> *"The project combines knowledge and skills in different subject areas of the students. This allows them to develop skills they already have, acquire new skills and learn to use them in new ways. This facilitates the student thinking outside the box, gaining new knowledge of science and art subjects, and enhances his understanding in the learning process so that the knowledge remains and the ability to solve new challenges in future increases."*

One US-student expressed joy over a new understanding for science as an approachable and usable subject:

> *"I used to believe that science was only for super-smart people with super-high degrees and all that kind of stuff. But now that it´s connected to something that I like, arts and crafts, I believe that anyone and anyone can do science in their own different type of way. And that it´s not just limited to these super-smart people that go to super-high universities or something."*

Discussion and reflection

This chapter summarizes the findings, discusses and reflects over what they reveal with regards to answering the research-questions. A reminder of what this thesis is researching:

> **In what ways can sustainable Ecoscenography principles be integrated into the process of creating visual frames of the Global Science Opera? And how can these principles affect the creative process?**

I would now like to take this a step further by discussing the common themes of the various sections of my findings and what the implications of that might be.

A summary of the findings

The empiric data shows that the integration of the Ecoscenography principles into the Global Science Opera affected the creative process in several ways. WHC focuses on creativity as a journey of becoming, where the creator is shaped by his or her creation and vice versa. The data give several examples of this happening. The connection between the holistic approach to the environment represented by the sustainability of Ecoscenography and the journey of becoming is evidenced in the data. The majority of students express engagement, even enthusiasm, over the introduction of sustainability into an area they didn´t think it applied.

Students worked mainly collaboratively, taking and sharing control in the process. They immersed themselves into building, painting, draping, crocheting, etc. Their exploration of the medias available to them involved taking risks, and developed into new ideas, some of which were interesting beyond the classroom.

The global aspect induced them to make an extra effort, and the eco-creative process sparked a new approach to problem solving. An example is the costume-group making the poncho (p. 50), where a dual process took place, both that of using recycled materials in the costume, and planning in the imagination how the real-life moon-suit-version would function. Creativity may have been present in any case in an educational setting. But the data suggests that in the GSO project´s combination of art and science, creativity may take on a different shape and even be reinforced through the implementation of Ecoscenography, which in turn increase motivation (Volta e Sousa, Ben-Horin, Ramos, Lopes, 2016). This might be connected to the way young people feel about the ecological challenges

that lie ahead, and their wish to make an impact on their own future (Green, 2016). Providing students with tools that can be used in taking action towards this future, adds to their motivation.

The common themes and crossing points

There are some common denominators between the two main sources of theory guiding this research – WHC and Ecoscenography – and the GSO, albeit in different fields. Working collectively towards a goal is one of them. Creativity is an essential part of accomplishing this goal. Beer even presents the word “eco-creativity” to describe the innovative process of working sustainably. When analyzing the data, several passages had multiple codes from the three sources, showing the overlapping between these areas.

Creative wisdom

WHC emphasizes the importance of an ethical use of creativity, the infusion of neutral creativity with wisdom by collaborative action for a common good for all humanity (Claxton, Craft & Gardner, 2008). Craft links this ethical, or wise, creativity and the environment as a wager against the “divinity” of the commercial market-forces, claiming "starting to take or consume less would mean seeing creativity as fulfilling a wider function in society" (ibid. p. 28). Beer concurs, believing it is our responsibility to prepare children for the ecological challenges ahead[51]. Australian research confirms a growing awareness and concern regarding the future among young people (Green, 2016). When combining Ecoscenography into the GSO there is need of this wisdom-infused creativity, as a preparation for the real world. The creativity needed in overcoming the monumental ecological challenges needs to produce not only brilliant solutions. These solutions must be wise, promoting results that benefit us all. In this clear ethical intersection of the applied theories, the data confirms an engagement in the students, perhaps idealism, wanting to contribute for a common good. This idealism may have been latent, but there may be reason to believe part of the students´ engagement in the workshop was enhanced due to the introduction of sustainable design.

[51] Tanja Beer in e-mail of May 5th, 2017

Level of skills = level of creativity?

According to Dreyfus (2004) it is not until one reaches the 3rd level of skill-acquisition – "competence" that one is able to be creative within the accomplished skill (Dreyfus, 2004). The novice and the advanced beginner have yet not enough experience to master the tools of the skill. Their theory is about completion of learning and separate creative tools must be understood as opportunities that open (or not) when reaching a certain skill level within a specific activity.

As previously mentioned, both WHC and GSO promote a democratic approach to creativity, claiming that everyone can be creative in their own world and that creativity should be assessed with regards to context. Ecoscenography on the other hand aims to reinvent the well-established concepts of design and therefore requires a completely new way of thinking, ergo a higher level of acquired skill in creativity is needed. However, when we combine them, by introducing Ecoscenography into the GSO framework, there are clear signs in the data of contextual creativity going on in all groups and in all assignments given.

Some of the creativity displayed appears to be on a higher skill-level than one would expect, according to Dreyfus (Dreyfus, 2004). Based on the data and observations, I believe this may be in part due to the emotional engagement released by the real-world issues of ecological challenges and in part due to the students´ high intellectual capacity. The first may be related to Craft´s (2013) Four-C´s theory, where the little-c is partly recognized as coping with the 21st century´s changing challenges by using the imagination (Craft, Cremin, Burnard, Dragovic, & Chappell, 2013; Banaji, Burn & Buckingham, 2006 p. 29). The latter may be related to Gardner´s (1993) work on multiple intelligences or human intellectual competences. His cognitive approach suggests a diversity of levels within respective skills or areas of intelligence (Gardner, 2011; Banaji, Burn & Buckingham, 2006 p. 54-55).

Creativity – an intellectual or practical feat?

In spite of the fact that the data has yielded results regarding the creative process, there are still some relevant areas of knowledge, which the study has pointed at, but could not fully answer in itself. Some of these, and related questions are presented below.

Both science and arts evolve through creativity, albeit often displayed in a variety of different ways. When the two fields meet in collaboration, we might consider if it is the same creative process that takes place in both fields, or if there is a difference? Is one more or less intellectual? More or less emotional? One might be more theoretical, the other perhaps more practical? They may be difficult to isolate one from the other, as they are intertwined. The data isn´t sufficient enough to confirm any answers to these questions. Although Gardner´s cognitive approach may explain part of the issue (Banaji, Burn & Buckingham, 2006 p. 55). There was an interesting episode during the US workshop that made me wonder about this.

One of the teacher-assistants reflected upon how the creative process was displayed. Due to the lack of formal training in arts, the students had problems in solving simple color-mixing questions. When the teacher explained to them how mixing primary colors would produce secondary colors, she said they were "slow to understand". The teacher got a feeling they understood on an intellectual level, rather than on a practical level based on previous experience. The students in the US had no previous education in arts and crafts in school. As such, in average they are likely to be placed in the novice- or beginners-group, even if they had practiced artistic skills at home. This might explain why they struggled to mix secondary colors. They understood the "how to" as instructed by the teacher, yet the moment when the colors changed, and the predictability was gone, the outcome was new to them. Almost as if it was magic.

The creativity displayed in the workshops, did so in two different ways: in the practical process of making (physically painting the backdrop), and on an intellectual level of expressed imagining [52] (What would an astronaut wear?). The students' intellectual understanding of the moon and it´s historical value is knowledge rooted in the curricula. Through the workshop´s artistic project and the exploration of paints´ qualities in the workshop, the students were pushed to explore concepts and innovative thinking around the moon, which they otherwise might have overseen in a factual conversation. The paint served as a framework through which to explore the moon´s qualities. Experimenting with a

[52] The imagination needs a material of expression to be called creative, it must be shared with the world through a meadia, be it paint, dance or words.

new medium triggered new inquisitive exploration in the students. In this particular workshop the students´ lack of skills in painting contributed to the method in which they might simulate ideas around the qualities of the moon.

If we support Gardner´s cognitive theory of different intelligences, will the expressed imagination be equal to the practical painting in status? While producing as anticipated in one area, the other is exceeded in creativity. Then we can claim that creativity did exceed expectations.

The interesting question is, when it appears that the students surpassed their pre-supposed skill-level in creativity, what caused this to happen? Was it because of the student´s high intellectual level, pushing them beyond the expected level of practical experience? Or is it even possible to distinguish the two in real life, the intellectual imagination and the practical expression, intertwined as they are? Gardner (2011) advocates that a separation of intelligences is possible (Gardner, 2011; Banaji, Burn & Buckingham, 2006 p. 54-55). A human intelligence is recognized by a set of skills, such as identifying and solving a problem, which seems relevant to the skill of creativity. He has also categorized several intelligences within various areas: *linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, naturalistic and personal intelligence* and is considering adding *existential* or *moral* intelligences (Davis, Christodoulou, Seider & Gardner, 2011). (In this day and age, perhaps "*ecological intelligence*"[53] should earn it´s place in his theory?)

If we compare the students´ processes by separating the medias of painting with egg-tempera and of expressing imaginative solutions orally, the difference in skill-levels can be noticed. The students have more training in expressing themselves with words than with paint, but both can be creative expressions. Their painting is on a novice-level, but their spoken imagination is innovative in it´s suggestions. However the practical work allowed them to explore ideas they may not otherwise have had. For example, when one of the

[53] Daniel Goleman defines “ecological intelligence” as individuals’ ability to apply what they learn about their impact on the environment to make changes in their behavior and live more sustainably. (https://www.ecoliteracy.org/sites/default/files/Ecological-Intelligence-Teacher-Guide.pdf)

students was mixing the egg-tempera with color, he started wondering if the moon´s surface smelled like rotten eggs (p. 49-50). The practical exercise sparked the intellectual imagination and the scientific discussion that followed.

Would this have happened if the students were on a higher skill-level of the respective artistic techniques (painting, crocheting, etc.)? Would they gain as much from the workshop? Would they gain more? Or would they gain other things? It is difficult to say, as I have not conducted the Ecoscenography workshop with students with high competence in arts and crafts, and can therefore only speculate (Dreyfus, 2004; Sawyer, 2011 p. 300-301).

The journey of becoming and the awakening of eco-awareness

WHC explains the interconnection between a creation and its creator, how they mutually influence each other through the creation process. This relationship is undoubtedly related to the Ecoscenography trajectory, where the thinking (the mindset connected to the worldview) and the practice are closely linked together. As one embodies the holistic approach to eco-design, one is shaped by it´s message. One cannot "un-know" and go back to ignorance.

Almost all the students (and observers) expressed they had learned about sustainability, and even though the introduction of Ecoscenography was aimed directly at the GSO-project, a large group of students saw how they could transfer knowledge and skills into different areas in their own lives. This varied from a direct transfer of recycling sets and costumes at different venues, to transferring to different fields of interest, and how one could co-operate with other groups with similar or complementary interests. The latter are signs of student´s engagement moving beyond the initial awareness-stage, into involving the community or moving beyond the theatre into the real world. The data showed a plausible, almost unanimous engagement in the students around caring for the environment, confirming previous research (Green, 2016). For many, especially in Japan, this was expressed through eco-efficiency-related words like *recycling*[54].

[54] It might be worth remembering that there was an extra link in the chain of communication in Japan, were many of the translated answers were similar.

Creativity and consciousness

The data shows conclusive evidence of creativity "committed" in all five areas of WHC during the interventions. As all the students are new to Ecoscenography, it was unexpected to see indications of a stated interest beyond the awakening-awareness point in the trajectory. The practical part of the trajectory was pre-organized by the workshop-leader, but a few of the students showed thoughts around engaging with the community, how to work trans-disciplinary and how to contributive practically in the world beyond this project. Even though some of the students were previously involvement in eco-groups at their school, I believe the display of eco-creativity in a larger student-body is at least in part due to the emotional engagement the students showed in their care for the environment.

The workshops were finished courses, but the intervention in the US only marked the beginning of the scenography-process, so the students there have the opportunity to work with the Ecoscenography principles over time and may come up with interesting eco-friendly solutions in their final product. After the evaluation day two, they started a discussion on what materials and techniques to work with on an outside semi-permanent set/installation in accordance with Ecoscenography principles.

The sustainability of quality craftsmanship

As a trained arts and crafts-teacher one of my concerns regarding the GSO interventional project-model, is how it is able to take care of the arts-field, apart from being a "tool of fun" for science. The intention is good, but is there time and space within the project for taking the arts and crafts seriously? Introducing Ecoscenography may be a step in the right direction in this regard.

The pendulum of the contents in arts and crafts-education has swung from a conservative skills training to a free "do anything you want with a toilet paper-roll"-creativity (Frayling, 2012). According to conservative philosopher Scruton (1987), there is a worry concerning a binary opposition between "pointless creativity and "real learning" (Scruton, 1987, p. 39-44; Banaji, Burn & Buckingham, 2006 p.17). The education in arts and crafts today is influenced by the 21st century skills, which tend to favor the modern tools of ICT. As an example it may highlight visual communication via digital design, rather than teaching how to draw or paint

an expression in itself. Living in a time of transition, there are of course pros and cons to both a free and a conservative approach. Taking care of both vision and tradition within a tight schedule may prove a challenge; nonetheless it should be a goal to bring with us the best of the past into the future (Hall, 2016 p. 12). By training students to be skilled in crafts, being able to take pride in making products they can utilize, be it sewing a garment or craft a table, ensures not only safe-guarding a strong tradition, it is sustainable. Well-trained students may contribute to rejuvenating the tradition, reinventing it in a more sustainable direction, once they have mastered the skills. Mastering the skills in craftsmanship does not mean shunning the skills of future technology; on the contrary they may complement each other. Sustainable eco-design embraces new technology as well as quality craftsmanship[55].

Eco-design needs innovative minds to rethink the industrial production of needed goods. It is sustainable to make better quality products of renewable and healthy materials with longer life cycles. To be able to be self-sufficient, making high-quality, usable goods is fulfilling a core-value in sustainability. Hence, a sustainable crafts-education should promote both creativity and high quality craftsmanship. By implementing sustainability into the GSO, one of the challenges is to take care of both aspects: that everyone can contribute in the process of original ideas and to stimulate the quality of craftsmanship.

The interesting question here is if and how this is possible to achieve in an interventional project like the GSO? I believe this is a work-in-progress well-worth exploring extensively. Through the workshops I was able to test several approaches on how to make costumes in a short timeframe. I admit, I have not reached that goal, it is difficult to fill all the criteria: versatility, sustainability, quality, efficiency, "novice-achievability", etc. The concept of building blocks in set however has received positive reviews. But my study is just a beginning and further practical research may produce a cornucopia of sustainable, high-quality design.

What impact does the GSO Ecoscenography have?

No doubt the world is in a transitional phase regarding human ecological impact. Almost all

[55] For instance, in Ecoscenography there is a world of possibilities within cross-over fields between set and lights: video-mapping, projection of images or film, etc. However, most schools will not financially support expensive, advanced digital equipment, and it is the GSO´s task to find good sustainable options.

scientists agree that climate change is real and reinforced by human behavior (Sachs, 2015). We live in a critical time that demands a fundamental change in attitude and behavior that recognizes the responsibility humans have as the "smarter" species.

The vastness of this task may seem discouraging. Increasingly aware of how the ecological changes will influence on their future prospects, the physical and mental well being of children are being affected (Pronczuk & Surdu, 2008). However, it is not impossible, and eco-design shows a way to go into the future creating a positive legacy. Hes and DuPlessis underline the importance of showing young people that there is hope for the future, and how an ecological worldview can contribute to it being even better than the world as it is today (Hes & Du Plessis, 2014). Providing them with the tools to engage hands-on in sustainable practice may help the planet, including its future inhabitants (Pronczuk & Surdu, 2008). Introducing Ecoscenography into an educational project may seem an insignificant contribution in this bigger picture. However it may be one small gateway into an educational approach to this transition. The impact may be larger than it at first implies. Ecoscenography builds on eco-design, and the guiding principles can apply to other areas of life.

How much impact can a few hours of creative exploration in a workshop have in the larger scale of things? In itself a few hours of theatrical design will not change the world. But the combination of these three: Ecoscenography, creativity and the GSO appear to strengthen each other in making an impression that lasts longer than a workshop with just one of these themes would. Perhaps it is the combination of fun, facts and function that appeals. Perhaps because it speaks to some core values in some of the students, of what they believe is essential. Perhaps it is because the Ecoscenography builds a bridge between science, art and education. You can create science without applying art and you can create art without applying science, but eco-design requires both science and art in its creation[56]. That said, of course not all students are equally influenced by this type of project. People learn in different ways; for students who learn best in very structured environment, this might be too free in its form.

[56] Perhaps chemistry is the field of science closest to the application of Ecoscenography. In attempting to produce a toxic-free scenography, one benefits from having basic knowledge in what chemicals are used in materials and products and their effects.

Challenges of implementation

The resources

There are challenges connected to implementing Ecoscenography into the GSO initiative. Just like other theatre-productions or educational activities, a GSO project requires resources: time, money and people. The driving force is often human engagement and a will to make an extra effort for the students.

Saving the planet[57] or saving the budget?

Conducting a GSO project may require funding. By applying Ecoscenography, one might actually save money on expenses for set, costumes, lights, etc. However, it is important to stress the fact that Ecoscenography´s primary goal is to help save the *planet*, not to save *money* per se. Saving money is a good thing, but it should be considered a bonus, not the main objective, although it may be a fundamental issue in some countries. Schools should not use Ecoscenography as an excuse for giving their students trash to create with, in order to fulfill short-term budget goals. Students´ creativity should be taken seriously, and serving them garbage does not do that. Taking creativity seriously is taking subjects that promote creativity seriously. Practical, aesthetical subjects like arts and crafts promote quality craftsmanship as well as creativity. At times, quality materials may cost a bit more there and then, but in the long run, quality is better for both people and planet, as they are more durable and less polluting.

That said, recycled or free, discarded excess materials can challenge the creativity in a constructive direction, when you have to see possibilities in what you have at hand to work with, instead of shopping new materials, half-fabricated or even finished pieces. Some students expressed astonishment about the possibilities presented in the visual introductive presentation, where excess materials were used in some of the inspirational material. And this astonishment may be the source of the extra gear in creativity – learning to see possibilities where one didn´t think of looking for them.

[57] ”Saving the planet” is here used as a headline slogan. While I am aware the workshops will not actually save the whole planet per se, it is an ambition to contribute towards this goal.

In other words, the budget should not limit the quality of craftsmanship, just as the sustainability should not limit the artistic expression. Beer emphasizes the importance of the teacher´s qualification in conveying seeing possibilities instead of limitations.

The time-turner

A GSO-involvement may be demanding of human resources, if several teachers are collaborating on the project. If cooperation is difficult to administer in practice, perhaps the project is easier to conduct for one teacher if spread over time. In the US-intervention, where the students meet two hours a week over the course of a year, they can explore both science and art through the GSO scene they are making. Even though it is not tested in an intervention yet, I suspect that it is a good idea to structure an Ecoscenography workshop over several days. This will allow the students to digest the knowledge, and at the same time facilitate access into the eco-creative process of choosing materials, hence adding another dimension of practical learning. The challenge with this might be an inequality in the teacher´s knowledge-bank, if one teacher is solely responsible for scientific, artistic and ecological input, especially on a higher level of education.

The need-to-know challenge

One main challenge is a basic need for education for the facilitators. As previously stated, Ecoscenography is a wide and complex field, requiring knowledge on a range of production-processes, materials and craftsmanship. A good starting point could be twofold: a workshop for GSO teachers and a written supplement to the already existing GSO teaching material.

A teachers training workshop should be a combination of theory and practice, and could cover areas from eco-design and holistic thinking, to costume-construction and set building. It could be executed in cooperation with an already existing teacher training GSO workshop, or it can be conducted on it´s own.

The written material should be a practical guide covering all areas of scenography: set, costume, lights, props, hair and make-up. It could include basic hands-on approaches to eco-friendly creations: how to utilize local resources, how to easily make adjustable costumes, how to alter a set, how to make energy-efficient lighting effects. It could include a section on how to work creatively with science-based theatre.

Feedback from a teacher-assistant in the US supports my reflections around this. Even though she was educated in art and with a personal interest in ecology, she still learned a lot from the theoretical introduction where the two fields are combined through Ecoscenography. She believed that an introductory course is vital for a common understanding.

Attending a workshop, where one can actively participate and discuss with fellow practitioners is more efficient than only reading about a subject. But such participation will necessarily require funding, which in turn may not be equally easily accessible for all participating GSO facilitators. Perhaps a solution is to supplement the workshops with online tutorials, or interactive online workshops. The goal is that the additional learning material should be easily accessible, and practical to use, so it will indeed be helpful for facilitators who wish to implement Ecoscenography.

The basic research done in this thesis may advance these educational efforts. However, there are several fields of interest for continued research that can only strengthen this implementation-attempt.

Potential future research

This thesis deals with two iterations of an Ecoscenography workshop. Although this has given a substantial amount of valuable data, I believe further research into the field of educational Ecoscenography is beneficial. Although testing out the material in three different settings, I feel that there is more that can be researched on concerning the adaptability of the GSO teaching material as well.

The first thing I would like to test out is the effect of the time frame of the project. I´ve only had short workshops, and I think it would be beneficial to see if and how the learning outcome would change if the Ecoscenography were worked with over time. The class in the US is working with their contribution over the course of a whole year, and it would have been valuable to follow their process, to see their eco-creative evolvement. A few students expressed a wish to learn more about Ecoscenography, and over the course of a year (one to two hours per week) one could go deeper into the complexity of all aspects of eco-design. The knowledge is transferrable to several other areas, as the students pointed out

themselves, and I believe this is where some of the main potential in this concept lies. Working creatively with an inspirational, interdisciplinary project can spark an interest for further investigation, a hands-on knowledge of how-to among the students.

Another area of potential and interesting future research would be to test how the resources available affect the outcome. As Craft (2008) points out, creativity may be conceived differently depending on the cultural context (Claxton, Craft & Gardner, 2008, p. 19-25). The GSO operates in over 30 countries in all the inhabited continents. Even though I´ve held workshops in three of these continents and in different cultures, all three countries have been rich in resources, when considered on a global scale. I believe it would strengthen the future learning material if it were tested in a school or a country with a scarcity of resources. What would the creative process look like? Would it be different in how the students explored the materials and in how they solved the tasks? Would a lack of material resources increase or decrease the creative process and outcome? This area of research is vital in developing a methodology that is usable for all participating countries, not only those rich in monetary resources.

Yet another interesting area for future research is to test the age-adaptability. GSO operates from lower elementary-classes to university-classes. Both interventions in this thesis were in high schools, with students between 14-18 years. It would be interesting to test the workshop design with different age groups. How can we teach Ecoscenography to 6 - 7 year olds in elementary school? How can the material be adjusted to a level they can understand? Would their creative process and product be fundamentally different from, or resemble that of 20-something-year olds in universities?

The small glimpse into the Japanese students change in attitudes over the course of a month, before and after the workshop, indicates a very interesting area for further research. To what degree does practical work with eco-design through a GSO workshop affect participants interests, feelings, reflections, attitudes and even core values? The data shows a clear appreciation in the students regarding the transferability of eco-design into other areas of life. To what degree is this transferability a factor in this change of attitude? Would there be a difference if the workshop is done over a weekend or over a year?

Conclusion

Educational Design Research studies aim at producing a twofold contribution, one of practical value and one of theoretical value, both available and helpful for others interested in the research area. Completing a preparatory project and two iterations of Ecoscenography workshops within the GSO framework provided valuable in-depth knowledge. However, I acknowledge the limitations of the research, and the fact that the practicalities around this study has not allowed for all sides of the implementation of sustainability into the GSO to be adequately studied yet. Nonetheless, this chapter attempts to present the two contributions.

Following the EDR-plan in figure #9 (p.37) the theoretical approach should contribute with knowledge regarding the GSO Ecoscenography workshop; while the practical approach should produce a design for a GSO Ecoscenography workshop.

Building blocks on the road to future theoretical contribution

The GSO project is well recognized, despite it´s young age. Part of it´s strength is the inquiry-based inter-disciplinarity and its adaptable nature. Previous research shows that the first enhances an emotional engagement in participating students, which in turn has the potential to improve the learning outcome with regard to science and art (Volta e Sousa, Ben-Horin, Ramos, Lopes, 2016). The latter makes it user-friendly and universal in its ability to adjust to a series of variables. This study confirms this, and shows how the integration of Ecoscenography into this interdisciplinary collaboration may compliment and strengthen the project.

Another effect of this integration is drawing attention to the previously slightly neglected area of visual design. The recognition of quality craftsmanship in the arts-field has been underestimated for decades by policy-makers. However, creativity is on the international agenda being revived and celebrated as an essential skill for the future workforce. Ecoscenography in the GSO promotes both creativity and craftsmanship, while at the same time pointing at the importance of utilizing these skills for good for our common future.

Ecoscenography performs as a field-bridge, linking the areas of science and arts. Knowledge and skills from both areas are needed for a successful sustainable design. But it also represents another important field: that of the ecological challenges that lie ahead of us. This affects the students emotionally as well as practically. Perhaps the best trait of the Ecoscenography is it´s transferability. The study confirms previous research showing that young people care about the environment and the ecological challenges ahead, and it shows a will to act upon this (Green, 2016). Being given concrete tools of knowledge, and combining it with practical hands-on work, which utilizes this knowledge, appears to be received with gratitude by many students. The eco-creative process seemed to spark recognition in the students on how they could transfer the principles into their own lives. This application of the Ecoscenography principles into the real world seems to be a promising result of the study.

The knowledge gathered through this research may therefore serve as theoretical building blocks for further investigation of the GSO or other interdisciplinary education in arts and science. The following figure (#10) represents a bridge between the theoretical building blocks and the practical contributions below.

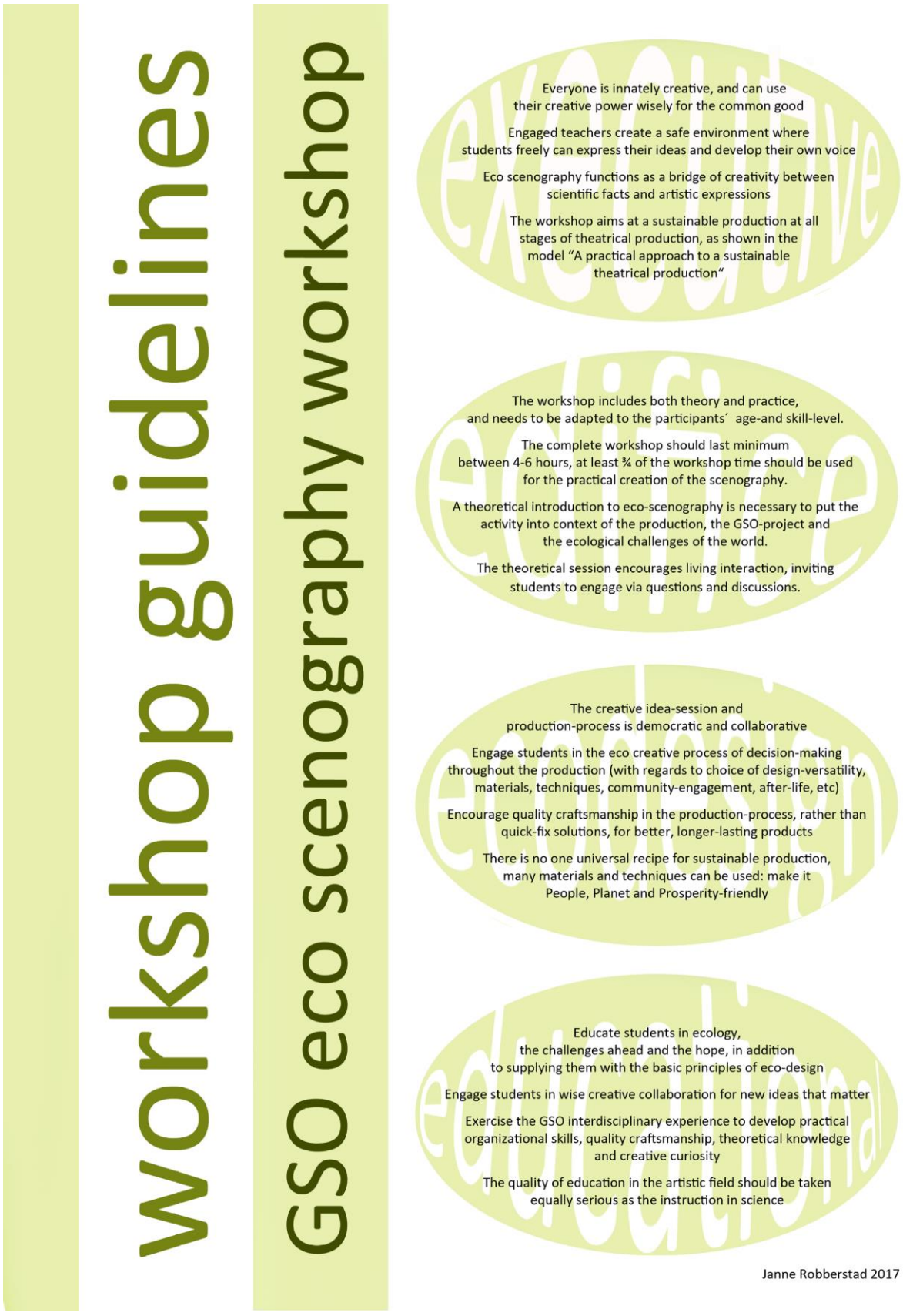

Figure 10: Guidelines for a GSO Ecoscenography workshop, Janne Robberstad, 2017

The practical contribution

Working with this study has lead to two practical contributions: guidelines for a GSO Ecoscenography workshop design and a visual model of *A Practical approach to sustainable theatrical production.* During a workshop, all stages of this model are mentioned, however the focus is on materials and the hands-on ”making”. Below is a presentation of the model:

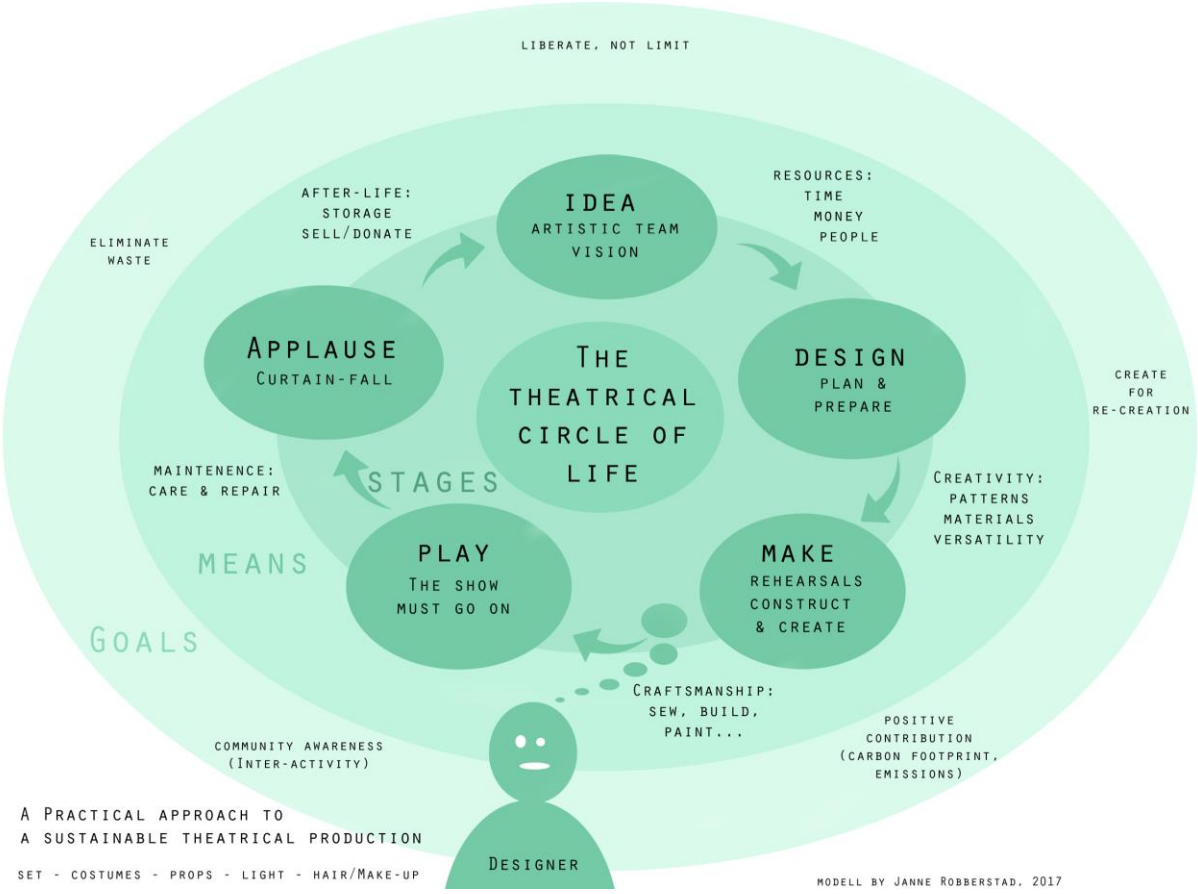

Figure 11: A practical approach to a sustainable theatrical production, Janne Robberstad, 2017

A practical approach to sustainable theatrical production

The model shows the different stages in a theatrical production, focusing on the elements of scenography: set, costume, props, light, hair and make-up. In each of the five main stages, there are elements to consider when making an environmentally friendly show. For each stage of the process, there is a goal to achieve, and a suggestion of means by which to reach this goal.

The five main stages of a theatrical production include (1) the idea-stage, where the artistic team shapes the vision of the final product, including the Ecoscenography. The goal here is to not be limited by restriction of eco-efficiency, but to liberate the creative senses when (2) designing. The goal is to create in such a way, that everything easily can be reused, recycled or recreated after the show is done. This can be accomplished by a conscious choice of materials, designing with adjustability and versatility of use in mind. In the actual (3) creational stage of construction and building, the goal is to achieve a positive environmental contribution. Building things of durability with quality craftsmanship, avoiding toxic chemicals, can do this. (4) Once the show opens, the audience can be made aware, directly or indirectly, of the eco-effort. In practice the main effort is focused around maintenance of what is already made. (5) After the show is finished, inspired by nature not to create waste, everything is cleaned, repaired or de-constructed, and stored, sold or given away for a second life. For every department there will be variables to consider. For instance, the set-builder and the hairdresser have different chemicals to attend to.

The model is based on a general life-cycle assessment model combined with inspiration from Beer´s Ecoscenography trajectory and principles and Cradle to Cradle´s life-cycles model, combined with real-life experience (Beer, 2016; McDonough & Braungart, 2010). The model is meant to be a visual reminder, and should not be considered absolute or complete. All rings in the circle can be supplemented; especially the “means” can be expanded.

While the model has been developed for this research, the process it visualizes can be widely applied outside the GSO project.

Workshop design principles

Ideally I would offer a complete “recipe” for a GSO Ecoscenography workshop. This is not only difficult due to the need for more research; it is undesirable because of the nature of both the GSO and of Ecoscenography. Both are in essence and in core adaptable. This adaptability is part of the foundation for the project´s strength. It would seem that there is no *one* universal “right” way of conducting a GSO Ecoscenography workshop. However, some guidelines can be of assistance when planning and conducting a workshop.

The principles described below determined in a tentative way, the manner in which this study and the workshops were conducted. As a result of the hands-on activities it was possible to verify their applicability. The design principles for the GSO Ecoscenography workshop build upon the model above (figure # 11), aiming for a sustainable approach at all stages of a theatrical production. Based on the practice conducted in the fieldwork, and on the research, I recommend the following, some visionary, some practical, advice:

Executive visions:

- Everyone is innately creative, and can use their creative power wisely for the common good
- Engaged teachers create a safe environment where students freely can express their ideas and develop their own voice
- Ecoscenography functions as a bridge of creativity between scientific facts and artistic expressions
- The workshop aims at a sustainable production at all stages of theatrical production, as shown in the model "A practical approach to a sustainable theatrical production"

Edifice, workshop structure:

- The workshop includes both theory and practice, and needs to be adapted to the participants´ age-and skill-level
- The complete workshop should last minimum between 4-6 hours, at least ¾ of the workshop time should be used for the practical creation of the scenography
- A theoretical introduction to Ecoscenography is necessary to put the activity into context of the production, the GSO project and the ecological challenges of the world
- The theoretical session encourages living interaction, inviting students to engage via questions and discussions

Eco design:

- The creative idea-session and production-process is democratic and collaborative
- Engage students in the eco-creative process of decision-making throughout the production (with regards to choice of design-versatility, materials, techniques, community-engagement, after-life, etc.)
- Encourage quality craftsmanship in the production-process, rather than quick-fix solutions, for better, longer-lasting products

- There is no one universal recipe for sustainable production, many materials and techniques can be used: make it People, Planet and Prosperity-friendly.

Educational learning outcome:

- Educate students in ecology, the challenges ahead and the hope, in addition to supplying them with the basic principles of eco-design
- Engage students in wise creative collaboration for new ideas that matter
- Exercise the GSO interdisciplinary experience to develop practical organizational skills, quality craftsmanship, theoretical knowledge and creative curiosity
- The quality of education in the artistic field should be taken equally serious as the instruction in science.

As the GSO is global, the learning material needs to be as universal as possible. Still, the theme changes, and the scientific theme is adjusted to the age- and skill-levels of the students. The same applies to Ecoscenography, which will always value local resources. The one global resource best capable of sustainability is the human resource. Materials will vary globally and locally, and therefore it is difficult to recommend some materials above others. It is however the human beings that understand the potential of the local materials and can utilize them in a responsible and creative way. Sometimes recycling materials are the best option, sometimes new home-mades are the best, sometimes a third option will be rewarding.

The practical hands-on creative process should be the main part of the workshop. All products made should be of high quality, both in idea, materials and craftsmanship, so they can be used on stage. If products for instance are made of building blocks they can be used innumerable times. Make everything people-, planet- and prosperity-friendly.

Again I want to emphasize the importance of additional education for teachers into the complex field of eco design, as mentioned in the previous chapter.

Interests of implementation

The educational framework of this research is quite specific; the workshops are tailor-made for the GSO. In fact, part of the reason for the interesting outcome of the study is the project´s framework, with all its´ complexities. However, conclusions here should be of interest to several other parties.

The artistic field

The insertion of Ecoscenography into education is interesting for the artistic field of Ecoscenography, since it introduces the field to a larger audience of potential practitioners of eco-design. Opening the minds of young people to the possibility of an environmentally friendly alternative to conventional production is constructive from an ecological point of view. Several students expressed how they could transfer their new knowledge into similar areas in their own lives. On a practical, albeit modest, level this may be proving beneficial for the earth. It may also be ethically interesting, as students take their engagement with them into the world.

GSO-facilitators

For the GSO project the advantage of the implementation of Ecoscenography is clear, as it binds together several of the interest-points and values already dormant. It strengthens the inquiry-based and creative effort, the interdisciplinary approach and it underlines the importance of global collaboration. The current GSO learning material presents a relatively modest amount of information on how to best execute the visual design in an opera, so paying more attention to this particular area strengthens the project. When in addition, the ecological aspect can be incorporated; it may enhance the holistic approach to design. The ecological aspect should not be at the expense of the artistic quality, but it may lead it in another direction. This in turn may require an additional round of creativity. Since Ecoscenography in many ways is a combination of science and art, it may also serve as a doorway into science for art-interested students, and vice versa.

Other educational institutions

This study confirms previous research results in reaching a higher learning outcome when utilizing a creative approach to theoretical fields (Volta Volta e Sousa, Ben-Horin, Ramos & Lopes, 2016). Which means that although based on the GSO project, this research may be

interesting for all educational institutions that work interdisciplinary with science and arts through a creative approach. It may also be relevant for the Ministry of Education. In Norway, the teacher-training stands in front of a major reform in the fall of 2017, and the department should not only look at the length of the teacher-training[58], but on the quality of it. There is a general tendency towards a more theoretical education in many countries, Norway included, despite international research showing the need for varied forms of teaching (Claxton, Craft & Gardner, 2008 p.5-7). Sustainability should absolutely be on everyone´s agenda, the education system has a special responsibility since they are educating for tomorrow´s challenges. Both creativity and sustainability are already defined as areas of priority, however my experience has shown there sometimes is a gap between the spoken word and practical action when it comes to reforms of this sort in the education system.

Global collaboration for all?

A field that might be interesting to look into both from a practical angle and from a theoretical research point of view is that of the global aspect of the GSO. The data revealed several findings of students welcoming the idea of global collaboration. Although a positive contribution to GSO, it may also be a bit abstract. Students knew that their creative expressions would be seen across the world, and that intrigued them. Simultaneously, it was slightly unreal, as there was no direct contact between the students from different countries themselves[59]. This leads me to believe there is undisputed potential here.

In addition to the formal line of communication within the GSO community, there is a more informal portal of contact. Currently, teachers, scientists and other interested parties can connect via social media[60]. This serves several purposes, the main being to spread information. However, it is a network of like-minded persons, and one can easily get in touch with other members with questions or collaborative proposals. This is a valuable platform of connection across borders, and I have already claimed that the GSO is peace-work in practice through it´s collaborative approach. However, this is mainly limited to the adult

[58] Teacher training in Norway will from the fall of 2017 be expanded from four years to five years

[59] There has been collaboration between two schools in different countires in a previous year.

[60] A Facebook-group called Global Science Opera

facilitators, and not the students. I believe it would be of great value to establish a social platform for all the participating students. This idea derives from two discoveries: the first being part of the social media group and seeing it´s value for the adult group. And secondly, findings expressed students' appreciation of collaboration, and their thoughts around the value of global cooperation. If a social platform were to be established, where all the participating students had access, the global collaboration might become more real and less abstract. If students discover that they are working with the same issues in Sri Lanka and Canada, and help each other in their exploration of the scientific theme, for instance, this brings with it values on several levels. Meeting people from countries far away, albeit virtually, students may realize that despite religion, culture, nationality, we are not so different from each other, in fact, we have a lot in common. This is the real peace-work: creating friendships across borders. And here lies an untapped potential in the GSO project. The participants are already numerous and strong, so investing administratively in a social-media-platform, might result in a new dimension to the project[61]. It is a direct answer to the UN´s 2030 Agenda for Sustainable Development §4.7 (quote on p.4) declaring global citizenship, cultural diversity, promotion of peace, and non-violence i.a. (United Nations, 2015 §4.7).

My hopes

My hope is that the research results can be of use in the further development of the GSO project, supporting the introduction of Ecoscenography into the formal teaching material. The results of this research may hopefully act as a bridge across cultural divides and be relevant for similar educational projects. Ecoscenography has already informed an educational training material of the European Commission's Horizon 2020 Project, "Developing an Engaging Science Classroom (CREATIONS[62])" training material (Ben-Horin, Sotiriou, Stergiopoulos & Robberstad, 2016). This material aims at supporting the European Commission's vision of Responsible Research and Innovation (RRI)[63], one of which main themes is indeed sustainability.

[61] I am aware of the danger connected to children being abused or exploited online, there would have to be taken preventive measures against this possibility.

[62] www.creations-project.eu

[63] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

With regards to the eco-creative process, I believe there lies a large potential field of further exploration and research, in which I hope I may continue to contribute. I´ve previously stated the importance of maintaining a high quality craftsmanship, and mentioned the challenges of incorporating a time-consuming skill—training and craftsmanship in to the project. Being a challenge, does not make it impossible, and it should remain a goal. I have begun but not completed the task of finding good solutions to this issue. Hopefully my study will stimulate more research in this area and serve as inspiration for a collective effort of truly integrating Ecoscenography and sustainability into the GSO. My ultimate hope is that this study may invite to a discussion around integrating ecological sustainability into education on all levels on a wide scale.

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Appendices

Appendix 1: The Japanese survey

My Japanese colleague, the workshop-facilitator and physics-teacher, conducted his own quantitative survey among the 26 participating students. The same questions were asked a few weeks before the workshop, and again after the workshop. This gives an indication of how the students´ feelings have changed towards several subjects. My colleague has kindly shared the results with me, and here are some of them:

- Before the workshop, 44% of the students were curious about Ecoscenography, after the workshop 92% of the students wanted to learn more.
- The students reveal an increase in interest in the creative fields connected to the workshop. From 64% to 92% who were interested or very interested in making the set, costumes and sound-set. Acting in the scene caused a rise from 48% to 88%.
- The students were quite positive to GSO´s creative "opera-style" approach before the workshop at 52%. Still, this number rose to 73% after the 3 days of creating the scene.
- 44% of the students were neutral on the subject of the global aspect, after the workshop, 88% were positive, a couple of them explicitly expressing a wish to know more about cultural exchanges and learning more English.
- The survey reveals an increase in the curiosity for science from 25% to 85%. Specifically there was an increase in particle physics, which was the main scientific theme for this year´s opera, from 25% to 50%. This is a lot less than the general interest in science. However if we look at the other end of the scale, the reluctance against particle physics decreased from 40% to 4%[64].

The numbers here are significant in the difference in students feelings. It may be appropriate to ask if this is due to other factors than just the GSO-workshop itself. To what degree does the clarification of concepts play in? To what degree are the positive results affected by

[64] The same survey shows that there is no change in what the students believe they actually learned about particle physics over the course of the workshop. Their teacher believes this is a too complicated field of physics to learn in such a short amount of time, especially when also producing a scene and the scenography to frame it. Only one hour was spent lecturing about the light being both a particle and a wave in physics. I choose to mention this part of the statistics as a counter pole to the positive outcome, and avoid bias.

politeness towards their visiting guest? To what degree does the difference in teaching-style, if any, play a role?

It would be interesting for future research to conduct equivalent surveys before and after workshops in other countries and settings. It would add to the interest to combine it with qualitative follow-up questions, that might be able to explain the differences in the scores. It would also be interesting to ask the same questions again after a month or a year, to see if there is a long-time effect?

Appendix 2: Questions for students

Evaluation for participants at the GSO Ecoscenography workshop:

Please answer the questions below:

1. How do you feel about your own creative process in this workshop?

2. What is the creative process in your opinion?

3.How did the fact that this is a global project impact your process?

4. How can you use Ecoscenography in the future?

5. Do you feel like you´ve learned more science through the Global Science Opera – project?

6. Is there anything you´d like to learn more about?

7. Do you feel like you´ve learned more about sustainability through the GSO Ecoscenography workshop?

8.What have you learned about sustainability through the GSO Ecoscenography workshop?

9. What did you enjoy and what did you not enjoy about the workshop?

Appendix 3: Questions for teachers/scientists/observers

Questions for teachers/scientists who have a connection to the GSO Ecoscenography:

Please answer the questions below:

1. What is your role in the Global Science Opera-project?
2. What is your field of expertize?
3. What is your previous experience of the Global Science Opera-project?
4. In your opinion, how does the Global Science Opera-project promote creativity?
5. In your opinion, what is creativity?
6. In your opinion, how does the Global Science Opera-project promote science?
7. Have you attended a Global Science Opera-project workshop?
8. If yes, how do you feel about your own creative process in this workshop?
9. How do you feel about integrating sustainability into an educational project like the Global Science Opera?
10. Have you observed your students learning more about sustainability through the GSO Ecoscenography workshop?
11. What have you learned about sustainability through the GSO Ecoscenography workshop?
12. What do you think are the strengths and limitations of the Global Science Opera-project?
13. Do you think you will continue to use ecological and sustainability principles in your future educational work? Why or why not?
14. How do you feel about sustainability?
15. How do you feel sustainability is or can be integrated into your own field of study/teaching?
16. What do you think is the most important contribution(s) of the Global Science Opera-project?
17. What is your personal experience from working with the Global Science Opera-project?
18. Do you wish to continue working with the Global Science Opera-project?
19. Is there anything you feel is missing or could be improved in the Global Science Opera-project?
20. Do you feel that the field of science is being taken seriously through the GSO-project, and in which way/ in which way not?
21. Do you feel that the field of arts (drama, music, arts & crafts) is being taken seriously by the GSO-project, and which way/ in which way not?
22. Have you observed your students learning more about creativity/creative expression through the GSO Ecoscenography workshop?
23. Do you think your students have gained from participating in the GSO-project? If yes, what have they gained?
24. Are there any other observations of your students attending the workshop you would like to share?
25. Do you have any other comments or thoughts you´d like to share?

Appendix 4: Workshop design test-project

Test-project Ecoscenography workshop at GHOU/GTTP
5 minute introduction to Ecoscenography and task at hand
35 minutes of practical work
15 minutes of presentation (all groups including music and drama)

Yesterday´s headlines in the news was a discovery of a new neighbor: Proxima Centauri B, only 4,2 light-years from Earth.

Task: imagine the surface of Proxima B. Imagine there really is water there. Imagine there really is life there. What kind of life is it? Which life-forms? Is it life we´ve seen before? Or is it something completely new? Today we are going to explore the surface of Proxima B with our imagination. Based on your scientific knowledge, and just for today: not be afraid to add a little imagination where we don´t know the truth.

Scenography defines the environment for the characters to move in. Either directly and concrete, or even symbolically. It can be a painted backdrop suggesting time and place, it can be an abstract architectural 3D-set. The set has 2 main tasks: to give the actors an environment to play in and to help the audience understand the space/mood of the play.

Decide upon what the genre should be: Historical, animal-kingdom, futuristic sci-fi, osv.

How would you work with visualizing the environment on an exoplanet? What colors? Textures, materials? Smell? Feel? Temperature? Movement? Sounds? How can we sense the surroundings? How can we help/guide the audience to a certain mood?

Example: Force! How to visualize a force? How to visualize a particle? How to give the particle or force characteristics? Shape? Color? Movement? Sound? Smell?

What surroundings defines “home” to the creatures living on Proxima B?

Scenography is closely related to the lighting-design. Especially here. Without light, you can´t see! What color is the light on Proxima B? Are there nuances? Are there shades, clouds, mist/fog? How is the light in the daytime/nighttime? Are there seasonal changes? How can we illustrate this in practice with low-fi equipment?

Costumes: What are the life-forms living on Proxima B? How do we imagine them? What shape are they? What are their characteristics? If they were a person, what would be their traits, interests, talents, temperament? And from there, how do we visualize? Color? Shape? Size? Movement?

What is the story we want to tell and how do we visualize it? Because of the time-frame, I have made rather strict restrictions in the frame you can work within. And how can we add the eco-sustainability into the picture?
1: set – build construction from bamboo and paper-tape
2: lights – play with filters, different light-sources (overhead projectors, flashlight and par-cans, add water and liquid color?)

3: costume – play with origami, folding, cutting and tying together pieces of white cotton cloth. Think kilts and kimonos, Greek drapes and Indian saris)

Appendix 5: Workshop design Japan

Workshop 1: GSO Ecoscenography workshop in Japan

25 students, 3 days

October 8th
10:00 prepare for workshop
1:00-4:00 workshop costumes 3 hours

October 9th
9:00 -12:00 workshop set
12:00 - 13:00 lunch
13:00 - 16:00 workshop light

October 10th
9:00 filming the scene for the opera
10:00 interviews ca 2 hours

Day 1:
A little theoretical introduction:
What is Global Science Opera and how do you make an opera?
Work with the scene: Joao meets little girl for the first time. 4 groups work with different scenarios – follow GSO-method – vote.
Drama-group: Rehearse scene
Music-group: Make sound-set for scene
Show/play for each other

Day 2:
Working creatively with the set
Introduction: What are the visual frames of a theatrical performance, and how do you make them? (Set/scenography, costume, props, lights, poster/PR-material)
Introduction to eco-design and Ecoscenography. Sustainable materials and how to use them.
«The Ghost Particle» How do we imagine it looks? Can we, with our fantasy, imagine the world of a particle? A collective brainstorming on imagination and working creatively with visual ideas.
Practical assignment: How can we make a 3-dimentional shape from something flat? Inspiration from origami, kimonos and no-waste-fashion
1st group-work
Group 1: STITCH – 6 cloth-pieces can be twisted and stitched together into a costume
Group 2: DRAPE – drape 5 meters cotton fabric into a costume
Group 3: ORIGAMI - fold washi-paper into a costume
Group 4: CUT + TAPE – cut washi-paper and tape down into a costume

2nd group-work
Group 1: LIGHT. working with light and light-filters, projecting on different backgrounds
Group 2: BUILD. working with bamboo-sticks and tape, making light-weight constructions

We need: two or more light-sources (Theatre-lamps or strong flash-lights, whatever is available), light-filters, prism-glass, 100-200 bamboo-sticks between 1-1,5 meters long, some rolls of tape, sewing-thread, needles, scissors, natural fabric and an iron, a roll of washi-paper, tape, scissors,

Day 3:
Bringing it all together: rehearse, get into costumes, and film the scene
Evaluation: written questionnaires/interviews

Appendix 6: Workshop design USA

Ecoscenography workshop in MIT high school

Lead by Janne Robberstad, Stord Haugesund University College

Program:
Introduction (15 minutes)
- who are we and why are we here? Today´s agenda + warm-up
- What is GSO? (students already know about GSO, just need a quick recap)

What is Ecoscenography – Power Point Presentation (45 minutes) (– need video-projector)
- Scenography (costumes, set, light, ++)
- Ecology and sustainable design (why and how. Show examples)

"Moon village" (15 minutes)
- ESA´s vision
- The similarities of design in sustainable eco-design and designing a space-station
- How would we design for space? What do we need to think about? What criteria need to be followed?

Presentation of practical work in groups
Practical workshop, (105 minutes):

1. Set:
    a. Question: What is the moon made of and how can this be used on making the space station/things needed inside the space-station? What does the moon surface look like?
    b. Assignment: mix your own paint and paint a moon-inspired background. Collect grit and dirt from parking-lot or corridors (or similar places), mix with egg-yolks. Paint onto unbleached paper
    c. Materials/equipment needed: large roll of unbleached paper, 2 dozen eggs, 2 bowls, a mortar, a spatula, 6-8 paint-brushes in different sizes (We are making a backdrop, so interior paint-brushes will be good for size), access to water. Oh, and dirt. (natural materials, not mixing with technicals)
    d. Creative support/master-assistant/observer preparations: read about the moon´s composition and paint-recipe
2. Costume:

   a. Question: What do you wear in a space station, inside + outside, what functions does the clothes need to fulfill?
   b. Assignment: crochet garment for indoor use in space-station. Use either old T-shirts, cut into long strips of 5 cm (round and round circle best, then you don´t have to knot together often) (recycling) OR plastic bags cut into strips. If we have glue-gun and hard plastic bottles (like shampoo-bottles), cut into regular pieces and glue onto nylon-tulle-net for wearable protection-shield (reusing technical materials, not mixing with naturals).
   c. Materials/equipment needed: 3-4 glue-guns with glue, recovered hard-plastic bottles, scissors, 2 meters nylon tulle, 6-8 BIG crochet-needles, old T-shirts and/or a load of used plastic bags to be recycled
   d. Creative support/master-assistant/observer preparations: touch up on crochet-skills.
3. Light (and soundscape):
   a. Question: What is the atmosphere on the moon? What is required of the atmosphere inside the space station? Apart from light and color, what else makes an atmosphere? How would you make the space-station "home"?
   b. Assignment: Using overhead-projectors and flashlights, colored filters and such, make atmosphere on the moon. How can you make movement/changes in atmosphere? (water, wind, mirrors, ++)
   c. Materials/equipment needed: min. 2-4 overhead-projectors, mirrors, 6-8 flash-lights, colored filters, 2-4 see-through lasagna-pans, aluminum foil, access to water, inks, 2-3 empty spray-bottles, a hazer if you have access to one?
   d. Creative support/master-assistant/observer: if you choose to include sound, use body and random objects as instruments – keeping it low-fi.

All groups must discuss actual facts to questions, and be clear on what are facts and what is fiction/fantasy.

Present group-work for each other. (30 minutes)

Evaluation (30 minutes)
- oral – in group conversation
- written – answer questionnaire (This was moved to the next day)

<u>Assignment for observers:</u>
Feel free to move around in room, or stay with one group. Take special care to observe any moments when science and creativity merges, any "a-ha!-moments". Also observe if the are moments when science and creativity clashes, and prevents or slows down the process.
Please take notes as you observe, and add more filling notes after the workshop of needed. Anything else you find peculiar or interesting or funny or strange or any observed reactions from the students, be it boredom, interest, excitement… anything.
Every piece of information you observe and share with me, is greatly valued!

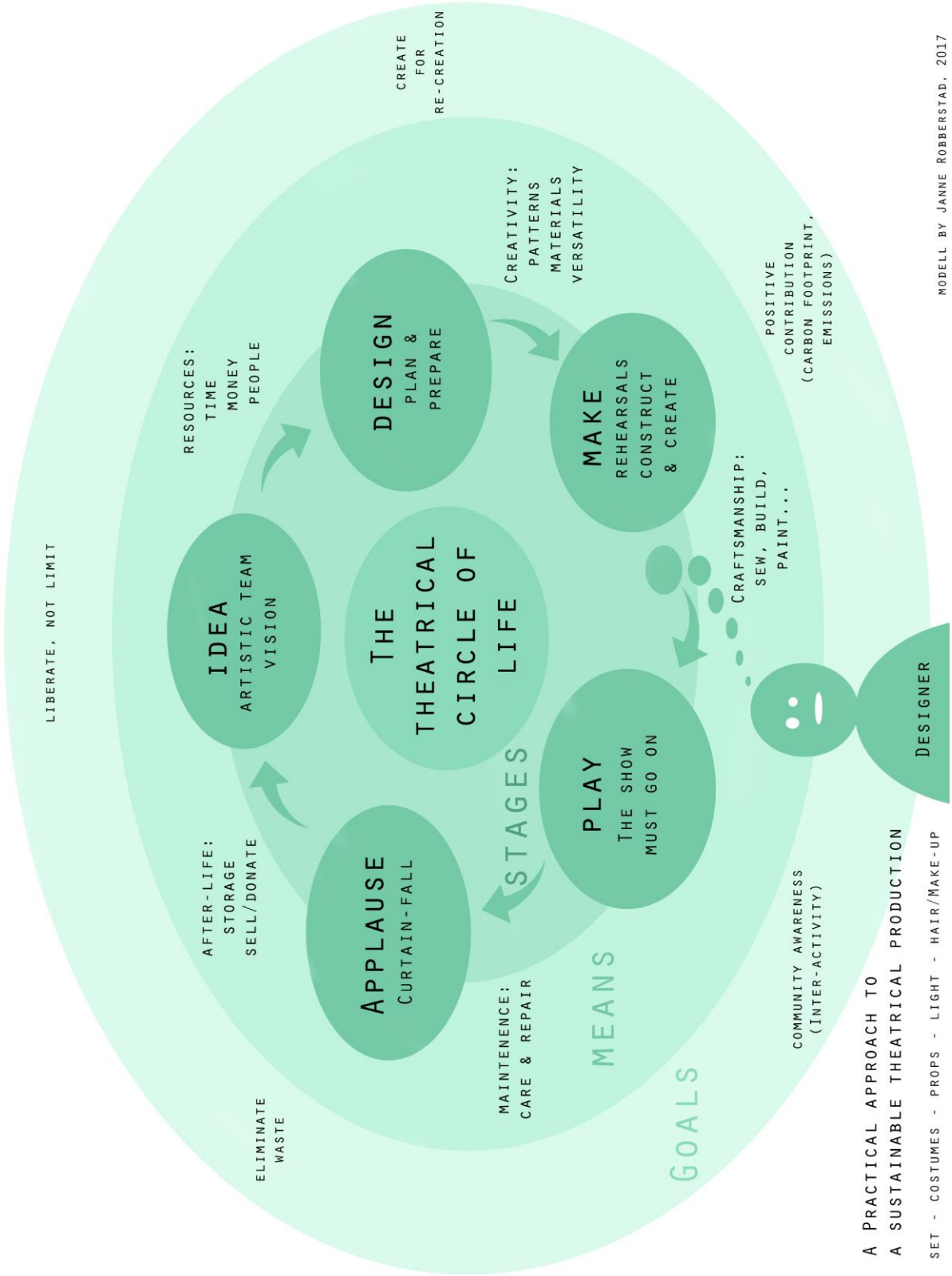
<u>Request for high school:</u>
Is it possible to have access to a technical support person to help with video-projectors, computers, and for the light- /soundscape group?

<u>Color-codes:</u>
Green is expected time-use
Blue is eco-reference
Orange is materials teacher and/or students will supply, please encourage students to start collecting
Purple is materials I will bring

Inspiration and information:
https://ecoscenography.com/what-is-ecoscenography/
http://www.bluehaired.com/corner/wp-content/uploads/2009/12/Cradle-to-Cradle-in-a-nutshell-Bram-van-der-Grinten-2008.pdf

The plan above is still a sketch, changes may occur.
Any questions, please contact Janne at: janne@spotogspindel.no

Appendix 7: A practical approach to a sustainable theatrical production



Appendix 8: How to improve the artistic quality of the visual framing of the Global Science Opera Production

In the Global Science Opera (GSO) we aim to achieve a high interdisciplinary learning outcome, cultural creativity, sustainable design and artistic quality. The visual frames include set, costume, props, lights, make-up and any printed or original artistic work presented in and around the opera. In order to enhance the artistic quality and the learning outcome for students involved in GSO, here are some general guidelines:

Concept. The purpose of the visual frames is to enhance the story and help the audience understand the setting and the characters. Embrace the ecological design as a creative starting point and opportunity.

Time. Allow the students enough time to make their artistic contributions for the visual framing of the show. Go beyond the temporary in pursuit of positive social and environmental contributions.

Creativity. The first idea is not necessarily the best. Dare to bring lots of ideas to the table before choosing what to do/make. Allow opportunities of place-based challenges and greet blissful chances.

Craftsmanship. The joy of creating grows with the ability to perform quality craftsmanship. Teach students techniques and skills needed to design and produce. Learning how to make oneself, makes you appreciate what others have made.

Culture. Celebrate the differences, embrace your own cultural heritage and be inspired by others.

Equipment. Give students proper supplies and tools to work with. This shows that their artistic contribution is being taken seriously.

Sustainability. Use materials that are both people- and planet-friendly. Simply because we want both people and planet to thrive! Embrace the ecological design as a creative starting point and opportunity. Acknowledge the ecological complexity in overcoming sustainability assumptions and challenges. This means learning about sustainable materials and processes.

Feedback. Give constructive feedback to students both during the creative process and at the finished result to guide them in their act of creating. Let students develop ownership with the show through their contributions.

Appreciation. When the students have completed their artistic contributions, take care to showcase it in a proper manner. The visual frame is an integrated part of the show. If you are displaying artworks outside the stage, make clean and tidy displays, for all to enjoy. Applaud the artistic effort.

Documentation and evaluation. Document process and product as inspiration for the next project. Evaluate what you did good and what you can do even better.

Recognize that people are always the greatest asset in a production!

* Ecoscenography principles by Tanja Beer, Melbourne University

Appendix 9: Practical guidelines for making ecological sustainable costumes

1. Plan ahead, make sure you have enough time to make affordably, so you don´t have to buy expensively. Plan materials to minimizing waste.
2. Be creative: reuse or recycle other textiles, save money and the environment.
3. Value high-quality craftsmanship. Costumes that are well-made, last longer, and saves money in the long run.
4. Appreciate natural materials, they are easier to work with and easier to recycle. And they are healthier both in producing, wearing and discarding.
5. If possible, do not mix natural and manmade textiles/materials together, they make it harder to recycle the materials later.
6. Support local businesses who supply short-travelled materials.
7. Value people and their knowledge and skills – ask for guidance and advice from professionals or retired grandmothers/fathers.
8. Consider how every costume should have several life-cycles and be used again and again. For instance by making the costumes adaptable to size (extra fabric in sides) and character (easy-to-remove-and-change embellishment)
9. Take care of costumes after use, so they can be used again in a new show.

Appendix 10: An overview of Arts and Crafts-education in Japanese schools

Primary school

grade	age	lessons per week (45 minutes per 1 lesson)			Note
		Arts and Crafts	Science	Life Environment Studies	
1	7	2	-	3	
2	8	2	-	3	
3	9	1,7	2,6	-	
4	10	1,7	3	-	
5	11	1,4	3	-	
6	12	1,4	3	-	

Junior high school

grade	age	lessons per week (50 minutes per 1 lesson)			Note
		Arts and Crafts	Science		
1	13	1,3	3		
2	14	1	4		
3	15	1	4		

Senior high

grade		age	lessons per week (50 minutes per 1 lesson)			Note
			Arts and Crafts	Science		
1		16	2	4		Science: 2 for "Basic biology", 2 for "Basic earth science"
2	science course	17	2	6		Science: 3 for "Basic physics", 3 for "Basic biology"
	literature course		2	2		Science:2 for "Basic biology"
3	science course	18	0	8 or 10		Science:4 for "Advanced chemistry", 4 for "Advanced physics" or "Advanced biology". They can study other two "Basic earth science" lessons if they want to take.
	literature course		0 or 2	2 or 4		Arts and Crafts: they can 2 lessons per week if they want to take. Science:2 for "Basic earth science". They can study other two "Basic biology" lessons if they want to take.

Appendix 11: Quotes

"I think this eco-scenography is a very interesting element of how you have a play in the play, but in a very serious topic. The way we consider some milestone of the moon village, we´ll have some construction, we´ll have some modules, which are protected from extreme environment, cosmic waves, meteorite impacts using the local soil. But also we have to find a way to recycle the oxygen, the water, also to make use of all the materials that we have there: metals, plastics and (clear?) it is nice to use a play about the moon-village to make people aware about this need for sustainability. And clearly we can also teach the public and the youth some of the challenges we have for lunar exploration about sustainability are going to help us also on earth to help us to develop thinking and also some practice on being more sustainable."

Dr. Bernard Foing, in interview of March 2017

"Sustainability should be incorporated in every aspect of children's education. We need to see sustainability as a fundamentally creative and cultural process – not just something that is discussed in science class. Ecoscenography is just one way in which children can engage with sustainability in theatre education. We should see it as our responsibility to prepare children for the challenges ahead."

Tanja Beer, in e-mail of May 5th, 2017

"One of the most important messages of the field of sustainable development is that humanity has become a serious threat to its own future well-being, and perhaps its survival, as the result of unprecedented human-caused harm to the natural environment." *Jeffrey Sachs, The Age of sustainable Development*

"Education is the most powerful path to sustainability. Economic and technological solutions, political regulations or financial incentives are not enough. We need a fundamental change in the way we think and act"

Irina Bokova, Director General of UNESCO, 2012

"The important thing about science is not so much to obtain new facts as to discover new ways of thinking about them"

W. L. Bragg