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Faculty of Architecture

Department of Interior Architecture

# Sustainability in Education:

Designing a Course on Functional Materials

for Upper Secondary School

Master's thesis

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# Abstract

The human species is a young living on planet Earth, and yet we seem to have the biggest impact on our surrounding environment. One can say we are still figuring out, how to live in the best possible way to sustain our lives here for the next thousands of generations. This requires a smart way of managing and taking care of the environment and therefore natural resources in order to satisfy our needs. I am interested in sustainable ways in which we could teach better approaches towards resources from the early stages of life.

This master thesis is dedicated to a subject upon which a new curriculum for upper secondary school level pupils could grow upon. I am looking at existing and new methods in understanding, teaching and creating materials for living. Based on the interviews, both quantitative and qualitative, done with most actors involved with the study process, pupils and teaching staff, it was clear that there is a need for new insights and skills in order to understand the current situation in environmental issues and feel empowered and able to take steps for possible solutions. The proposed new elective subject intends to combine skills and knowledge into an interdisciplinary workbook for students, combining knowledge from material studies, chemistry and biology. The attempt is to integrate different subjects, supporting theme of *Environment and Sustainable Development* in the National School Curricula in order to reach a more holistic approach by seeing more interconnections between the processes in everyday life.

This might also be another way to engage and find those, who might want to dedicate themselves into any form of architecture, who would usually not get in touch with it in the general school and the non-formal education of architecture studies for this age group in Estonia has only started a few years ago. Subject gives a chance to learn by making while engaging all senses.

Keywords: environmental sustainability, education, biodesign, materials, wasted resources.

“Never let schooling get in the way of your education.”

Benjamin Franklin (1706-1790), American polymath

## Introduction

### *Statement of the problem and research questions*

People worldwide spend an estimated 90% of their days indoors.<sup>1</sup> The materials we use inside the buildings affect our health. Currently so many commonly used standard materials and compounds in interior architecture are potentially toxic elements.<sup>2</sup> This thesis suggests that to change this in the future, we need to educate an environmentally aware generation which is aware of materials, and their ecological footprint.

Currently, there is a lack of multidisciplinary teaching methods in the subjects of school curricula in upper secondary schools<sup>3</sup> in Estonia, which would enable students to think and see the materials around us in a more holistic way. Designing through materials is a novel topic which is now developed at university levels, but it should be introduced to a younger audience too. Margus Pedaste, biologist and visiting researcher at the Stanford University, writes that the majority of the research done on education from elementary to high school claims that most of the commonly used teaching methods are inefficient.<sup>4</sup> Hence if exchange of ideas and communication between researchers of different fields, educationists, teaching

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<sup>1</sup> The Indoor Generation. –Velux. <https://www.velux.com/indoorgeneration>. (Accessed 15 November 2019).

<sup>2</sup> L. Peoples. Are Toxic Chemicals In Building Materials Making Us Sick? – *HuffPost*. 12 December 2013, [https://www.huffpost.com/entry/building-materials-asthma\\_n\\_4427243](https://www.huffpost.com/entry/building-materials-asthma_n_4427243). (Accessed 28 apr. 2020).

<sup>3</sup> In Estonia, an upper secondary school (grades 10-12) is a voluntary general education school following a basic school. which provides opportunities to acquire general secondary education. The standard period of study in an upper secondary school is three years. Põhikooli- ja gümnaasiumiseadus. – *Riigi Teataja*, 2010 <https://www.riigiteataja.ee/akt/13332410> (Accessed 29 April 2020).

<sup>4</sup> M. Pedaste, Miks Nobelist hakkas haridusteadusega tegelema. – *Õpetajate Leht*, 13 April 2018, p. 4.

methodologists and teachers would be better, the curricula would also become more efficient.

This master's project aspires to bring together different elements of school curricula which relate to the material world. The aim is to design a curriculum which fosters knowledge and expertise of materials and sustainability within youth at upper secondary school level. I focus on materials which can be found in interior spaces (furniture, home textiles), since these are the ones we come to contact most.

My study into an open-minded interior architecture curriculum was driven by the wish to contribute to a world in which designers and architects act responsibly for what materials they choose in designing the environment around us. I have often turned down design-related jobs offers because I do not want to work with materials which have a negative impact on the environment. Therefore, in my master's thesis I felt the urge to learn more about what sustainable materials and ways of creating.

Finnish architect and environmental artist Marco Casagrande once said at an event in our interior architecture department that architects are like horses and interior architects are ants, referring to their scale of influence. This could be exemplified by the fact that by law the structure of the house is supposed to be guaranteed for at least 50 years, whereas the interior design and fitting should only last for 5-20 years. I believe that interior architecture can become a 'horse' as well. Some materials are ageless and only gain more beauty with time, such as wood and leather. Others lose their face – usually plastics. As designers, we do not just design the environment, we are designing experience and behaviour. I hope that by dealing with materials I raise awareness towards more sustainable and natural choices.

My hypothesis is that to gain a more holistic understanding of the environment, students must both study the materials and make (something with) the materials. Therefore, I am designing an elective school subject which consists of three main categories: environment, materials and design.

Taking everything into account, the study seeks to address the following questions: What is sustainable thinking, making and creating? How to teach sustainability within a creative study process? How to study and create in a way which is active, raises more awareness of environment, teaches responsibility through the process ?

### *My viewpoint on education and personal commitment*

Imbi Henno, from National Examination and Qualification Centre, in her presentation for the conference on “*Values and Conflicts in Environmental Ethics*” calls upon a need for a discourse shift in the root-metaphors used in discourse on education.<sup>5</sup> She stresses the importance of language in the role of education for sustainable development. I agree with her claim that there must be a change in the thinking and I believe it is slowly happening in the Estonian educational scene. If we keep on thinking of ecology the way we are used to in subject-based curricula<sup>6</sup> we cannot make changes.<sup>7</sup> If we shift our thinking to enable more connections, teaching methods and new courses in which sustainability and environmental protection are integral parts of learning, we can move towards more holistic thinking

Over the last decades there have been some pioneers who have given their input towards a more interesting and happy school environment. For example, *Huvitav kool* (Interesting school) is an initiative started by Ministry of Education and Research to make learning experience exciting for both students and teachers.<sup>8</sup> Some of the fresh practices are which I intend to bring in my curriculum are: integration of subjects, novel teaching-methods, connections to real life, creative projects, formative assessment and up to date concept of learning.<sup>9</sup>

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<sup>5</sup> I. Henno, The discourse of education for sustainable development and Estonian teachers' approach to education for sustainable development. – *Values and Conflicts in Environmental Ethics*. Eds. R. Kesksaik, S. Rattasepp, K. Kotov. Tartu: Estonian Naturalists Society, 2005, p. 20.

<sup>6</sup> Kust tüled ja kuhu lähed, Huvitav Kool. – Huvitav Kool, 28 February 2020, <https://www.huvitavkool.ee/2020/02/kust-tuled-ja-kuhu-lahed-huvitav-kool.html>. (Accessed 20 April 2020).

<sup>7</sup> A. Diamond, The Science of Attention. – *On Being*, 19 November 2009, <https://onbeing.org/programs/adele-diamond-the-science-of-attention/> (Accessed 29 April. 2020).

<sup>8</sup> Huvitav Kool. – *Huvitav Kool*, undated, <https://www.huvitavkool.ee/>. (Accessed 11 May 2020).

<sup>9</sup> Eesti elukestva õppe strateegia 2020 [Estonian Lifelong Learning Strategy]. – *Haridus- ja Teadusministeerium*, undated, <https://www.hm.ee/et/est-elu-kestva-ope-strateegia-2020> (Accessed 29 April 2020).

I am myself a teacher at a non-formal art school where I have had the opportunity to practice innovative project-based teachings and field trips outside of the school. I believe that non-formal education is often a role model for formal education, with its freer and more individualised take on teaching processes. There is an informal setting and children have bigger urge to create and learn new things. My aim is to bring this kind of thinking closer to formal education.

### *Current situation in teaching ecological sustainability in Estonia*

In Estonia, there are currently around 120 institutions providing environmental programmes for children and grown-ups: kindergartens, schools, universities, state-sponsored environmental education centres, NGO-s, State Forest Management Centre (RMK), local municipalities etc. In 2016 Estonia joined an international Eco-Schools global programme initiated by the Foundation for Environmental Education. Over 120 educational institutions around the country have joined by the year of 2019.<sup>10</sup> The fact that so many schools have joined in a considerably short time shows that there is a need and large interest in such topics.

Interestingly, a big part of environmental learning from kindergartens up to upper secondary schools takes place outside of the schools. In the countryside, families must drive their kids to bigger towns to be able to take part of such courses.<sup>11</sup> Ironically, to teach sustainability an extra amount of carbon dioxide gas is emitted in the air.<sup>12</sup> There is even a special Environmental Education Bus<sup>13</sup> in Järva county which also drives around neighbouring counties, burning even more fuel. I believe it would make more sense to attach environmental learning more strongly to local schools. However, as visiting forests and different environmental landscapes is part of the learning processes, there are no easy solutions. Another aspect is the rise of online learning, which can help reach more pupils,

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<sup>10</sup> Roheline kool. – Keskkonnaharidus, undated, <https://keskkonnaharidus.ee/et/vorgustik/roheline-kool> (Accessed 11 May. 2020).

<sup>11</sup> Öppeprogrammid. – Keskkonnaharidus, undated, <https://keskkonnaharidus.ee/et/oppeprogrammid> (Accessed 30 April 2020).

<sup>12</sup> S. Pärismäa, Keskkonnaharidus pole vaid bioloogiaõpetaja rida. – Õpetajate Leht, 13 April 2018, <https://opleht.ee/2018/04/keskkonnaharidus-pole-vaid-bioloogiaopetaja-rida/> (Accessed 20 April 2020).

<sup>13</sup> Keskkonnahariduse buss. – Keskkonnaharidus, undated, <https://keskkonnaharidus.ee/en/group/58> (Accessed 20 April 2020).



while on the other hand one must be aware of the dreadful ecological footprint of ever-growing data banks.

Overall, environmental awareness and sustainable development has become a leitmotif in governmental documents on education. Asta Tuusti, adviser on environmental awareness at the Ministry of Environment in Estonia, claims that nature is the basis of culture and economy and therefore it is an important resource and value to protect and keep. Nature in general and natural sciences are popular subjects among Estonian pupils, as statistics proves that the number of students choosing to study life and natural sciences in universities is growing: in 2015 it was 26,5 % , in 2019 already 28,5% and is expected to be 29% in 2020.<sup>14</sup> However, the problem is that environmental thinking and sustainability is squeezed tightly within natural sciences classes and this has a negative effect on youngsters' ability to grasp the 'big picture'. She suggests that the educational system should come up with a systemic approach through collaboration. Furthermore, school as such should operate in a sustainable way and set a positive example.<sup>15</sup> The lead-by-example approach is also the key attitude of my thesis.

### *Methodology*

My master's thesis is formally divided into two main parts. The first part is the thesis which gives a theoretical grounding for the second part which is a workbook designed for pupils who would take part of the course suggested in this thesis.

The theoretical thesis is divided into three chapters. The first chapter introduces the most important terms and concepts (sustainability, materiality, ecodesign, learning, research-based teaching) used throughout the thesis. In the second chapter I introduce and analyse three educational projects (Materiom, Living Materials and School of Architecture) which have inspired my solution. In the third chapter I introduce the elective subject in detail: what are

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<sup>14</sup> Üldharidusprogramm 2020-2023. – Haridus- ja Teadusministeerium [https://www.hm.ee/sites/default/files/4\\_uldharidusprogramm\\_2020\\_23.pdf](https://www.hm.ee/sites/default/files/4_uldharidusprogramm_2020_23.pdf) (Accessed 20 April 2020).

<sup>15</sup> S.Pärismaa, Keskkonnaharidus..., p. 9.

the themes which will be taught, how the programme is going to be structured and what will happen during each of the 16 meetings. Furthermore, I explain how pupils will be evaluated.

The thesis contains four appendices. Appendix 1 introduces the questionnaire I made among pupils to find out about their needs and wishes in terms of learning about the environment. Appendix 2 is transcription of an interview I conducted at an earlier phase of my project. I interviewed an employee of an Estonian company who imports luxurious foreign leather products to Estonia to find out what feeds such environmentally dubious business in a country which itself produces excessive amount of leather waste each year. Appendix 3 introduces an experiment with materials which I conducted myself and would like to bring in to the curriculum as well. Appendix 4 is the workbook.

In terms of designing the curriculum I rely on process-, project- and problem-based learning which will be introduced in Chapter 1. Chapter 2 analyses various process- and problem-based learning projects which inform my curriculum. Besides that I make use of several interviews conducted with teachers, I bring in my own experience as a teachers and make use of my background as a leather artist and designer to initiate course which makes extensive use of experimenting with materials.

### *Literature review*

In terms of sustainability the key source in my thesis is *Sustainability: A History* by Jeremy L. Caradonna.<sup>16</sup> In terms of design I have relied on *Ecodesign* by S. Barbero, B. Cozzo, P. Tamborrini.<sup>17</sup> As for information on materials I have found useful the *Handbook of Biopolymers and Biodegradable plastics* edited by Sina Ebnesajjad.<sup>18</sup> It gives a good overview of the history and also what is the approach and current trends in researching them. Also I rely a book called *The Chemarts Cookbook* published by Aalto University.<sup>19</sup> Pirjo Kääriäinen, one of the developers of CHEMARTS, writes that speculative design and design

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<sup>16</sup> J. L. Caradonna. 2014. *Sustainability: A History*. New York, Oxford University Press.

<sup>17</sup> S. Barbero, B. Cozzo, P. Tamborrini. 2015. *Ecodesign*. Potsdam: H. F. Ullmann Publishing.

<sup>18</sup> S. Ebnesajjad (ed.), *Handbook of Biopolymers and Biodegradable plastics*. Properties, Processing and Applications. Oxford: Elsevier, 2013.

<sup>19</sup> P. Kääriäinen, L. Tervinen, P. Vuorinen, N. Riutta, *The CHEMARTS Cookbook*. Espoo: Aalto ARTS Books, 2020.

fiction are great tools among designers to encourage their audience to ask questions and act rather than simply consume.<sup>20</sup> This is what I wish to build my project upon as well.

*Kunstiõpik gümnaasiumile (Textbook for Upper Secondary School)*<sup>21</sup> by Jaak and Andres Adamson helped me frame some of the exercises in the project part. The School of Architecture's teacher's book *Arhitektuur ja Elukeskkond (Architecture and Living Environment)*<sup>22</sup> gave a good overview of how built environment has been taught in the last decade to particular school age group.

There are several master's theses which I draw upon. From the didactical point of view I found helpful Eva-Maria Truusalu master's thesis *Environment Initiating Play: Kindergarten as an Abstract Play Landscape*.<sup>23</sup> Although she was looking into rather how the physical environment itself could help investigate the topic of preschool educational facilities and question how the physical environment of kindergartens could become a more active partner in children's development process, she touched many important features connected to children creativity.

For the theses connected to material studies, I found several works important. Annika Kaldoja wrote in her *Kohvi morfoosid. Jäätmest ressursiks (Coffee Morphoses. From Waste to Resource)*<sup>24</sup> about circular economy principles around the ground coffee waste from Tallinn's Old Town cafes from which she was experimenting making new possible materials applied variously. Katrin Kabun in her master's thesis *Jääkvill. Kasutamata ressursist interjööri lahenduseni (Waste wool. From unused resource to interior solutions)*<sup>25</sup> studied how to apply unused wool fibers as valuable material for the interior solutions. Not only is it a source for designing part of the subject, but also the vision shared of a leftover materials as a source of inspiration and valuable material.

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P. Kääriäinen, L. Tervinen, P. Vuorinen, N. Riutta, *The CHEMARTS Cookbook*, p.25.

<sup>21</sup> J. Adamson, A. Adamson, *Kunstiõpik gümnaasiumile [Textbook for Upper Secondary School]*. Tallinn: Argo, 2020.

<sup>22</sup> K. Klementi, K. Nõmm, *Õpetaja raamat. Arhitektuur ja elukeskkond.* – Arhitektuurikool, 2017. <https://www.arhitektuurikool.ee/wp-content/uploads/2020/01/AKE-6petajaraamat-29-04-2017.pdf> (Accessed 20 April 2020).

<sup>23</sup> E.-M. Truusalu, *Environment Initiating Play: Kindergarten as an Abstract Play Landscape*. Master's thesis, Estonian Academy of Arts, 2019.

<sup>24</sup> A. Kaldoja, *Kohvi morfoosid. Jäätmest ressursiks*. Master's thesis, Estonian Academy of Arts, 2016.

<sup>25</sup> K. Kabun, *Jääkvill. Kasutamata ressursist interjööri lahenduseni*. Master's thesis, Estonian Academy of Arts, 2017.

I have also benefited from discussions with professionals active in the field sustainability expert Evelin Valtin, art and crafts teachers Triin Suurküla, Anete Lomp, wood workshop master Avo Tragel, fellow student Martin Kukk, plastics expert Pawan Saunya and polymers expert Ahto Luuri.

# 1. Environmental awareness in (teaching) design and architecture

## 1.1. Sustainability

The term sustainability as an economical concept was first described as term by German tax accountant and mining administrator Hans Carl von Carlowitz (1645-1714) in his book *Sylvicultura Oeconomica*. The basic principle of it was that no more wood is cut than grows, therefore no more energy used than produced. In modern economical situation we can see how the opposite is being praised in the image of loans for example. James F. Caradonna writes in *Sustainability* how the term became ubiquitous since 1970s and has been gaining popularity since.<sup>26</sup>

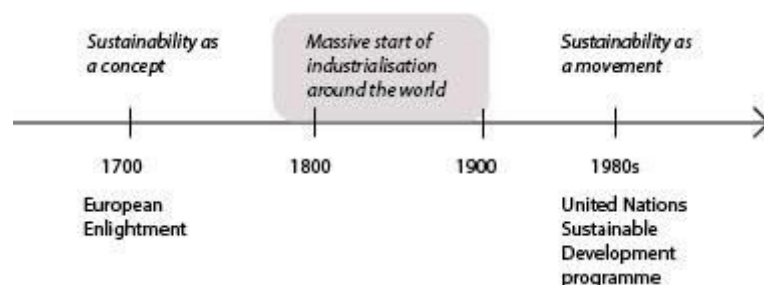


Figure 1. Timeline of sustainability.

I doubt the generations before did not think about those principles that make a society safe, stable, prosperous, and ecologically minded<sup>27</sup>, there might not have been such an outstanding need to sustain all these aspects. There is evidence we do not know it intuitively, not all of us. Amanda Sturgeon, architect and environmentalist, sees a tendency to care about nature much stronger in women than men. On a societal level, they work together and not always know in sum the best for sustaining in the long run. Story about the people of Polynesian Rapa Nui island, who over-exploited their land by cutting off all the wood they

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<sup>26</sup> J. Caradonna, *Sustainability...*, p.1.

<sup>27</sup> J. Caradonna, *Sustainability...*, p.2.

had to an almost extinction of their tribes, shows that it is not always intuitive to use resources wisely. Still, usually, as Corodonna portrays, indigenous tribes are living as stable societies in tune with nature and therefore sustainably and it is only the western world which needs the concepts and movements due to unstable society. It is still important to understand the need for teaching sustainability it in all possible frameworks.

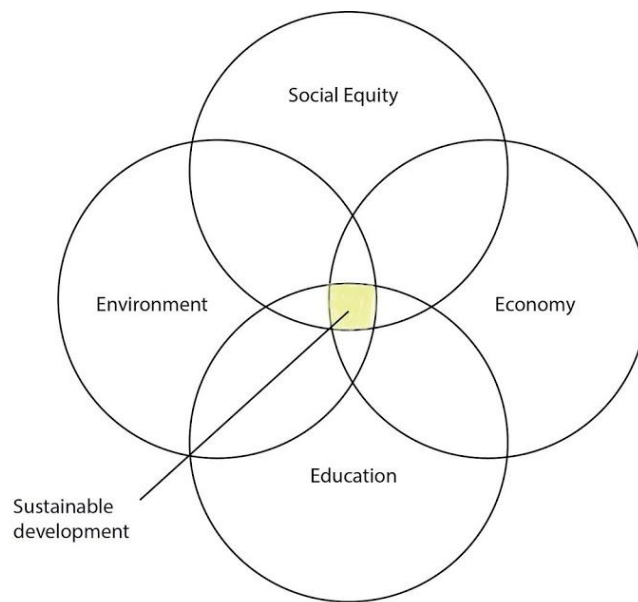


Figure 2. Venn diagram for sustainability with education included.<sup>28</sup>

Sustainability is a destination point to which this diagram (figure 2) is reaching, presenting the idea that sustainable development can be achieved when economic development is conducted in a manner that preserves and protects the environment and its resources while supporting individual and community well-being<sup>29</sup>. In the field of architecture, the path to sustainability would be through green or sustainable architecture, which focuses on developing buildings that are built and operate efficiently to conserve resources. It includes (a) the use of building materials that are produced sustainably or are recycled, (b) energy efficiency and the use of renewable energy sources (e.g., solar panels, wind turbines, heat pumps), (c) on-site waste management (e.g., composting toilets, food waste composting gardens, gray water management), and (d) designed in harmony with its

<sup>28</sup> J. Caradonna, *Sustainability...*, p.2.

<sup>29</sup> Venn Diagrams. –ScienceDirect, 2019. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/venn-diagrams> (Accessed: 19 May 2020).

surroundings<sup>30</sup>. This thesis focuses on these aspects that contribute to the use of sustainably produced and recycled materials, promoting use of non-toxic and non-synthetic materials and locally-obtained woods.

The construction sector is the leader in producing both materials and waste<sup>31</sup>. The U.K. Green Building Council states that it uses 400 million tons of material each year, 6 tons per person, most of which has adverse impact on the environment<sup>32</sup>. For example, in Estonia, there is a tremendous growth in the building sector between year 2017 and 2018<sup>33</sup>. And we do not know yet what to do with these materials other than dispose them. Especially because there are raw material crises, it is crucial we make conscious choices.

There are several important figures and discourses which on contrary believe in the abundance of ecological resources. Maybe this could be summed with the statement was *Après moi, le déluge* by Louis XV (1710-1774), the king of France. This is how many of us are living today and that's why climate change is the hottest topic on the plate. Again, it would be selfish of us to keep destroying our possible future, towards something that would cause massive extinction, because we do not know any other species who know how to take care of all the 440 nuclear power plants out there worldwide<sup>34</sup>. But already in 1848, it was J.S. Mill who stated that economic wealth should not rise indefinitely, but should culminate in a stationary state<sup>35</sup>. Simply, sustainability is about making smart choices in the very long run, caring for our own health and for the ones of future generations. Eco-labels in all kinds of industries, from food and energy, clothing, hygiene and building industry are abundantly growing, which logically drives to a thought whether all of certification systems and programs are reliable and make sense.

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<sup>30</sup> A. Ragheb, H. El-Shimy, G. Ragheb, Green Architecture: A Concept of Sustainability. – *Procedia - Social and Behavioral Sciences*, Volume 216, pp. 778 – 787.

<sup>31</sup> Resource use. – *UK Green Building Council*. <https://www.ukgbc.org/resource-use/>. (Accessed 27 March 2019).

<sup>32</sup> J. Snook, How Does Construction Impact the Environment? – *GoContractor*, 21 June 2017 <https://www.initiafy.com/blog/how-does-construction-impact-the-environment/> (Accessed 3 January 2019).

<sup>33</sup> Ehitus, IV kvartal 2019. – *Statistikaamet*, 25 February 2019, <https://www.stat.ee/13057> (Accessed 27 March 2019).

<sup>34</sup> J. Caradonna, *Sustainability...*, p.2.

<sup>35</sup> J. Caradonna, *Sustainability...*, p.2.

Since the industrial revolution world is portrayed as unsustainable, we are again seeking for the beauty in smaller scale: returning to small-scale energy production, local agriculture, decentralized decision making and low-impact practices<sup>36</sup>. At the moment it is so clearly needed in this time of COVID-19 outbreak and alertness of the world about it. The idea of decentralizing responsibility through taking on active roles, is what the young generation is feeling, yet not always knows how to channel the raw wish and emotions. I took part of 8-day global education training in the mountains of Busteni in Romania in 2013. There it was clear that to take in action, we need to understand the current situation and from where to make the shift happen. Seems like today the awareness of global issues and climate change is already vast and has reached mass media.

Thinking in terms of sustainability is becoming increasingly popular in higher education as well. In 2012, there was a workshop at the EAA interior architecture department led by Simo Heikkilä, which had a task to narrow down the amount of cutlery and flatware to 15 pieces, from all 20 000 objects a person is said to use over the period of their lifetime. At the end of the workshop they exhibited their choices with a simply designed wooden frame in the body of a shelf or another piece of furniture. This task illustrates well how little we actually need and that reducing what we don't actually need and refusing new by acknowledging old leads to simplicity and therefore order and beauty.

Emanuele Coccia, philosopher and author, talks about how we are back in the plant-renaissance time: the way we have started to draw more attention to them and learn from them. He writes beautifully about plants in his book *The Life of Plants: A Metaphysics of Mixture*.<sup>37</sup> He brings out an interesting thought that the world is a garden and the plants there are gardeners themselves, not as we are thinking from anthropocentric point of view, just plants we take care of. He states that the change in paradigm in biology since 1950, when symbiosis was proved, that plants have a lot to say in the way things could work. What he means by it is that everything on Earth is produced by another being, and as plants are responsible for the CO<sub>2</sub> and O<sub>2</sub> circulation, they are rather the active actors<sup>38</sup>. It is a little

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<sup>36</sup>

J. Caradonna, *Sustainability...*, p. 4.

<sup>37</sup> E. Coccia, *The Life of Plants: A Metaphysics of Mixture*. New Jersey: John Wiley & Sons, 2018.

<sup>38</sup>

The World After Plants According to Emanuele Coccia. – Youtube, 27 December 2019. <https://www.youtube.com/watch?v=ouXxdMO9EuU> (Accessed: 15 May 2020).



inconvenient for most to compare plants world to animal world, yet I do believe that more recognition and understanding how much we depend on them from most of the world would only do good. So is the aim of this thesis to work in collaboration with the plants.

## 1.2. Materiality

Just as sustainability is not the end point, so is not the materiality - they both show visions. Materiality is all encompassing: if architecture equals content plus form, then even fashion is architecture, just at a different scale. It also requires forms, materials and a body, which in the bigger scale is our earth or the embodiment of our spatial needs. Our material world today in 2020 is made up from all various materials we could think of as humans throughout our evolution. Some of them have stayed in the stories of history, others have been preserved either by their nature or with the good care of people.



*Figure 3. Living room and materials in it. Author's photo.*

I am living in a wooden, 'Lender type' house, built in 1916. Some of the usual materials in my living room (Figure 3) and their known or estimable age:

1. Suitcase - made from faux leather - 20-50 years.

2. Piece of felt - 100% wool - 5 years.
3. Speakers and Dell laptop - plastic and metal - 10 years.
4. Lamp shade - Metal (structure) and textile (shade)- 40 years.
5. Typical chair in Estonian older households, also known as folks or peoples chair - wood, plywood - 100 years<sup>39</sup>.
6. Windows - glass - 104 years.

The average age is quite high, 50 years, although I understand that these are just selected objects. Just wanted to illustrate with this example how long is a lifetime of some objects compared to nowadays, for example the folks chair from Luther factory and bad structured chairs typically sold at supermarkets or cheaper stores and which break within few years or lose their appealing looks, and are usually sold in high quantities<sup>40</sup>. It is rare to have a laptop, which is almost 10 years old and still operates, not comparable to newer versions, yet still takes the usual commands.

### *Material classification*

Looking at materials at the molecular level, there are different ways to classify materials, depending on the discipline. And, it is possible to go more precise with each table. Next there are divisions that gradually show a way to natural polymers, that I will mostly work with. In my work I am mainly focusing on biodegradable natural polymers (figure 4). Chemically polymer is a large molecule, or macromolecule, composed of many repeated subunits. Natural polymers are plant (cellulose, starch, etc.), animal (gelatine) and microbial (alginate) origin.

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<sup>39</sup> J. Kermik, *A. M. Luther 1877-1940: materjalist võrsunud vormiuuendus*. Tallinn: Sild, 2002.

<sup>40</sup> A. Tragel, *Interview with the author*, 18 May 2019.

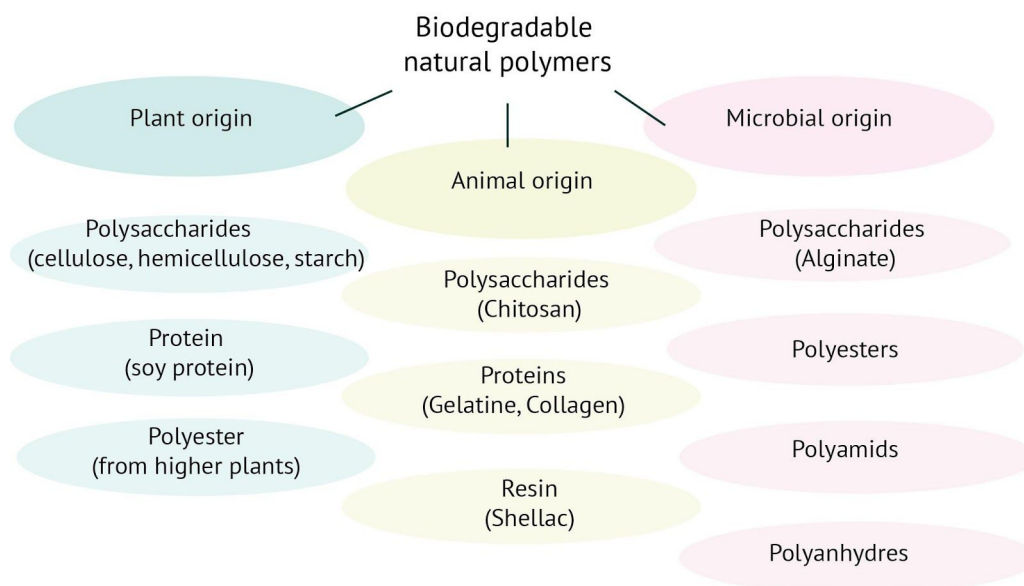


Figure 4. Classification of biodegradable Natural Polymers.

Plant-based materials have been traditionally used as food and feed. Their use as pharmacological and nutraceutical resources are increasing. Their use in industry as fuel and other consumer commodities began in the 1920's, but the low cost and durability of petroleum-based chemicals soon took over their role after the World War II<sup>41</sup>. I use those materials in my work, because they are widely used and usually grown out of our habitual areas, rural ones and origin of which often not fully understood, therefore I see a need for discussion and knowledge of their origin, such as there is an ethical debate in society over using some of them, for example the animal-based polymers.

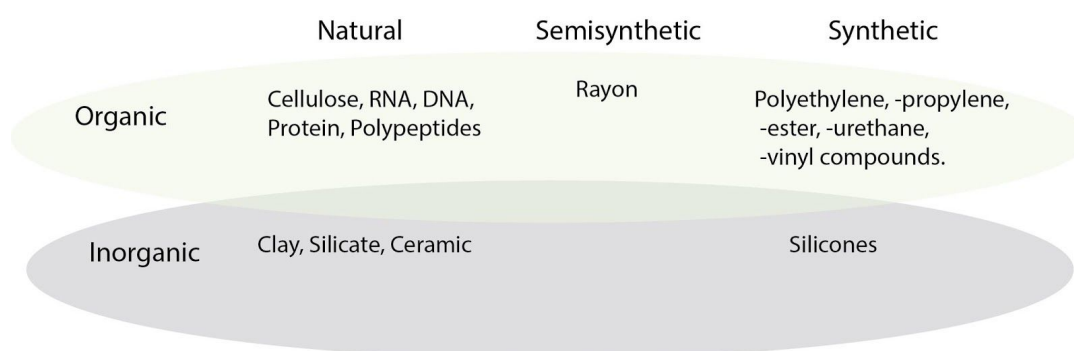


Figure 5. Polymers-based sources.

<sup>41</sup> S. Ebnesajjad (ed.), Handbook of Biopolymers, p.1.

Now commonly used petroleum-based polymers, which are derived from non-renewable resources, are on one side beneficial due to being disposable and can be highly durable<sup>42</sup>, yet have also brought, due to their large exposure and availability, overconsumption of materials. Nevertheless, petroleum resources are finite and they cause environmental problems, because of the amount of carbon dioxide released in the air from disposing those materials, such as fast-food utensils, packaging containers, and trash bags<sup>43</sup>. That is why it is more important to focus on developing materials that are organic origin and biodegrading fast and harmless to surrounding.

The main challenges of converting renewable resources into industrial materials are durability, compatibility, affordability and sustainability. When a new material is designed and manufactured, one consideration should be sustainability, including resource availability, land use, biodiversity, environmental impact, energy efficiency, soil conservation, and the impact on the social community. Besides a favourable life cycle analysis, research and development of bio-based products should consider the limits that will maintain sustainable development<sup>44</sup>.

Asta Tuusti, Adviser of Environmental Awareness to the Ministry of Environment says that we must be sure that the possible outcome gains from the environmental programme are bigger than the negative impact on the environment<sup>45</sup>. Sun states that important platforms for bio-product applications are the usual plant protein, oil, starch, lignin and cellulose materials. Since they cannot be used as they appear in nature, they need to be converted through various technologies into functional polymers<sup>46</sup>. She sees that in the coming century the effort must go into interdisciplinary approach within integrated research teams of material science and engineering, plant science, biochemistry and economics. An important role is on people who come in touch with the materials firsthand, designers and architects and why not the end

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<sup>42</sup> S. Ebnesajjad (ed.), Handbook of Biopolymers, p.1.

<sup>43</sup> S. Ebnesajjad (ed.), Handbook of Biopolymers, p.1.

<sup>44</sup> S. Ebnesajjad (ed.), Handbook of Biopolymers, p.6.

<sup>45</sup> S. Pärismäe, Keskkonnaharidus...

<sup>46</sup> S. Ebnesajjad (ed.), Handbook of Biopolymers, p. 8.

users, as we all are. Although there is hope and evidence of actions towards shift in types of raw material, I often hear how it is mainly behind the affordability, such as also with recycling the plastic waste. There is knowledge for recycling the “non-recyclable” light-weight plastic, yet it is financially it is not accepted.

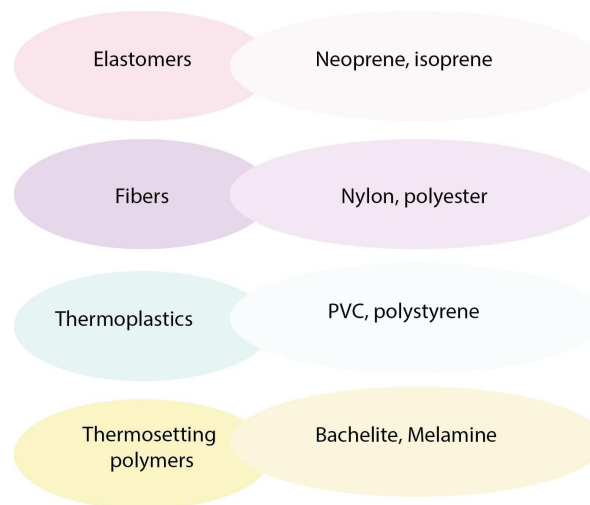


Figure 6. Polymers based on molecular forces.

In conclusion polymers are a group of materials that can be classified based on source, structures, reaction mode of polymerisation and molecular forces. For the experiments in class it is most useful to know them based on source and molecular forces.

### *From visual to tactile experiences*

Depth is an intrinsic quality to materials. It is necessary to touch the topic of senses, when talking about materials. We are living in predominantly visual world, most of nowadays architecture puts most stress on visual aspects. Famous philosopher Edmund Burke said in 1757 that the senses have a role on intervening the qualities of specific bodies mechanically to the mind. Juhani Pallasmaa, Finnish architect and author, former professor and dean of architecture, compares in his book *Space, Time and Architecture*, dealing with interior spaces

as a way to deal with our own inner space. In *The Eyes of the Skin* he thinks that vision and hearing are now the privileged sociable senses, whereas other three are considered archaic sensory remnants with a merely private function<sup>47</sup>. For example the time spent behind screens is mainly a visual experience, the tactility comes in from the use of mouse and keyboard or screen and those are rather supportive actions. It is clear when observing people on the streets and own actions that these days in general we have more experiences behind screens at the expense of other more fully engaging ones, such as sports, hands-on arts, reading a real book.

Peter Zumthor is an architect who always emphasizes the sensory aspects of the architectural experience. The way light plays with the materials is important in his work. And just as culture, architecture is something one must experience. And the only way is through our senses. Machiel Spaan writes in the book *Music, Space and Architecture* that many buildings are designed to please the eye, yet other senses influence how we experience buildings spatially<sup>48</sup>. He declares that in addition to sight, smell and touch, hearing determines the experience of space to great extent. Semir Zeki, professor of Neuroaesthetics at the UCL shares in his Ted talk that although the experience for visual and musical beauty happen in different areas of the brain, they are both reacting similarly to beautiful and ugly<sup>49</sup>. Perhaps at least one thing to derive from is that to maximize the experience of beauty, both visual and musical stimuli should be perceived as beautiful. Therefore, we must at least try to focus on including all senses when designing design.

“Architecture is frozen music” as world-known German writer Goethe said. Good simple visualisation to that are ideas from Japanese Dr. Masaru Emoto who wrote much critiqued book on way the water molecules form fractals according to the vibrations or specific music around it: rock and roll music creates blurrier and some classical pieces ordered ones.<sup>50</sup> Therefore, beauty in the sound and music is very much connected to the appearance of the thing, place itself. Sometimes the sound affects our whole experience, but sometimes it

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<sup>47</sup> J. Pallasmaa, *The Eyes of The Skin...*, p 16.

<sup>48</sup> M. Spaan, Research – M.Kloos, J. Bennett, C. Erens (eds.), *Music, Space and Architecture*. Amsterdam: Architectura and Natura Publishers, 2012, p 30.

<sup>49</sup> The neurobiology of beauty. Semir Zeki. TEDxUCL. – Youtube, 2 July 2012. <https://www.youtube.com/watch?v=NlzanAw0RP4> (Accessed 25 April 2019).

<sup>50</sup> M.Emoto, *The Hidden Messages in Water*. New York: Astria Books, 2005.

creates the visual outcome itself. Often how one or the other comes out depends a lot on the materials that are used for these purposes and wood is a good sound transporter.

### 1.3. Ecodesign

Renewable raw material sources and unused side streams or waste are being researched around the globe. More and more designers and other creative minds are becoming engaged in innovative material research and development processes, together with scientists and engineers.<sup>51</sup>

The way we build our homes and the materials we use in the process have changed a lot since last century. Amanda Sturgeon, CEO of the International Living Future Institute, recipient of the Women in Sustainability Leadership Award, is concerned with the idea that today the major design of buildings is representing the dominance of humans. She sees them as hard edged, cold and supposed to communicate the strength of people. They are less like nature. The reason for that she sees is that in the past we used to build with local materials found from the place, which had to be used wisely to consider the climate around. Nowadays on the other hand, the artificial light and air conditioning has given a push for dwellings into which one can isolate from what's happening outside, sealed off, be less responsive and connected to the environment.<sup>52</sup>

When it comes to sustainable ideation and design, considering the environmental impact of a product once it is placed on market is unavoidable, as the authors of *Ecodesign* claim<sup>53</sup>. So is with the process: so far, I have left behind processes which have included using widely materials from non-renewable resources. There are much more objects made from synthetic plastics today, which are trying to compete with wood. The same authors note that designer is

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<sup>51</sup> P. Kääriäinen, L. Tervinen, P. Vuorinen, N. Riutta, *The CHEMARTS Cookbook*, p.12.

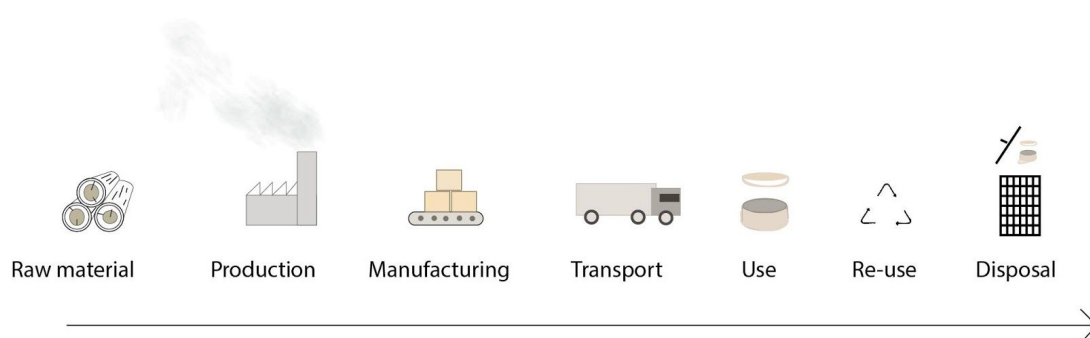
<sup>52</sup> A. Sturgeon, We Can Save the World. – *Architect Magazine*, 6 April 2020. [https://www.architectmagazine.com/practice/amanda-sturgeon-we-can-save-the-world\\_o](https://www.architectmagazine.com/practice/amanda-sturgeon-we-can-save-the-world_o) (Accessed 20 May 2020).

<sup>53</sup> S.Barbero, B. Cozzo, P. Tamborrini (eds.), *Ecodesign*, p.22.

not only able to develop the form, but to change production processes and behavioural habits in the name of greater environmental sustainability. Authors believe that compared to conventional industrial production, ecodesign, like design in general goes to the source to assess the desired result in all aspects and that products designed this way are more flexible, durable, modular or multifunctional and adaptable or recyclable. Designing in a sustainable way means using the most suitable resources for object and its function, not just justifying the laws of market <sup>54</sup>. Nowadays it is often only a question of budget that restricts the process. In the local scene, although the prices for wood are growing and will be, since we have used a lot of valuable wood by now and it takes time for the new forests to grow on, it might be wiser to make things from local less valued materials that will last, when taken care of.

There are a few higher education facilities who are reinventing new ways of applying the traditional knowledge inherited from our ancestors. University of Tartu Viljandi Culture Academy has a curriculum of native construction and textile. So does Tallinn University Haapsalu College have a curriculum of craft technologies and design. TalTech, Tallinn Technical university has a curricula of material studies focusing especially on wood, textile and plastics. We are giving importance to developing local and traditional making into with a help of new technologies on a national scale. To encourage young people to study the matter more closely, getting engaged and interested in that, it is better to bring such topics to life already in the upper secondary level, just before university is a next logical step.

### *Linear and circular economical models*



*Figure 7. Visual of a linear thinking in terms of material use.*

<sup>54</sup> S.Barbero, B. Cozzo, P. Tamborini, *Ecodesign...*, pp. 12



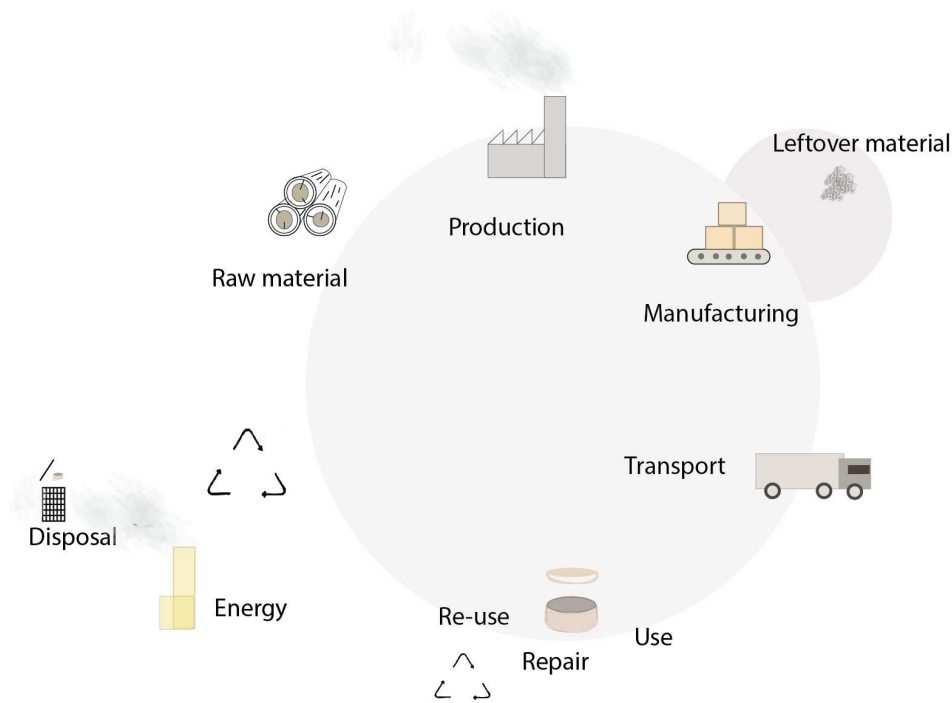


Figure 8. Diagram of a circular thinking in terms of material use.

The dominant way of thinking of a materials' life span in the capitalist societies is linear (Figure 7). Circular economy on the other hand is aiming toward a more sustainable development and use of resources and is a more natural way, minimizing environmental impact and optimising use of resources (Figure 8). Following the circular module there are many enterprises that make products from recycled plastic and other reclaimed materials. Not just furniture but also whole interiors and even roads are being made of recycled materials: Netherlands have made first attempts in creating bicycle lanes from recycled plastic.<sup>55</sup> On one hand it is a great way to reform the material not needed anymore, but at the same time it might give the feeling as if it is alright to continue to overuse of plastic and we can always find a way to reshape them, which still will keep us using the non-renewable energy resources. Recycled materials require less processing and fewer virgin materials need to be produces or gathered. It does take time and labour and requires expenditure, yet makes people feel good for putting in extra effort for a good cause, cleaner environment and spared resources.

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M. Sousa, The Netherlands Unveils the World's First Recycled Plastic Bike Lane. – *ArchDaily*, 23 September 2018.

<https://www.archdaily.com/902414/the-netherlands-unveils-the-worlds-first-recycled-plastic-bike-lane> (Accessed 4 January 2020).

Another reason for using biodegradable natural polymers is the number of leftovers that usually go straight to the waste disposal line although there is large potential in the large amount of misplaced material, which our experiments in class will be based on. By dealing with unused or leftover part of materials, bringing it back to the system, there is ideally less need for other similar competing products from other unsustainable resources.

## 1.4. Learning

Learning is a lifelong process, awareness and objectives of which depend on the age and individual nature. Learning happens through game and imitation, observation and reflection, experience and practice, exercise and testing, remembering and creating. Pupils inner motivation is an essential aspect when developing lifelong learning into a lifestyle.<sup>56</sup>

This quote is based on the national curriculum for basic and secondary education in Estonia. Learning is a very complex process and the modern approach seems to be linking it very strongly as a form of lifestyle, which means that the learning does not merely happen inside of classroom, but also before and after school day, at home and in public places. As it is natural for us to need variety and yet have a continuous feeling of experiences, it is better the topics inside are strongly interlinked and mirroring what is happening outside the school rooms, creating a pattern on the fabric of one's education.

Adele Diamond, professor of developmental cognitive neuroscience at the University of Columbia is bringing the results of unfolding science into classrooms and educational systems - informing environments where children learn how to pay attention, to solve problem, to collaborate, and to work creatively with what they know across the life span. Based on research, the facility in these skills is a stronger predictor of any success, than IQ.<sup>57</sup>

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<sup>56</sup> Põhikooli ja gümnaasiumi riiklik õppekava.

<sup>57</sup> A. Diamond, The Science of Attention.

Diamond brings out in the interview that schools should focus on teaching skills rather than content, which people tend to forget over time. She also brought out the issue of underestimating all kinds of arts in modern curricula, excusing it with lack of time and money and need to focus on achieving levels of knowledge examined in other more theoretical subjects. She thinks it needs to change, since music, dance and storytelling, play have always been part of our human condition for thousands of years and we should teach it at schools more often.

Each one of us can relate to this - my brightest memories from school days are connected to moments filled with emotions and that usually happened either at rare school plays, annual photo sessions of moments when one is already self-leading learner in later year classes and can make more connections between the subjects. Although I am intending to create an interdisciplinary approach, I understand there must be some space left for imagination and synthesizing to be done by an individual themselves. Trips to further areas in the country one might not usually take with family, due to busy working schedule or other issues, might be the only times a child learns broadly through experience about the country they live in.

Helen Sooväli-Sepping, cultural geographer, head and member of many sustainable environment development related chairs and programmes, brings out that students today are very well aware of the environmental problems and prefer to attend universities which already have the sustainable development written in their programmes or in the overall politics<sup>58</sup>. They have an expectation for a university they choose to work towards sustainability.

This is important to know especially at our Estonian Academy of Arts (EAA), where a study was conducted within a subject Green Group, led by Kätlin and Ott Kangur in 2019. It showed that 300L of different waste from wood workshop + 180L of wood chips + 100L cutting dust is created alone weekly and all of it goes into the same container with other waste. The same waste in other bigger industries is often turned into products like chipboard, pellets, etc. Although the quantities are smaller, it is a serious amount of material that could

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<sup>58</sup> Plekktrummi: Helen Sooväli-Sepping. – *Eesti Rahvusringhääling*, 4 May 2020. <https://arhiiv.err.ee/vaata/plekktrummi-helen-soovali-sepping/latest> (Accessed 7. May 2020).

be turned into something other than waste or be burnt.

### *Thinking through making*

Tim Ingold, British anthropologist, unites environmental perception and skilled practice. Ingold explores the human as a feeling organism which is constantly in motion, always creating and being changed by spaces and places as they are encountered. At the international conference *Tales from the North* at the Saami Cultural Centre SAJOS in Finland he brings out rather unusual alternative thought to creation, he opposes two approaches of creative process:

Ever since Aristotle, it has been customary in the western tradition to think of making as a bringing together of a preconceived, ideal form, in the mind of the maker, with an initially formless mass of raw material. In this view, all the thinking has been done before the making begins. And for those who encounter the finished object, the thought can only be recovered by reading back from the work to an idea in the mind of the maker. Here I present an alternative account of making, as an inherently mindful activity in which the forms of things are ever-emergent from the correspondence of sensory awareness and material flows in a process of life.<sup>59</sup>

This type of bringing the process of creation to the centre and a fruitful act of thought itself, supports the idea of rather experimenting with materials and being opened to the end-result the process will derive to and give new ideas for. This is the type of approach I am using in the project part of my thesis: not trying to finish to a specific project, but rather opening the discourse of thinking in different material terms. I can recall from my own experience from the past, where just encountering the material, gave me ideas rather than having an idea and then looking for a specific substance to explain it physically. I do not think one is better than the other, rather they work as a constant feedback loop: seeing material, getting inspired, imagining something in it, working on the project and already

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Ingold – Thinking Through Making. – Youtube, 31 October 2013. <https://www.youtube.com/watch?v=Ygne72-4zyo> (Accessed 18 May 2020).

having new ideas how to make it even better, which would not have been known without the experience.

Ingold mentions a metaphor from painter Paul Klee's personal notebook: form is the end, death and form-making are life. He explains how making is no longer a projection of form on matter, but rather an on-going binding together of material flows and sensory awareness in a form of improvisation, where he believes the creativity lies in, rather than innovation. This is another idea that supports the need for more time given to learning materials through exercises, experiments and other hands-on techniques. Poetically he explains how he sees surfaces: as something not contained, but places where there is a continual interchange between materials and environment, between the solid and the air, which surrounds it. This is an analogue to the understanding in psychology that our conditions in the environment affect us on a physical level as well. So is learning influenced by social and contextual factors.

### *Intuition is richer than logic*

Ingold defines maker as someone who must follow the material, joining their own life to ones they work with. This idea can be supported by the way surnames have been given: in Estonia people got their surnames a century ago based on the place they were living in or what they were doing for living, being an occupational surname derived from the trade name. For example, my surname, Špongolts, used to be Shponholts before being adapted to the cyrillic alphabet, and comes from words *span* (chip) and *holz* (wood), was given to my great grandfathers, because they were carpenters in Haapsalu. Written down in the passport, the name has been influencing my own choices in life and so I let the material guide me. This might sound irrational, yet this is the way it is and explains perhaps what has driven me to work with these materials, perhaps by Ingold, the material chose me.

This kind of shift in thinking in opposition to the dominant one in teaching architecture could also reverse the way we approach space creation : instead of starting with plans and ideas, we could start by working with potential materials that could form into a whole in the

image of furniture, room or even a house. Although I have noticed that most architectural companies today are using increasingly only digital space to just highlight the idea, not as a thinking tool, due to time limitation and the realistic representation of the digital. The situation in educational field is a mixture of both, thinking through making and making through thinking, if we are working with models, there is a material involved in the process and new thoughts arise from it too.

Is there a correlation between composition and engineering solution? For example, how I made a structure module for task connected to Tsooru former kolkhoz-center, from pattern of zig-zag, which also roughly form the thread takes in a row of weaved fabric, working on the triangle, which is the mother of all forms<sup>60</sup>. Thinking of national textiles, which work in the logic of woodwork as well, they are not only visually appealing, but can be technically made as a structure. Matthias Rippmann, young architect, shared his ideas at open lectures held at EAA, which support the principle: a good structural form can be evaluated intuitively based on its graphical appearance. The idea behind my model started from just one idea of making a short pathway into an abandoned house to illustrate the passage from outside to inside better, yet grew into building a two-storey platform for experiencing the building. Luckily, I had time for that and the more I worked on it, the more ideas I was able to project on it. I also took it as necessary to use only materials left unused in the workspace.

## 1.5. Elective subject

In the current Upper Secondary School systems there is an elective subject each students must choose. It is one semester, 35 academic hours long. Elective subjects give a student more freedom forming their curriculum and are a good chance to dive into a subtopic a young person is more interested in and would like to dive deeper in. The priorities set in the national curriculum for upper secondary schools<sup>61</sup> in Estonia are very close to the ones I have set for

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<sup>60</sup> M. Relander, Interview with the author. 11 November 2019.

<sup>61</sup> National curriculum for upper secondary schools – *Riigi Teataja*. <https://www.riigiteataja.ee/en/eli/524092014009/consolide> (accessed 24 III. 2020.)

my module design, which is explained in the 3rd chapter that dives into the proposed subject itself.

The following are priorities for fulfilling these functions and achieving these objectives: (1) independence of students, shaping their worldview and readiness for coping in life; (2) shaping an adequate self-esteem; (3) developing independent learning and cooperation skills; (4) introducing and assessing opportunities for a future educational career; (5) shaping of civic skills, activity and responsibility.

The field of elective subjects often is formed by what is going on in higher education. Universities work also as greenhouses for ideas on improving education, because soon what happens at the higher education level is reflected onto the other levels, such as upper secondary level, if it is just my wishful thinking, I hope it to be so in future. Simone de Waart, creative director and materials expert at Material Sense, with a background of industrial design and design management finds that education has a great importance in the emerging field of material design. Product design faculty at the Estonian Academy of Arts has also tied sustainable design and principles of circular economy into their renewed curriculum<sup>62</sup>. Therefore it is very likely soon this principles will be seen at upper secondary schools and adapted systemically.

## 1.6. Research-based teaching methods

### *Project-based learning*

Project-based learning is a teaching method in which one gains knowledge and skills by working for a specific period, from weeks to a semester, to investigate and respond to an authentic, engaging, and complex question, problem, or challenge<sup>63</sup>. In this case the problem

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<sup>62</sup> Harrik, Airika. Ülevaade: milliseid uusi õppesuundi toob ülikoolidesse sügis. 14 mai. 2020, <https://novaator.err.ee/1090043/ulevaade-milliseid-uusi-oppesuundi-toob-ulikoolidesse-sugis> (accessed 20 V 2020.)

<sup>63</sup> What is PBL? – Buck Institute for Education, undated. <https://www.pblworks.org/what-is-pbl> (Accessed 30 April 2020).

will be environmental issues due to human action, especially in creating spaces, built environments.

This kind of approach either in a classroom or more informal setting has lots of benefits over the traditional one: it (a) empowers children with voice and choice, (b) puts them in the makers mindset, (c) they become inventors and creators and learn to take creative risks, (d) get into the growth mindset and (e) become problems solvers, through which (f) system thinkers, who are also (g) able to think outside the box (h) they learn it is alright to be different and also develop (i) critical thinking<sup>64</sup>. Not only they become more engaged, and lead a creative life, but also it gives problem solving a meaning<sup>65</sup>.

John Dewey, educational reformer of the 20th century, who initiated this type of approach already in 1916, claimed that a student learns more if they are interested in the subject and learn by doing<sup>66</sup>. It makes sense for me to make the subject I am about to create an optional one, yet still work on the aspects that build up the attraction towards it. The media has finally taken up the topic of environmental issues, climate activism is at rise and eco-labelling



happens on every possible product. It is hard not to notice the need to deal with the topics, because a person cannot be subtracted from the environment.

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<sup>64</sup> What is PBL?

<sup>65</sup> What Happens When Students Engage in Project-Based Learning. – Youtube, 20 August 2019. <https://www.youtube.com/watch?v=6IqjSRhPEk&t=26s> (Accessed 30 April 2020).

<sup>66</sup> S. Boss, Project-Based Learning: A Short History. – *Edutopia*, 20 September 2011. <https://www.edutopia.org/project-based-learning-history> (Accessed 2 January 2020).



Figure 9. Exhibition on the 5th floor of the National Library.

One example of project-based learning is an exhibition *How can I help the nature?* at the National Library of Estonia opened in January 2019. Exhibition is made up from the outcome of 12 free workshop series for children, that took place prior to that in autumn of 2019. Labora is an organisation that works together with Ukrainian Culture Centre in Estonia. They are known for authentic craft-making, workshops for children based on traditional techniques and living in harmony with their space in the old town. Their motto *ora et labora*, in translation reflecting while working, highlights well the idea Ingold refers to, thinking through making. I have been engaged in the process of organising children camp in summer 2013 in their rooms, where we also worked in their graphic art workshop, where I noticed their authenticity.

The workshops portrayed at the exhibition were run thanks to the Creative Makers project. The main idea was to create a discussion with children. They were basing their discussion on articles of UNICEF, the United Nations of Children Fund, agency responsible for providing humanitarian and developmental aid for children around the world. Standing for the right of getting the education and responsibility of using it and topics of environmental protection<sup>67</sup>. The installation itself is made of two piles of dried wood branches placed similar to the pyramid structure up until the ceiling of probably around 3 meters and hand-printed graphics on handmade papers are hanged on a rope. Bigger, size in between of A4 and A3 works are printed from letters used in traditional printmaking. The works are rather abstract, but presentations of human figures and some actions can be imagined. They have been done in a group work, since



<sup>67</sup> A Human-Rights Based Approach to Education. – United Nations Children's Fund, 2007.  
[https://www.unicef.org/publications/files/A\\_Human\\_Rights\\_Based\\_Approach\\_to\\_Education\\_for\\_All.pdf](https://www.unicef.org/publications/files/A_Human_Rights_Based_Approach_to_Education_for_All.pdf) (Accessed 10.05.2023)

are signed by many children per page and carry a title linked to actions towards environmental protection.

Figure 10. Artwork from the exhibition.

Tutors of the workshop state in the abstract of the exhibition that children were prone to collaboration, finding the problem themselves and trying out new mediums to work with. This is a great example of project-based learning, where children were given an opportunity to solve a problem in a collaborative setting and through art-making.<sup>68</sup>



Figure 11. Work from the Labora exhibition.

This project is successful one: it is located in a library, a place people often go to learn something new and are therefore opened for experiences. The object is an installation, which tries to communicate the concert of those children who were creating those prints at the workshops. The design of the prints came out from their own knowledge and one shared during the classes. It also has this rustic aesthetics, which brings closer to earth and even reminds of the sea, since resembles to a boat. Labora's project is heart-felt since it is connecting the traditional printmaking with contemporary problematics and showing off the artworks of children. It is actually not so common to see children's art exposed in galleries, since it is costly and there is no culture of buying children art, which could cover the costs. Perhaps a library works here as shared public middle ground.

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<sup>68</sup> E. H. J. Yew, K. Goh, Problem-Based Learning: An Overview of its Process and Impact on Learning. – *Health Professions Education*, 2016 Volume 2, Issue 2, pp. 75-79.

Architectural projects, as the name reveals, are in their essence project-based, and if we look at professionals, Santiago Calatrava, Spanish architect known most for his bridges supported by single leaning pylons and simple looking, yet very well engineered architecture, is one whose aim in achieving movement through architecture fascinates me. There is a study formed into a book done by Alexander Tzonis on Calatrava's work called *Santiago Calatrava: The Poetics of Movement*, which analyses his work throughout the years. Tzonis believes that the quality of Calatrava's work results from collective thinking and collaborative effort. This accompanies very well my aim with this project, a collaboration between children, step by step, towards creating our surroundings in a more sustainable way. The author also talks about Calatrava's ability to create an object that rather enhances the uniqueness of a landscape it stands on rather than subjugates it's character, is embedded in the terrain like the tree<sup>69</sup>.

### *Problem-Based Learning*

According to Stanford University, problem-based learning is a way in which students work with classmates to solve complex and authentic problems that help develop content knowledge, problem solving, reasoning, communication and self-assessment skills.<sup>70</sup> History dates to 1950 and Case Western University, first addressed to medical school students to solve real life problems. Problem based learning focuses on solving problems in unique ways. Since the conventional school exists in a one-size-fits-all models where everyone usually must go through the same materials and homeworks, and must consume the content. It is also another type of actively engaging in the process, therefore being more attentive.

Project- and problem-based learning are similar, yet they have some small different nuances. The main difference between project-based and problem-based learning is that in the last one, one does not need to design a product, but simply solve a problem. What is it that they implement in this case? Can it be an action in this case? And how do they measure or

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<sup>69</sup> A. Tzonis, Santiago Calatrava.

<sup>70</sup> Problem-Based Learning. – *Stanford Teaching Commons*, undated. <https://teachingcommons.stanford.edu/resources/learning/learning-activities/problem-based-learning> (Accessed 12.1.2020).

what is the guideline in the evaluation stage, by which means do they solve the problems then? 3 levels at which problem-based learning it can be implemented: (1) Individual student - predetermined objectives can be identified for each student personally; (2) Group - each group can have either the same objectives and different problems, or *vice versa* and (3) Curriculum - all problems and objectives are identical for all students.

Raising awareness through problem-based learning was done by citizen-initiated group KesKonnad, who was determining themselves as local youth initiative focused on getting global and environmental education to the small communities in Estonia. Although the learning happens spontaneously, on the spot they are at, without any pre-registration or teaching in mind, it still carries the aim to solve environmental issues through first engaging people by widening their awareness.

Today they are no longer active, but in years 2008-2011 they were actively creating seminars and workshops all over Estonia at different events and festivals. They used a bus, which they called Environmental Bus, by which they rolled from one place to another. I asked Evelyn Valtin, one of the organisers in the initiative during the our conversation, whether or not they calculated the emissions coming from the bus compared to the impact it made on the people, and she said that they found more good reason over the quantity of CO<sub>2</sub> emitted. She believes that their message reached and made an impact on those involved<sup>71</sup>.

By their own statistics, approximately 1000 people attended the seminars and events and even more witnessed the materials on the project bus during its travels. Based on the youth seminars, booklets were compiled that introduced different simple ways for people to be more environmentally friendly in their everyday lives. As the first 600 booklets were distributed and ended before the last events, 600 more booklets were printed and distributed also to different organisations and youth centres where more people have access to the materials after the end of the project.

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<sup>71</sup> E. Valtin, Conversation with the author. 20 January 2020.

Evelyn brought out main outcomes and impact from the project: (1) Raise of awareness within the group who organised events; (2) Grown ability to create and make projects happen; (3) Proficiency to talk about the sustainability (4) Gained new important contacts; (5) Carried on the principles in their everyday life. She feels that the biggest value of these projects is the experimenting itself. Her answers show that a leader or a teacher is often the student themselves and also gains more experience and knowledge from the projects they do, which is also an important aspect of education.

*Sailing for Sustainability* is another example of this method. The project is a European-wide Global Education activity focusing on the topic Sustainability. Launched in 2011, In context of Rio+20 (United Nation Conference on Sustainable Development) there were organised four one-week seminars for youths and young adults from across Europe, especially the Baltic region, and several one-day events in harbours on our sailing route for local public. The project took place on the sailing ship Lovis, which is itself a tool of the sustainability. I want the whole project to be sustainable in sense of environment and in sense of further outcomes of the project.

The Sailing for Sustainability project was organised by the Forum of Global Education Multipliers, which was based by Global Education Network of Young Europeans alumni (GLEN). What made this project sustainable according to Evelyn Valtin, environmentalist and Kristofer Soop, (landscape) architect from Estonia<sup>72</sup>: (1) The food was vegetarian and vegan; (2) Intense discussion over sustainable development topics; (3) Keeping the boat still going. The biggest value of this project, by the participants is the unusual amount of people interested in the same topic and the power of the group. There is a lot of motivation inspiration and cooperation between people. She believes it is irreplaceable way of communication eye to eye over important topics, since watching a video on something talking about the issues or reading it on newspapers does not give the same experience. The presence is the key. Taken part of similar projects in Estonia and elsewhere, I can relate to their thoughts and opinions. Opposed to the example of project-based project, the focus is on the process of learning and change that happens with the learner within, rather than deriving to any visual outputs.

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<sup>72</sup> K. Soop, Conversation with the author. 3 March 2020.

This project happened also outside the classroom, was rather focusing on raising awareness on different environmental problems in our Baltic region and the participants were adults. The feedback from participants shows that the memories from projects that happened somewhere unusual, on a boat, are often filled with more emotions and therefore better memorable. I am intending to apply at least a bit of this out of classroom activity when designing the project in the classroom.

## 2. Case studies: projects and programmes

### 2.1. Materiom open data platform

Materiom is an open-source web platform, which provides open data on how to make materials that nourish local economies and ecologies. They support companies, cities, and communities in creating and selecting materials sourced from locally abundant biomass that are part of a regenerative circular economy<sup>73</sup>.

It is a great platform, because not only it gives free access to other people's recipes, it invites everyone to participate and have their input. Here one is not valued by the degree, but rather the contribution. The front page says *Nature's recipe book*, the same Amanda Sturgeon calls people upon action to create. Website provides also data besides the material library.

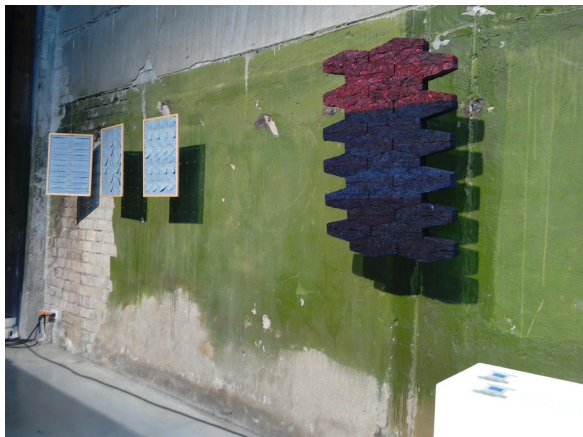


Figure 12 . Modular wall panels. Figure 13. Photo of substances.

<sup>73</sup>

Materiom. – Materiom, undated. <https://materiom.org/> (Accessed: 30 April 2020).



In autumn 2019 I was attending a conference called Material Futures in Noblessner, Tallinn. Part of the programme was an exhibition happening there. The founder of Materiom, Zoe Powell was also there and conducted a workshop on biomaterials on the spot.



*Figures 13-16. Photos from the Future Materials exhibition.*



## 2.2. Mycelium project Living Materials

“We live in an era characterised by materials that are designed to never decay, forming a layer in soil that will be a symbol to this century, to be discovered and handled by future generations. This fact is one of the reasons why young designers are interested in developing new materials and contribute to experimenting with various possibilities of how to leave no trace or make less harm to our planet.”<sup>74</sup>



*Figure 17. Photo from the mycelium making process.*

This was a mandatory yet exciting project during our studies in spring of 2018. It was led by Erki Nagla, a mycelium-whisperer, Kärt Ojavee and Annika Kaldoja, designers at biomaterials lab at EKA. Our challenge was to design and build a display table for materials done in this field of biomaterials at our academy in the previous years. This was a site-specific project with a specific goal and function. It did not stay long in situ, where first exhibited in rooms at Mektory Innovation Centre, but was later moved and shown at the Estonian Academy of Arts as well.

The focus was on the material and the process, rather than the final function. The course I am designing consists of series of smaller-scale experiments, which at first do not have a

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<sup>74</sup>

Exhibition: Biomaterials on Display. – Annika Kaldoja, 2018. <https://www.annikakaldoja.com/biomaterials> (Accessed 15 May 2020).

specific task to carry, but in the later stages will try to derive to a specific desirable form to present at the exhibition. There are similar and different aspects. Annika Kaldoja writes about the possible conversation this exposition provides with other fields of study and industry<sup>75</sup>. It was several months long project, where we were working in lab-type conditions in turns and had to follow a specific step-by-step procedure. What made me worried was some of the materials used in the process. For example, it was impossible to use anything else than specific plastic bags in order to control the process of inoculation working progressively. I would have assumed that the process itself could be green as well. This is something I will be aiming with my project.

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<sup>75</sup> Exhibition: Biomaterials on Display.



Figure 18-19. From the exhibition in Mektory. Photos by Tõnu Tunnel.

### *Aesthetic aspects*

There is an aspect of beauty matters when dealing with the waste materials. Yael Reisner, an academic, architect, curator for the next Tallinn Architecture biennale *Beauty matters* in 2019 in her interview with Siim Tuksam, founder of parametric design studio PART for architecture magazine MAJA discusses how the word beauty has become empty over the time, and that there is an imbalance in the “form” and “content” discourse, where the design of the objects has lost its significance<sup>76</sup>. I recognise myself in the description that designers see themselves rather as problem solvers preoccupied with rational thinking when they became focused on sustainable issues. Perhaps the truth is somewhere in the middle, since the world has just become so that we must look to those areas that just overflowed with problems, like the waste management and design process that already thinks of it ahead. Also, I would still claim that aesthetic reasons are my primary decision criteria, when designing, and waste materials can even be creativity enhancing. On the other hand, the authors of *Ecodesign* write that the secret of a good design is not merely about showing off a product and enhancing its aesthetics<sup>77</sup>. They stress that ecodesign must consider the systems and relationships within which the products are generated. My unwritten, now written down here rule is that the creation must also be beautiful.

## 2.3. Arhitektuurikool (School of Architecture)

The School of Architecture (Arhitektuurikool) is a one of a kind hobby school in Estonia where kids between the ages of 7 and 19 explore and exercise creating the spatial world. This type of content taught for such age group is also not very common in other Northern Europe and Baltic countries. They hold week lessons at the Architecture museum and other location,

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<sup>76</sup> S. Tuksam, Nauding illust, p.125.

<sup>77</sup> S.Barbero, B. Cozzo, P. Tamborini, *Ecodesign* ..., p. 34.

organize events all over Estonia, publish and openly share study materials to promote creativity and education on built environment<sup>78</sup>.

This school's activity and educational programmes and their books as a base for my qualitative content analysis. They too share a vision of sustainable development. They bring out the human-oriented focus while noticing other species. It is often that design are too human-centered and other species tend to be forgotten. I would love human-centered design to flourish,



Figure 20. Cover of Handbook for teachers “Architecture and Living Environment”<sup>79</sup>

while also taking into consider others: bird, mammals and insects that live next to us, who are also important players in the ecology of the world. I am not saying we should be building feeding houses for rats nearby us and invite them to chew all our houses down, but rather taking all our neighbours into consideration, especially those whose lifestyle have no harm on us.

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<sup>78</sup> Arhitektuurikool. – Arhitektuurikool, undated. <https://www.arhitektuurikool.ee/> (Accessed 30 April 2020).

<sup>79</sup> K. Klementi, K. Nõmm, Õpetaja raamat...

They have been doing workshops and project since 2011 and one of their most memorable exhibitions has been. I am inspired from them is their elective architecture course for school students since 2017/2018, which was made in collaboration with The Estonian Ministry of Education and Research, the Ministry of Culture and the Estonian Centre of Architecture<sup>80</sup>. The simple language they use, didactical approach with interesting tasks and the structure of classes is what I am fond of. There are parts in the handbook which are dedicated to materials. I believe I intend to rather enrich the knowledge in that field.

Their project School Space is also an example mixing of project- and problem-based learning, where students all over Estonia use various scientific and design methods to explore the nature of school today and to create a vision for a new school. There is a time limit, five months, at the beginning of which they are given eight research and creative assignments leading to an understanding of how to improve their own school space. Then they present ideas to the school's governing body or to the other listeners at a meet-up<sup>81</sup>. To go roughly through 8 topics over this period should be enough. There will be 16 meetings in total and I wish to dedicate 2 weeks, therefore 4 academic hours (3 h) in total to one material related topic. The difference will be that instead of suggesting ideas, we will suggest new design possibilities for the future design projects with a small exhibition at the end of the course.

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<sup>80</sup> Valikkursuse „Arhitektuur kui elukeskkond“ kava [Curriculum]. – Innove, undated.

[http://oppekava.innove.ee/wp-content/uploads/sites/6/2016/11/arhitektuur\\_kui\\_elukeskkond\\_valikkursuse\\_kava17.10.pdf](http://oppekava.innove.ee/wp-content/uploads/sites/6/2016/11/arhitektuur_kui_elukeskkond_valikkursuse_kava17.10.pdf) (Accessed 20 May 2020).

<sup>81</sup> Arhitektuurikool, koduleht. - <https://www.arhitektuurikool.ee/> (accessed 30. IV 2020)

### 3. Elective subject design proposal

#### 3.1. Towards designing an elective subject

Based on the research and information gained, personal experience as a teacher and personal contact with materials I am designing an elective subject as a reflective conversation with the current global environmental and economic situation. Deriving to a specific project through the process, using science-based teaching methods, aiming for transparency of interrelations and sharing my findings about the educational and environmental material projects and experiments I have done myself, I plan to put together an elective subject for upper secondary school level, at first for Tallinn European School in mind, in English. Their arts and craft teacher Triin Suurküla is looking forward to new inputs to her curriculum, since she has already tried tasks from School of Architecture's handbook for teachers and is fond of those<sup>82</sup>.

At first I intended to carry out the pilot project with smaller children first, because it is the age group I am currently teaching a private art school and due to their more open and willing state to learn state compared to older ones, who might already have their opinions rooted. Imbi Henno brings out, that the ones most in need are pupils going through basic and secondary education, that pupils of elementary school, ages from 7-12 years old visit different programs anyway. Therefore, I decided to focus on grades 8-11, since their current curricula profile matches the subjects I plan to joint together in my own module and that resonates with my intuitive wish to do the project with children, who already have basic background knowledge on the issues. The structure and exercises can later be adapted according to the level of knowledge of an age group.

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<sup>82</sup>

T. Suurküla, Conversation with the author. 20 April 2020.



| Tallinn Art Gymnasium |    |                       |                         | The High School of Collegium Educationis Revaliae (VHK) |                         |                         |           | Tallinn 21st School   |                         |           |  |
|-----------------------|----|-----------------------|-------------------------|---|-------------------------|-------------------------|-----------|-----------------------|-------------------------|-----------|--|
|                       |    | Technology/ handcraft |                         |   | Nature studies/ biology |                         |           | Chemistry             |                         |           |  |
|                       |    | Technology/ handcraft | Nature studies/ biology | Chemistry   | Technology/ handcraft   | Nature studies/ biology | Chemistry | Technology/ handcraft | Nature studies/ biology | Chemistry |  |
| I                     | 1  | -                     | 2                       | -   | 2                       | 1                       | -         | -                     | 1                       | -         |  |
|                       | 2  | -                     | 1                       | -   | 2                       | 2                       | -         | -                     | 1                       | -         |  |
|                       | 3  | -                     | 1                       | -   | 2                       | 2                       | -         | -                     | 1                       | -         |  |
| II                    | 4  | 2                     | 1                       | -   | 2                       | 2                       | -         | 2                     | 2                       | -         |  |
|                       | 5  | 2                     | 2                       | -   | 2                       | 2                       | -         | 2                     | 2                       | -         |  |
|                       | 6  | 2                     | 3                       | -   | 2                       | 3                       | -         | 2                     | 2                       | -         |  |
| III<br>High School    | 7  | 1,5                   | 2                       | -   | 1                       | 2                       | -         | 2                     | 1                       | -         |  |
|                       | 8  | 2                     | 2                       | 1   | 1                       | -                       | 2         | 2                     | 2                       | 2         |  |
|                       | 9  | 1                     | 2                       | 1   | 1                       | -                       | 2         | -                     | 2                       | 2         |  |
|                       | 10 | 4                     | -                       | 2   | 1                       | 2                       | 2         | 2'                    | 5                       | 2         |  |
|                       | 11 | 4                     | -                       | -   | 1                       | 1                       | 1         | 2'                    | 5                       | -         |  |
|                       | 12 | 4                     | 3                       | -   | -                       | -                       | -         | 1'                    | 5                       | -         |  |

courses a week at each school

Figure 21. Analysis of chosen subject in specific schools' curricula in 2019/2020.

As part of the study I looked at 3 subjectively chosen Upper Secondary Schools in Tallinn, Estonia. First, Tallinn Art Gymnasium, I chose as my home school, where I studied for 12 years. The High School of Collegium Educationis Revaliae, is also focused mainly on art-related field of education. And as a contrast I chose a prestigious Tallinn 21st School, which is more natural studies focused. I saw that the best age group for who to design the course are students from grades 8-12, because the subjects I intend to integrate, chemistry, biology and craft, are all in their curricula at the same time. Still I narrowed the gap even more down to make sure it was going to be an elected subject. The Upper Secondary Education is not mandatory, which doesn't mean that all children are equally motivated to attend, but at least there is already a bigger percentage of potential eager learners.

There are 4 main topics besides education, which merge one into another throughout the course:

1. Environment- This is where the material origin, sourcing and global distribution comes to the scene. Economical aspects and globalisation processes.
2. Materials - This is where material properties and applications come into context through sensing them with all senses and making them ourselves.
3. Design - This is where each one works individually or in a group towards the result that will showcase our process and progress during the semester.



4. Recycling - This is where the vocabulary of circular economy principles comes in. The emphasis is also on the processes and possible directions. The reflection and meta-analysis over what we are doing at the same time during the classes.

### 3.2. The programme

Within 1 school year there are 4 breaks: one in autumn, one longer during winter and two in the spring semester. Typically, elective subjects are 35 academic hours long, which would fit the programme in one semester. The elective subject that will last two academic quarters will be divided upon them into two modules. Both modules will be supported with the homework and background knowledge from the workbook.

In the first module they will get to know materials to be used in the second phase more closely. They learn to think about the origin, sourcing, locality, waste aspects and rethink the need for things in the first place. This phase will mostly support unleashing the creativity using the materials on the principle of bricolage<sup>83</sup>. The outcome of this module will be a small booklet with material samples and analysed properties.

In the second phase they will get to design with those materials. Collaboration with different small-scale enterprises dealing with materials such as wood, leather, who have not planned the circulation of their leftover materials will be present. At the end of this module an object will be made based on the knowledge obtained from the first module and reciprocated in the second.

The programme requires slightly different school room, where there could be space for temporarily storing the material trials and large enough table surface to do them, at least 1m<sup>2</sup> per each student. A room like a chemistry lab would be best. Also, a sink and some heating stoves. An essential object is the ventilation cabinet or ventilation tubes, important to use when working with toxic chemicals, which in this case are primarily thermoplastics. A

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<sup>83</sup>

Bricolage is an ancient way of creating with materials found and available at hand. Contemporary vast use of materials from afar has created the need for a term as such.

chemistry class room is typically rectangular with tables in the middle either in two or one rows. There is usually more than one sink, situate close to the main working area. It is advised to bring a working robe to protect clothes in the process.

The study is accompanied by a workbook, which consists of information about the materials taken into the process within the course, inspirational projects to look upon and study from, hometasks and guidelines for experimentations. Additional notebook for student's own documentation process and writing down answers from tasks and ideas that came out during the working process, is also necessary.

## Module I Material

|    |  |
|----|--|
| 1. | Introduction, overview of the course, getting to know each other and where we stand in knowledge. Goals, success criteria, introduction to materials, classification. Locality aspect and materials, we are going to be working with. Principles of circular economy. <i>Homework 1: Go for a walk (look at task 1 in the workbook).</i>   |
| 2. | Visiting an exhibition during Tallinn Design Week, where new materials and innovative thinkers are usually exposed. This one will take 3 academic hours. In case there isn't one an excursion in the schoolhouse, looking at the house from the material point of view. In case this is something they have already done with the <i>Architecture and Living Environment</i> course, an option is to look through the whole library of oncoming at materials around and looking at processes, how they are made; showing samples. There will be an on-site game at the selected exhibition or space to look deep into. Students will for a group of 2 and each will get a task to investigate one specific type of material of object and what it is made of and present it shortly to others. 10-15 minutes to look, each group gets 5 minutes to talk and 2 minutes for questions. |

|    |   |
|----|---|
|    | <p>Guided examples of questions, such as (1) why there is need for such materials, (2) where else could these materials be applied, (3) how long might they last and what will happen to them afterwards will be given as well.</p>   |
| 3. | <p>People and plastic. There is a homework for this class in the workbook, given 2 weeks prior to this day, with a task to collect plastic materials either at a specific natural site and /or at home. Lecture and videos on plastic: how and what from is it made, what are its advantages, and disadvantages, different types of plastic, application. Going through different cases where recycled material is applied into a new form, how is it done on a government level, what are the actual numbers behind plastic recycling and looking at smaller enterprises trying to tackle the environmental problems. Experiment 1 (see workbook) to experiment with thermoplastic polymers collected with a heating press. each one will cut pieces from the material they brought to the class for a homework and make an ca A5 sized melted sheet.</p> <p><i>At the end give a task week of journaling materials we come to contact with, choosing one and diving into it (origin, how it was made, how it got here - journey of a material).</i></p> |
| 4. | <p>Bioplastics. What are bioplastics, what has been done, different projects. Looking at samples. Discussing where they could be applied. Trying out for the next hour.</p> <p><i>Homework: compare petroleum-based thermoplastics and biopolymeric plastics</i></p>  |
| 5. | <p>Wood industry and small-scale waste, types of waste. Lecture on circulation of materials on example of wood. Wood waste: sawdust, ashes, trying to mimic. Biogeometry as a source of inspiration. Looking at already existing architecture inspired from that (<i>Harpha, velcro, etc.</i>) Experiment 2 (see workbook).</p>   |

|    |   |
|----|---|
| 6. | <p>3D print in a low-tech way (or 3D printer in case there is one at school) from same materials as looked at before. Merging 2 different types of materials in a sample. Bioplastics + wood-related waste. Experiment 3 (see workbook).</p>  |
| 7. | <p>Creating a small library of materials, <i>folding a bookcase, binding all the materials into a book, using a simple technique stitch or applying the origami pocket (exercise 1 in workbook).</i></p>  |
| 8. | <p>Visual vs. other senses. Lecture on different properties: texture, temperature, softness/hardness, smell. Dominance of visual based on thought of Juhani Pallasmaa. Introducing Masayo Ave work to especially bring all the other senses next to visual to the table. Analysing material properties of samples done previously.</p> <p><i>Task: Imagine you are a thumb size person and looking at the environment, how would you see the materials. Ask them to take photos and share photos with explanations at the end of the class. Adding the properties of material samples to the small book of samples.</i></p> |

## Module II: form

|     |   |
|-----|---|
| 9.  | Refreshing our minds with what we did before the break. Looking at various projects that have been done with local and reclaimed materials only, lecture and video. Discussion of what could be the local materials here, what do they know from biology class and personal experience. Introducing the design brief and the next following 7 weeks to make a project happen.               |
| 10. | The design brief is to seek the play of light and shadows in the forms created. Based on materials and techniques tried out before, to which library some additional leftover materials will be added, such as wood from the wood workshop, leather, etc. They will be free to choose the materials.  |
| 11. | Lecture and tips on how to visualise ideas. Three steps borrowed and adapted from origami expert Robert Lang: 1) abstract idea, form of lines 2) more detailed version, define shapes 3) full shape, ideal shape. Ideation and sketching week. Choose a suiting technique or tips from Sou Fujimoto for making a project happen <sup>84</sup> : (1) Sketch, (2) model, 3d sketch, (3)write. |
| 12. | Looking at what has been done by others - presentation of other simpler and more advanced projects. Supervising, looking through ideas. One by one, 5 mins for each. Everyone actively participating. Determining what other workshops' assistance and access needs to be included (wood or metal workshop).  |
| 13. | Working on the specific project. Trying out in form, simultaneously drawing more specific drawings, making patterns.  |
| 14. | Creation, modification and preparation of materials. Either using an existing frame or creating one (some extra time in the workshops will need to be used, assembling, planning 2 extra hours to finish on time within the week.   |

<sup>84</sup>

S. Fujimoto, Keynote Speech at Tallinn Architecture Biennale. – *Symposium Beauty Matters*, 12 September 2019.

|                                    |   |
|------------------------------------|---|
| <b>15.</b>                         | Testing the structure for light and shade. A pop-up exhibition with the opening in the school hallway. Photos will be taken. Effective to choose a location to bring the light-shadow effect out in the best way. |
| <b>16.</b><br><b>Final Meeting</b> | Looking back on the whole process. Self-evaluation from students, sharing critique on the subject. Talking about possibilities of further engaging on the topic outside or after graduation from the school.      |

### 3.3. Class structure

Weekly for 2 academic (1,5 h) hours studying in sequences for 25 minutes and then having a short break for at least 5 minutes is also known as a Pomodoro technique, which is proven to be an effective way to stay engaged in studying for a longer period. Since this age group is already good at self-conducting, what they do with the 5-minute break is up to them. Suggested is to look outside the window, do some stretching, talk to classmates, and other similar well controlled short-time activities.

#### *Lesson structure*

Three times 25 minutes long studying with two five minutes long breaks in the middle. First 25 minutes is usually for theory and expanding the topic and the following two for tasks<sup>85</sup>. Intervals for studying with a specific break time are one of the principles used in pomodoro technique, which helps to study and accomplish projects much more effectively. I have been using this technique often when writing this thesis.

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<sup>85</sup> Cirillo, F. 2006. The Pomodoro Technique (The Pomodoro). Agile Processes in Software Engineering and, 54(2).

### *Assessment method*

Formative assessment - is a type where learning is made visible to the student. Goals, success criteria, assessment of learning progress are given out and improving through self-assessment and self-efficacy as well leaving space for learning from mistakes<sup>86</sup>.

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86 Voinea. Formative Assessment as assessment for learning improvement. Journal of Pedagogy, 2018 (1), 7 – 23 14 okt. 2018, [https://www.researchgate.net/publication/326190241\\_FORMATIVE\\_ASSESSMENT\\_AS\\_ASSESSMENT\\_FOR\\_LEARNING\\_DEVELOPMENT](https://www.researchgate.net/publication/326190241_FORMATIVE_ASSESSMENT_AS_ASSESSMENT_FOR_LEARNING_DEVELOPMENT). (accessed 6. V 2020)

## Summary

My master thesis topics have been on my mind for the last decade. As a student of materials and a global citizen, one always comes to contact with materials, they are all around us, and it up to us which ones we choose to use from the sources that are available to us. During my studies I saw more what is behind certain industries and in the following projects I always tried to make the best possible choices concerning the effect it has on the surrounding well-being of human and nature in general. One can say we are still figuring out, how to live in the best possible way to sustain our lives here for the next thousands of generations. This requires a smart way of managing and taking care of the environment and therefore natural resources in order to satisfy our needs. I am interested in sustainable ways in which we could teach better approaches towards resources from the early stages of life.

Therefore I found that by becoming aware of the issues already happening widely, the next logical step it to start taking actions towards it. Young people have a strong will with the climate change movements and some of them are also taking up projects to make an impact. I decided to design a subject upon which a new curriculum for upper secondary school level pupils could grow upon. I am looking at existing and new methods in understanding, teaching and creating materials for living. Based on the interviews, both quantitative and qualitative, done with most actors involved with the study process, pupils and teaching staff, it was clear that there is a need for new insights and skills in order to understand the current situation in environmental issues and feel empowered and able to take steps for possible solutions. The proposed new elective subject intended to combine skills and knowledge into an interdisciplinary workbook for students, combining knowledge from material studies, chemistry and biology. This might also be another way to engage and find those, who might want to dedicate themselves into any form of architecture, who would usually not get in touch with it in the general school and the non-formal education of architecture studies for this age group in Estonia has only started a few years ago. Subject gives a chance to learn by making while engaging all senses.



Based on all the knowledge and experience I gained from practical research and literature, I define my design proposal as an attempt to enrich already existing school curricula with more project-based methods and add ways of integrating subjects of environment and sustainable development. Studying materials, becoming aware of environment through materials each student will have a sensory experience, learnt more new words and ways to think of constantly evolving field of materials, which is very needed nowadays. I believe this kind of approach will enable children to make more connections to their everyday life and habits and take better care of their environments. My design process could be seen as thinking through making, where the process and ideas come improvised through real experience and needs. I leaned on this more natural concept which Tim Ingold has argued most for, which is much needed to balance to the currently dominant thinking in modern techno-science and traditional way of projecting already formed concepts and ideas onto material. The result is a schools subjects that support the sustainable development in ideas as well as in actions.

## Summary in Estonian

Inimkond on elanud maakeral tuhandeid aastaid, ometi on meist vanemaid liike, kellelt nii mõndagi õppida. Üks teravaim teema antud ajal on kliimamuutused ning keskkonna seisund. Pidevalt otsitakse alternatiivseid lahendusi praegustele energia ning toorainega seotud probleemidele. Aina enam materjaliteadlasi ning vabakutselisi tegelevad materjaliuurimise teemaatikaga, mis moodustab ka antud töö olulise osa. Ülikoolid avavad aina uusi jätkusuutliku tootmise ning materjalide loomisega seotud õppeaineid ning õppekavu. Ka olulisemate arhitektuurialastes väljaannetes ning veebiajakirjades on viimastel aastatel materjalidele ning materjali keskele lähenemisele suurt rõhku pandud. Teema jätkuvuse huvides on oluline seda ka nooremale põlvkonnale tutvustada, sest nemad on peatselt ise otsustajad.

Mu uurimistöö teema on olnud mulle oluline kogu viimase kümnendi jooksul. Meie keskkonna küsimused nii globaalselt kui ka siin Eestis on mulle alati korda läinud. Oma õpingute jooksul olen alati otsinud viise, kuidas panustada jätkusuutlikkusse arengusse. Uudishimuliku inimesena olen õppinud tundma erinevaid valdkondi, näinud materjalide tootmise protsesse, nende kasutamise viise, tegelenud jääkide temaatikaga ja keskkonnaalaste küsimuste teadvustamisega. Magistritöös püüan välja pakkuda viise, kuidas aina kiiremini muutuv, ent siiski ka teadlikumaks muutuv inimkonnas nooremat põlvkonda ning vaimselt kui ka praktiliste oskustega valmistada ette eelseisvateks materiaalseteks katsumusteks. Linnastumise tendentsiga maailmas, vaatamata pisematele siia-sinna kõikumistele eri kümnenditel, on side loodusega nõrgem ning teadmised sellest kasinamad.

Kogutud teadmistest sai eesmärgiks luua aineteülene õppeaine, mis toimib eraldi mooduli või vabaainena, leiab väljenduse kunsti, tehnoloogia või ruumi haridusest huvitavale õpilasele suunatud töövihiku näol. Innustust sain Arhitektuurikooli õpetaja raamatust, mille vormi ülesehitusel eeskujuna kasutasin. Usun, et võimaldades nooremale järelkasvule mõistmist materjalide saamisest, valmistamisest, kasutusaladest ning ringlusest, sealjuures võimalust ise katsetada pannes mängu oma loovus, organiseerimis- ja koostöövõime, saab noor inimene võimaluse tunda vastutava ja aktiivse kodaniku rolli ning seega olla võimeline oma elu looma ning juhtima.

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# Appendices

## Appendix 1. Questionnaire among pupils

Because now it is not possible to do a control study and analyse in real life how children would react to my programme, I made a pre-analyse, to understand whether there is actually need for this in their own opinion. I asked teachers of Tallinn Pelgulinna Upper Secondary School teacher to share the online questionnaire with her students from grades 7-12. Although the programme is made for grades 10-12, the ones in 7-9 are soon to be in those grades and should be heard as well. Main intention was to find out how they evaluate their own knowledge in the field of materials. It is important to note that this school is advanced in teaching art subjects. I also explained what do I mean with word materials, since it is a very rich word in meanings. Materials all synthesized or made by people from those close to our skin, clothes to everyday products and those our built environment is made from. The values on 5 point scale are: 1 is low value and 5 is high value.

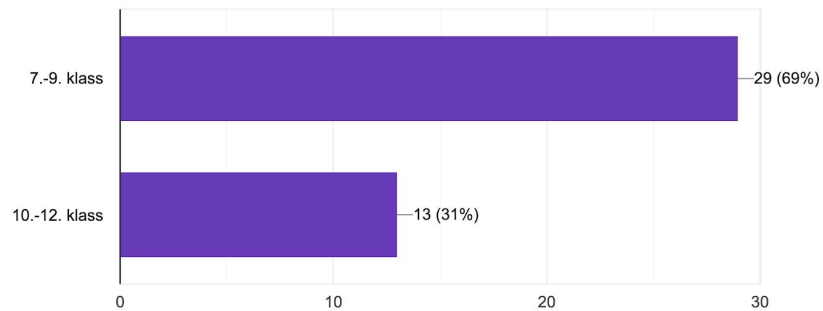
Questions were following:

1. Their current grade, 7-9 or 10-12.
2. How would you value your knowledge on materials (origin, properties, manufacturing, environmental impact)?
3. Why such estimation? Please explain in few sentences. What has affected it the most?
4. How important do you consider knowing materials?
5. Have you ever experimented with materials?
6. In case you answered yes, what was it?
7. In what kind of school subject there could more hands-on tasks?
8. What would you like to know more about materials?
9. If there is anything else you would like to ask or add about materials, please feel free.

Answers:

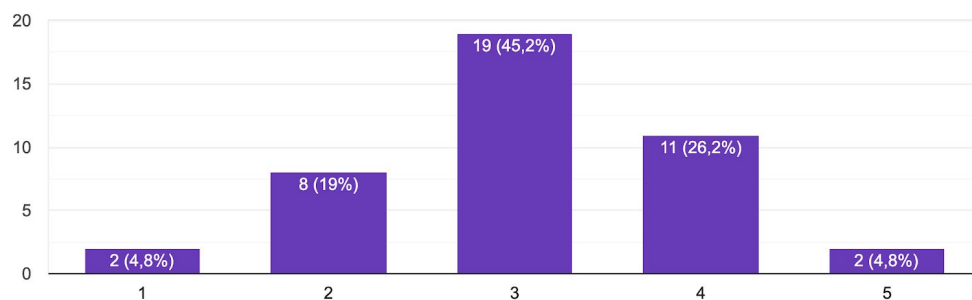
1. Altogether there were 42 answers, 29 (69 %) of them in grades 7-9 and 13 (31%) from 10-12. I decided to not consider their sex.

Millises õppeastmes õpid?  
42 vastust



2. On a scale 1-5, where 1 is *I know somewhat* and 5 is *I am well aware*, their opinions varied and on average they think their knowledge is moderate.

Kuidas hindad oma teadmisi sind ümbritsevate materjalide tundmises (sh päritolust, omadustest, tootmisest, keskkonamõjust) ?  
42 vastust

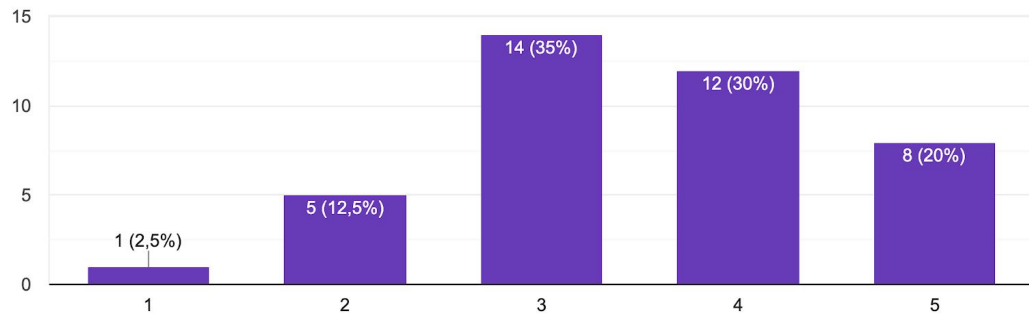


3. Those who evaluated their knowledge higher, was usually due to family, thanks to the school subjects ... Many notice internet forming what they know.
4. What surprised me positively was that the importance they put upon knowing the materials is higher than the knowledge they think they have, upon which I can

conclude that they are interested in knowing more about them.

Kui oluliseks pead materjalide tundmist?

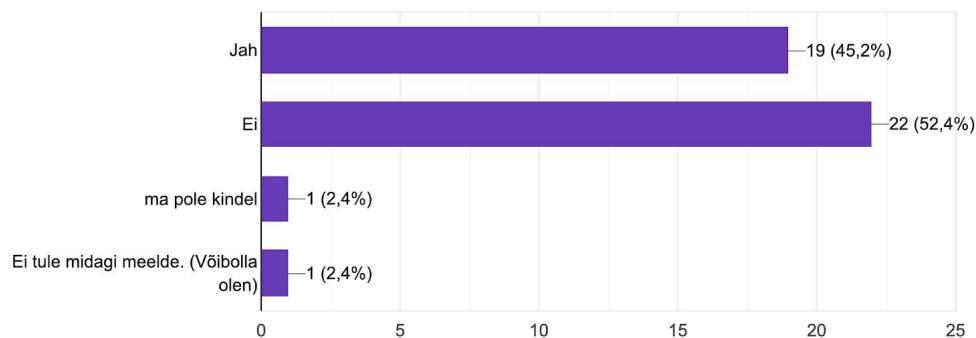
40 vastust



5. Those who had and had not tried making materials, were more or less in half. A few were not sure.

Kas oled ise kunagi materjalidega katsetanud (näiteks paberit vanapaberist, jne)?

42 vastust

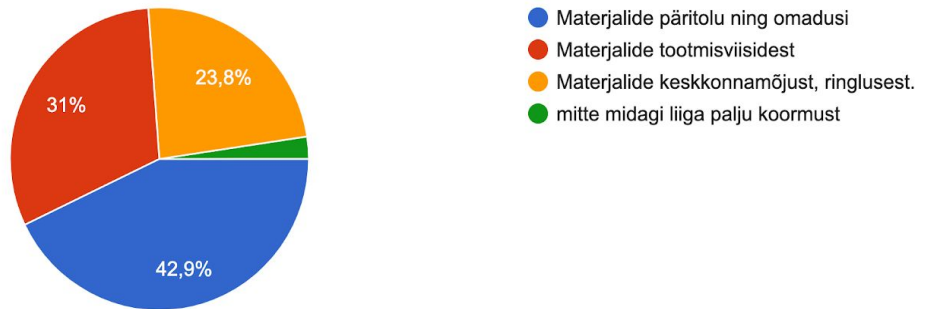


6. Most of the ones who answered yes to the previous question had done paper from recycled paper at various places from school to birthday parties.
7. This is the question in which the answers varied the most. Suggested subjects are mathematics, physics, arts and craft, biology, geography, chemistry, music. Most popular were crafts and chemistry suggestions. Few answered that they do not know and two people thought that there is no need for it, first it is a waste of time and second, there is no space in the curricula for such a subject.
8. Still everyone but one wanted to know something about the materials. 42,9 % wants to know about the origin and properties, 31% about their manufacturing, 23.8 % about

environmental impact and recycling and 2,4 % did not wish to have the subject due to overload of schoolwork.

Mida sooviksid materjalidest rohkem teada?

42 vastust



9. There were only few comments and one questions: (1) there could more questionnaires like this, (2) how to make fabric and (3) Why do people prefer new materials over used, second hand ones?

### *Conclusions*

Although there were overall only 42 answers, they still showed opinions of almost 2 class full of pupils. I take away from these answers that young people do want to know more about materials and that it is better to have the possibility to learn about it at school at least on their own choice. I will try to take into consideration the answers I got when planning the workbook.

## Appendix 2. Interview with Mirjam Vikisk

Interview with Alphenberg's Tallinn showroom account manager Mirjam Vikisk on 1st of November 2018. I have decided to keep this interview so far since the questions I ask are meant to be sustainability - driven.

*When I enter the showroom, the first thing I notice is a nice lady who greets me and shakes hand. She has been waiting for me. Almost everything, including walls and floors are covered in leather.*

What I found out from this meeting with Mirjam is that they are the only ones who are offering such leather solutions for interiors in Estonia. They have been active for over 6 years and are growing. What surprised me was that the origin of the materials. Although it might be logical afterwards, that with a mother company that is based in Holland, their hides come from India, first regular cows and second water buffalos living in the wild. In the country, where a cow has been holy, it does anyway make me question how come are they the biggest producers of leather in the world.

*Transcription.*

I have decided to bring out the moments that are important from the point of view of the thesis, mainly to see the way it is organised.

M- Mirjam

K- Kristiine

*At first she was showing me different material collections they have.*

K: "What type of leathers are they?"

M: "vegetable tanned leathers"

K: "Do you know where they are made?"

M: "They are made in the Netherlands, the hide is from India, from the Water Buffalos

*that are used in the meat industry. The skins are being frozen and transported to Holland.*

*K: "Why so far ?"*

*M: "Because the Water Buffalo lives there. Probably for the specific animal's leather."*

*Then she discusses on which ones are better to combine with each others.*

*M: "I guess they have decided for the leather in the process of product development.*

*Cannot compare it to the cow hides."*

*Alphenberg has a very wide range of upholstery leathers, this is more of an exclusive collection" referring to one on the table.*

*09:12 K: "Since you are the one talking to customers, how do you see, why people choose leather? It is warmer and.."*

*M: " And also because it is something different, it give a luxurious accent. Usually it's not like here, that the whole home is filled with leather, but rather doing some details and it gives a totally different look.*

*K: "I was surprised when I entered that, now I see that there are quite dark colours, but I do not feel pressured as I would have assumed it to affect me."*

*M: "Perhaps it is due to the natural dyes and tones that have been used and of course that is the job of the interior architect-designer."*

*K: " What about the the angle of health, how would you compare it to other options to cover the walls"*

*M: " For sure it is not harmful anyhow. Of course nowadays people have different allergies nowadays. But since it is tanned with natural materials, it does not have the poisonous chemicals used in the chrome-based tanning"*

*K: " What about the glues?"*

*M: " We have a special Alphenberg glue, the primer and the glues , I have not looked into the details, but the logic goes that if the material is natural, it cannot be very toxic glue."*

*K: "How much people know about you so far? How popular are you?"*

*M: " Yes , we are growing, we have been here for 6 years... The last project was in the new shopping center of Mustamäe. One effect wall and the doors of the closet. "*

*The also collaborate with NOA Design, who make light shades from wood and leather.*



*K: "How long could the leather floor last?"*

*M: "It has been here for 6 years now... It is actually very easy to maintain it. Just need to swipe the dust and also possible to mop it. Once a year it would be nice to recover with beeswax or some oils. Basically eternal. And if one panel gets damaged, it is possible to just replace one, instead other whole floor. And it is also possible to reuse it. We have used panels from one object on another one."*

*[...]*

*23:32 This one here is also covered from leather. We have covered so many things: handrails and steps of stairs, laetalad, whatever your fantasy puts limit on, the areas between the kitchen cabinets and also the surfaces of cabinets themselves, to make it even more beautiful."*

*We also do other works.*

*K: "And where and who does it? Do you do it here or through some third party? I am just looking at how you operate too."*

*M: "We have let it made in Tartu."*

*K: "Mhm, so locally..."*

*M: "Yes."*

*26: 10.K: "Have you got any feedback on the ethical side of the work? How that topic is reflected in your work?"*

*M: "Actually there are very few vegans. In these 6 years there has been one time. The owner had a meeting, I think it was an interior architecture company, where a girl asked "What if we are all vegans here?" That is what we are emphasizing on, that it is the byproduct of the meat industry, as long as people eat meat, there will be the skin and it seems reasonable to use that, what is the point of wasting it. I'd say the contrary, that it is a very green product."*

*[...] They claim that eating meat is not sustainable at all, but it is done and I don't think it is going to end any soon."*

*"In our climate it is also a tradition and a real need to use the leather. Maybe somewhere in the equatorial area there is no need, but we are Nordic people and it comes in use"*

*K: "Why do you think you do not use Estonian cow leathers?"*

*M: "It is a dutch company, I cannot answer that question now"*

*K: "OK, thanks you very much, I am out of questions"*

*M: " Oh, another thing about leather is that it quite resistant to fire. You can always test it by trying to put it on fire. [...]"*

*"It is 98% biodegradable. I would say it is a very green product."*

*K: " Thank you for welcoming me"*

*M: "You are welcome."*

Mirjam also suggested me to see several places where their work is exhibited: BOA Architecture Bureau, Viimsi Spa hotel administration, Mustamäe Shopping experience center, new Japanese restaurant Noya in Rotermanni. Later I find out from Olga Vertjajeva, a worker at Alphenberg Riga showroom, who was my first contact person, that the majority of the meat from the buffalos is transported to Arab states.

## Appendix 3. Experiment with waste materials

First, I went to the woods in the below zero degrees November day and hit off some smaller pieces of the species, since the bigger ones are a big challenge even with a knife and the smaller ones are said to be working better. The young fruit bodies were put to soak in lukewarm water and then cut into strips. Later they need to be stretched and beaten to separate the fibers.

Once it was soaked in the mixture of lukewarm water and ash, it was much easier to separate the soft inside from the hard husk.

It had not come out the way I expected. Perhaps I had either soaked them for too long or they were already old ones or something third, so I dried the pieces instead and later blandered the mass. The aim was to get a powdered, but it was rather a smaller hay-thick pieces, which I later bonded with glues.

For the whole process I took waste materials I could find around me at the time of the year:

1. leather dust

2. sawdust

3. ash

I bonded them with 2 different types of glues: natural glue from flour and water and PVA based glue. Also mixed them with each other and made 10 different samples. This was a

easily done process in do-it-yourself, DIY style, using well accessible materials.



Softer tissue of  
F.Fomentarius after crushed  
in the coffee mill.



3 samples from the experiment.  
From left: 1) fomes fomentarius, PVA, natural  
material based glue;  
2) sawdust, ashes, glue; 3) sawdust, glue.

In conclusion the first experiment failed. What I could derive from there is that next time I have to extract the most inner layer, because there are two layers that are very similar and the one I was working with was the sturdier one, which is not used for making amadou. Another question is, could these forest mushrooms be grown in lab or factory environment to create larger scale material that would come in rolls? Now the amount of effort and time gives very little material that makes it very expensive and not affordable to the majority.

## Appendix 4. Workbook

Attached as a separate printed file.