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Educate students in teacher training to sustainable consumption through the life cycle examination of an e-device

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Abstract

Sustainability is a highly complex, interdisciplinary field of education. Therefore, in the case of sustainability education in teacher training, it is especially important that students shall be able to see the natural, social and economic problems and challenges of sustainability, the possible solution of the problems and the causal relationships in a system. This is the only way to prepare them for providing children with quality education regarding sustainability education. In this study, our purpose is to demonstrate how the life cycle of smartphones as an e-product can contribute to an effective education of sustainability and the development of a complex approach of students. Besides, our purpose is to present the obtained results of a student survey related to smartphones. The questionnaire is supposed to answer the following questions: How do students appear in the consumer market as smartphone users? Whether the problem of planned and moral obsolescence appeared? What are their consumer attitudes towards smartphones? Is the device used in a conscious, environmentally-friendly way? Are students aware of the environmental, social and economic impacts of e-devices' life stages? The study presents the conclusions drawn from the results of the survey.

Keywords: sustainable consumption; smartphone; life cycle analysis

1. Introduction

When we would like to make sustainability education in teacher training more effective, it is worth taking into account the 2030's global educational framework developed by UNESCO (UNESCO, 2017; Könczey, 2017; Varga et Könczey, 2019). UNESCO is the Educational, Scientific and Cultural Organization of UN, which defines sustainability education goals for the 17 Sustainable Development Goals (SDGs) (SDG, 2015; Mika, 2017; Lükő, 2017). Fig. 1. shows the 17 sustainable development goals. It can be seen that it includes areas such as sustainable consumption and production, sustainable management of natural resources, climate change, poverty, gender and other inequalities, health, food security, infrastructure, as well as

peaceful and inclusive societies, etc. Goals related to the e-product lifecycle in a narrower or broader sense are highlighted in Fig. 1. UNESCO formulates unique educational goals for its 17 sustainable development goals in three main areas: cognitive, socio-emotional, and behavioural. In teacher training we try to keep in mind this complex three-pronged approach.

Fig. 1. The 17 sustainable development goals (SDGs). Goals related to the e-product lifecycle in a narrower or broader sense are highlighted.

https://www.bptargetneutral.com/us/how-we-work/choosing-our-projects/the-un-sustainable-development-goals/

It means that we do not deal with the environmental, socio and economic problem of sustainability on the level of knowledge alone, but we also emphasize personal connection to the topic; in this way can hope for a change in attitude. In addition, we believe it is important for students to be able to see sustainability challenges, problems, issues to be solved, and cause-and-effect relationships in a system, not out of context. We can only achieve students making their consumer habits more sustainable if they see their meaning and are aware of the wider impact of their lifestyles. We have already done many sustainability projects with our students in this approach, e.g. The „How others live" project (Hill et al., 2016b; Anthropolis, 2012). This complex vision can also be facilitated in the way presented in this study; that is, by examining the lifecycle of a product (Tamaska et al., 2001). When selecting the product to be examined, it was important an aspect that students were able to connect personally, that they had everyone's own, and that they had the opportunity to become involved mentally and emotionally during the analysis. This is how we chose the smartphone.

2. Aims and research questions

2.1. Aims

Our aim is to present that lifecycle examination of the smartphone as an e-product can contribute to effective sustainability education. Our goal is also to present a survey and the result of survey related to smartphones, filled by student.

The purpose of the questionnaire was to assess what kind of knowledge needs to be based on and to build upon, related to the lifecycle of a product and in which areas sensitization is of particular importance. Once we have a picture of this, we plan to develop and evaluate a product life cycle methodology with our students. In addition, we plan to assess whether consumer attitudes will change following the acquisition and sensitization of new knowledge. The research results and opinions are differ on the relationship between environmental knowledge and attitude. Some studies have found a positive (Campbell et al. 1999), however, other studies have found no positive correlation (DeChano, 2006). A very important aspect is the process and quality of the acquisition of knowledge. E.g. in frontal education we focus on acquiring lexical knowledge, so probably significant attitude change is not experienced. However, if a student acquires knowledge through the development of different competencies (like UNESCO defined key competences) and during this time experiences also a great deal of personal involvement, the expected change in attitude is significantly greater (UNESCO, 2017; Réti and Varga, 2008).

2.2. Research questions

- How do students appear in the consumer market as smartphone users? Whether the problem of planned and moral obsolescence appeared in students' thinking about smartphones?
- What are the students' consumer attitudes towards smartphone use? How conscious and energy saving are they in using the device?
- Are students aware of the environmental and social impacts of life stages of smartphones?

3. Theoretical background

3.1. Importance of education for sustainability in teacher training

When thinking about sustainability education in teacher training, it is important to keep in mind two main purposes. On the one hand, to educate students (future kindergarten teachers and primary school teachers) on sustainability, on the other hand, preparing them to be able to provide quality education in the field of sustainability. The following is a non-exhaustive list of concepts related to the evaluation of both mentioned goals, in accordance with key competences formulated by UNESCO (Hill et al., 2016a; UNESCO, 2017).

- Sensitization: developing a positive attitude and a realistic sustainable lifestyle through many positive personal experience.
- Adaptability: Develop a strategy for sustainability education, taking into account the current knowledge and attitudes of students.
- Thinking in a system: students will be able to see in a complex way the environmental, social and economic challenges, problems, issues to be solved, and causal relationships of sustainability. This will enable them to see and understand sustainability at global, local and individual levels and also recognize what they can do in practice for sustainability at local levels (community, school).
- Integration: As future teacher, it is important for students to realize that education for sustainability is essentially a part of any discipline, so integration into all subjects is required.
- Interiorization: the ideas of sustainability must become an integral part of the thinking of present and future teachers. Consequently, sustainable attitude and lifestyle and continuous self-improvement become an internal need.

- Multiplicative effect: students will lead and support the knowledge of many children about nature, and through the children they will also influence parents, so the role of teacher training will be strengthened.

3.2. The life cycle of a consumer product

Often, only one phase of a product's life (Ercan et al., 2016; Tamaska et al., 2001) is visible to us; namely, when we use it; the other phases remain hidden to us. This phase could be quite long, e.g. we use a piece of furniture for decades or could be extremely short, for example for a straw. However, the product has A pre-life, which comprises the raw material extraction, and various parts of the production process. Usually, little is known about these phases. The product has also an after-life; that is, it becomes waste or trash after use (Angyal et al., 2012). Many times we see this part only until we throw the product into the trash but we don't know where it goes from there. As Fig. 2. shows, each phase follows each other in a chain-like manner, so that the final phase is not closed into a loop with the initial one. That is why this type of production process is called open-chain production. Because of the linear nature of the process it would be more exact to use the term life chain or lifeway instead of life cycle, as it is in Hungarian, but since the English literature uses the term life cycle, we will follow it literally in this paper. At the same time, we emphasize that, unlike its name, it is a linear process and we would like to draw our students' attention to the problems that arise from it.

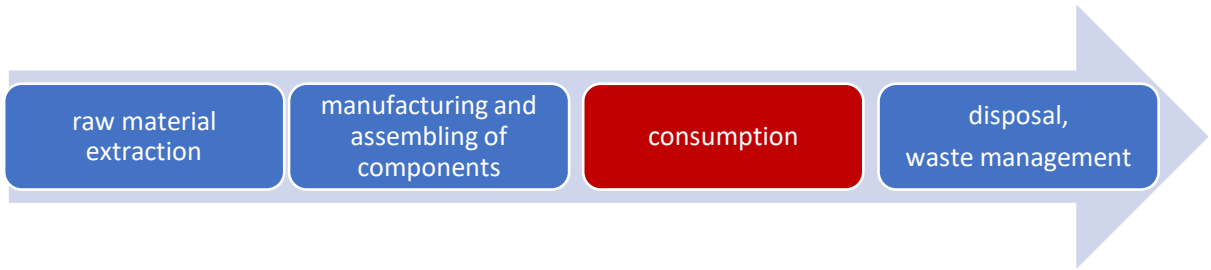


Fig. 2.
Life cycle phases of a product.

As a result of planned obsolescence (Reuss et Dannoritzer, 2017) product designed to go to waste, the reduction in the usage time of the product generates an increase in consumption. This increases the whole process, so the more often you change a product, the more will increase the raw material demand, production process, and waste and garbage. However, since these phases are not taking place before our eyes, it is possible that we do not think about it, and contribute to the cause of environmental and social damage unintentionally.

We believe that analyzing such a complex process along sustainability goals as the life cycle of a product, examining the environmental, social problems, and opportunities for change at each stage, helps our students to think systemically, recognizing causal relationships. However, it is also important for our students to be personally connected to the topic. For this reason, we chose the smartphone as a product. We assumed that all of the students (or almost all of them) have it and it is an integral part of their lives.

4. Methods

4.1. The smartphone life cycle analysis from pedagogical aspect

We collected sustainability (environmental, social and economic) problems associated with each phase of the life cycle, and made an overview of pedagogically important areas, and finally we prepared a summary of educational tasks. This is an important preparation phase for future research, where we plan to develop a methodology for processing the topic with students. This future methodological work is supported by the questionnaire, discussed in the next section.

4.2. Research method: survey

There are many fields of survey research on smartphone, eg. the use of applications (Havassy, 2016), the psychological effects of the smartphone, like the development of addiction (Aljomaa et al., 2016; Gligor et Mozos, (2019), Regarding the consumer's habits and attitudes, there are research results related with the replacement of the phone, the reasons behind the replacement, and end-of-life phones (Ylä-Mella, et al. 2015; Li et al., 2012), however, we do not know about research dealing with other phases of the life cycle. In our research, the aim of the survey as a conventional research method (Majoros 2011; Molnár 2010) is to obtain information about our students in the following areas: knowledge of smartphone life cycle, sustainability issues, consumer attitude, how consciously, environmentally friendly the device is used. The aim of the survey was also to raise the students' attention and focus it on the problem.

We hoped that the very act of filling the survey would have an attitude-shaping effect. The survey was completed by 498 students of the ELTE Faculty of Primary and Pre-school Education. The survey was included 20 questions, of both the open-ended and the close type (Majoros, 2011). The filling was done online so we didn't use a lot of paper and ink for printing. The questionnaire was filled out in Hungarian, the Appendix contains the translated English version.

5. The smartphone life cycle analysis from pedagogical aspect

5.1. Collection of sustainability problems associated with each life cycle phase

Although the whole life cycle is related to the product, each component (e.g. System on a chip/SoC, memory, display, camera, battery) has its own individual life path.

5.1.1. Phase 1. Raw material extraction

This includes raw materials required for the device and its components, as well as for packaging, protecting the device (e.g. screen protector, phone case).

Problems

- First point hard to access, rare raw materials (e.g. heavy metals, rare earth ores, cobalt, tantalum, lithium, gold, etc.) whose extraction results in severe ecosystem damage and destruction (e.g. deforestation) (MCS, 2020).
- Many of the required substances are hazardous to living organisms and the environment (e.g. heavy, and rare earth metals and their compounds) (Wu et al., 2016).

Because of the mentioned circumstances legal extraction has huge costs and a number of serious environmental, social, ethical, health problems and violations of the law occur as a result of shortcomings in the legislation. For example, illegal and dangerous mines and mining, child labor, exploitation, intimidation, armed conflict, smuggling of ore from mining, heavily contaminated mining areas (soil, air), posing a serious risk to public health.

5.1.2. Phase 2. Manufacturing and assembling of components

This phase includes the manufacture and assembly of individual components, which also raises a number of environmental and social problems. As well as raw materials harmful to many environments and health, additional harmful additives are added and toxic gases are released during production (Kang et al., 2018). Young or child laborers are employed in factories (i-slaves) for very low wages, 10-12 hours a day, in poor working and accommodation conditions. There is a very high rate of physical and mental illness among workers (depression, suicide, leukemia, cancer, etc.). Greenpeace and other human rights organizations carry out studies, reports to raise awareness and campaign on human rights issues during production, but because of their sensitive nature and the interests involved in production, "official" investigations and their publication are only rarely carried out.

5.1.3. Phase 3. Consumption

This phase is the shortest one with an average of 1.5-2 years of one smartphone being used (Baldé et al., 2017).

Relating to this phase, we should focus on and familiarize our students with the following issues:

- External costs (ISSC and UNESCO (2013) by which we pay a fraction of what the item actually costs.
- Second point planned obsolescence (Reuss et Dannoritzer, 2017) (product designed to go to waste) the consequences of this are *a,* the repair is not at all or only partially possible; *b,* it is impossible or only very expensive to get parts; *c*, in the case of parts failure the whole device becomes unusable (e.g. battery replacement); *d,* phone's operating system is slowing down
- Ethical obsolescence.
- It requires a lot of power (in the form of electric current).
- In the case of the smartphone, a psychological effect, addiction.

5.1.4. Phase 4. After-life of e-device, deposal, e-waste

Problems

E-devices (Baldé et al., 2017) no longer in use are shipped from Europe to Asia, Africa (e.g. Ghana, China, India) (EFFACE, 2015), so similarly to the raw material extraction and manufacturing processes, we do not have to deal with waste directly after use. Huge e-waste cemeteries are being created in those countries. People living there also try to extract the valuable, recyclable metals under inhumane conditions, which poses a serious environmental and health risk, as the e-waste and its combustion products contaminate the soil, water and air (toxic metals, combustion products, etc.). Only 20% of the e-waste generated all over the Globe was documented to be collected and recycled (Baldé et al., 2017; Rucevska et al., 2015) which corresponds to.

5.1.5. Phase 5. Extra phase: Transport, distribution

Transport accompanies the entire life cycle process, on land, by water, by air, starting with the transport of the mined raw materials to component factories. It is common for a component to be manufactured on several different continents so they can be transported to the assembly site.

The finished products are shipped all over the planet to distributors, shops. Finally, after a short period of use, e-waste goes to e-waste cemeteries. Students can follow a map, and can calculate the distance traveled.

5.2. Summary of educational tasks related to life cycle phases

The life cycle phases of raw material extraction, production and e-waste management (i.e., phases 1, 2, 4) are discussed together, while phase 3 (consumption) is dealt with separately.

The first, second, and fourth phases described above take place far away from us on other continents. The vast majority of problems occur there and exert influence also there, so our students feel much less about it, or may have never heard of it. So for these phases of producing a smartphone, other people are paying a high price for losing their natural environment, their peaceful life, their freedom, and maybe their basic human rights. In these phases, we emphasize that students have access to knowledge during sensitization, so we try to present the facts in such a way that they have the opportunity to be emotionally involved. Photographs, films (e.g. Complicit, http://www.complicitfilm.org/) that show the lives of people living in the areas concerned, the consequences of problems caused by mining, manufacturing and e-waste, provide an opportunity to do this. It means a lot if we do not generally talk about a problem, such as child labor, but relate a specific story, maybe show a person's face, or a personal life story is bound to it. Students may search for newspaper articles that are presented to each other (e.g. boy fell ill with leukemia during factory work). It is very important to note that the purpose is not to frighten but to induce responsible thinking and behavior through sensitization.

In phase 3, in the case of consumption, the primary goal is to become a (more) conscious consumer, which is fundamentally influenced by the knowledge of the topic and the emotional attitude.

Based on the generally valid aspects of conscious, sustainable consumption, we think about opportunities with a focus on the smartphone as a specific product. It is not our intention to try to dissuade students from using a smartphone, it would be a naive and pointless attempt. Our goal, however, is to see how much they can do, consciously thinking through their decisions and actions. Below are the re-things, consider the possible steps toward sustainability based on these:

- Rethink: Before you buy a phone, you should think carefully about what sustainability considerations you should take (e.g. buying from a manufacturer with more ethical life-cycle steps, such as a removable battery, etc.).
- Refuse: Rejecting such attractive offers as a higher category phone, or in the case of a sale (eg Black Friday). It can help a lot here if we explain to students how conscious the psychological influencing campaign is on the part of those who are making a profit. It is also worth influencing the students' self-esteem.
- Reduce: Consciously reduce the power consumption of smartphone, e.g. by selecting battery-saving mode, turning off wifi or mobilnet, or any other applications.
- Reuse: extend the life usage time of the phone by giving it away or selling it to a used phone dealer.
- Recycle: Disposal of the phone to the E-waste bin or specifically to the mobile phone bin will help recycle the phone's recyclable parts, materials (such as rare metals).
- Repair: Perhaps this is the least effective process as it is very rare that the smartphone may be worth repairing due to planned obsolescence.

In addition, a number of options are worth reflecting on and critically analyzing with students (such as buying a fairphone, signing petitions, etc.).

6. Result and conclusions of survey

The survey was filled by a total of 498 students. Young adults between the ages of 19 and 24, that is, members of generation Z (Mohr and Mohr, 2017), born of the digital age. The gender ratio among surveyed students, typically of our Faculty, is 3.6% male and 96.4% female, so from this point of view the sample does not represent the gender ratio in society and is not suitable for comparing the two genders relating to the topic.

The first set of questions measures how students appear in the “consumer market”. 99% of students have a smartphone, and the remaining 1% have a phone but not a smartphone. Only 2% of students have more than one phones. Fig. 3. shows how old they were when they got their first phone, and how old they think a child should be to be given a phone.

It can be seen that approx. one-fifth of them received or gave their child a phone between the ages of 6-9. Nearly half of the respondents received the phone between the ages of 10 and 12, while nearly two-thirds would buy one for a child of that age. So, if we were to project this to the entire Hungarian population, the members of today's Z and alpha generations, approx. 80%

would have had a telephone by the age of 12. Another Hungarian study (NMHH (2017) found that 71% of children have their own phones by the age of 12 (and further 9% use their parents or siblings phones). Considering that this data has been published more than two years ago and the number of children with phones has been increasing ever since the phones came on the market (Rideout, et al., 2010), the results of the two studies are similar.

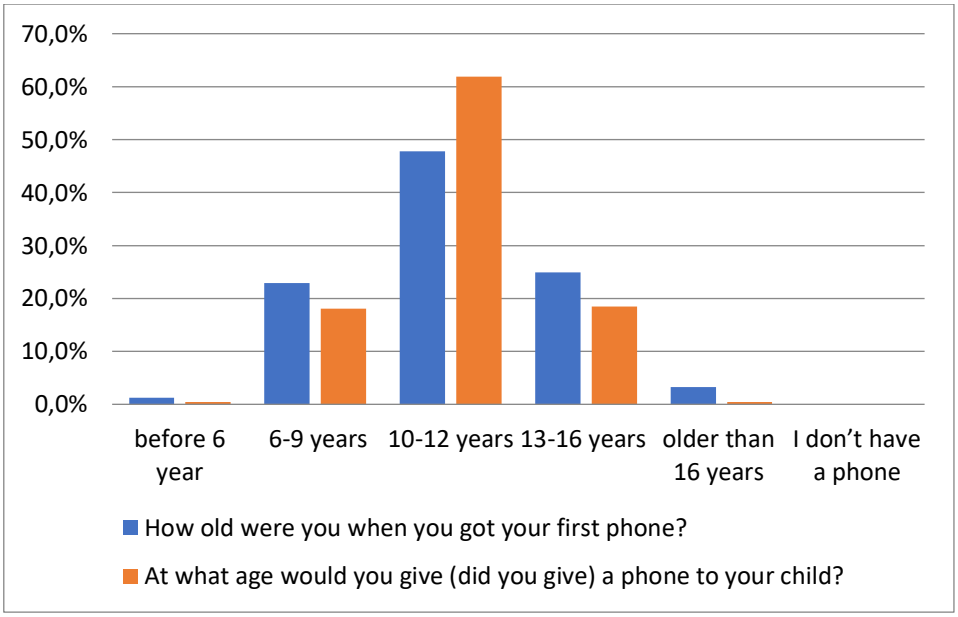


Fig. 3. The first time when students got their phone (red columns) and the first time when they would give one to their children (blue columns)

The following set of questions (Which phone / smartphone is your current phone, how long have you been using your current phone, and why have you replaced your previous phone) examines how the planned and moral obsolescence is displayed during phone use. Fig. 4. and Fig. 5. clearly show that phones are replaced very often. Based on these, we cannot yet determine whether planned or moral obsolescence dominates the cause of the replacement.

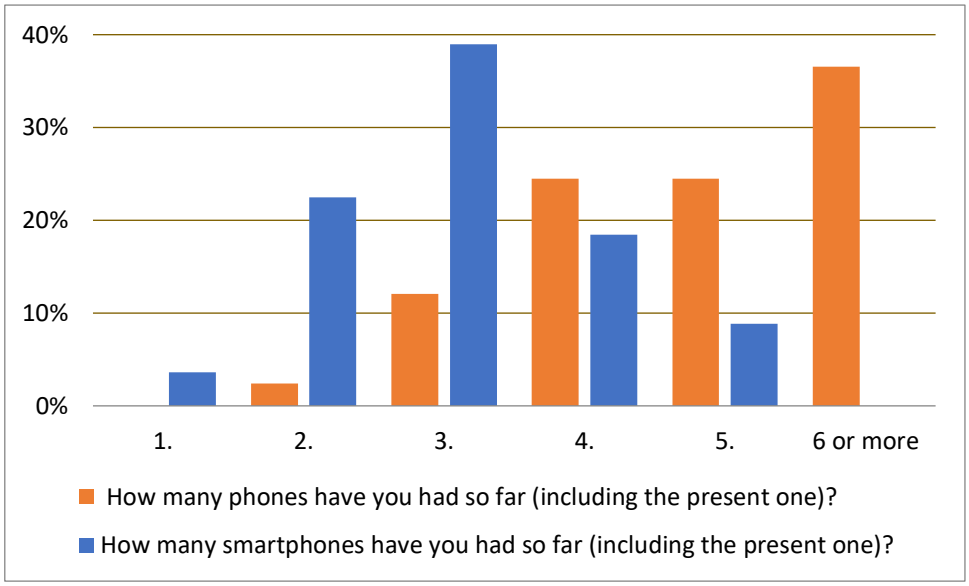


Fig. 4. Which phones (red columns) or smartphones (blue columns) are the current ones of students'

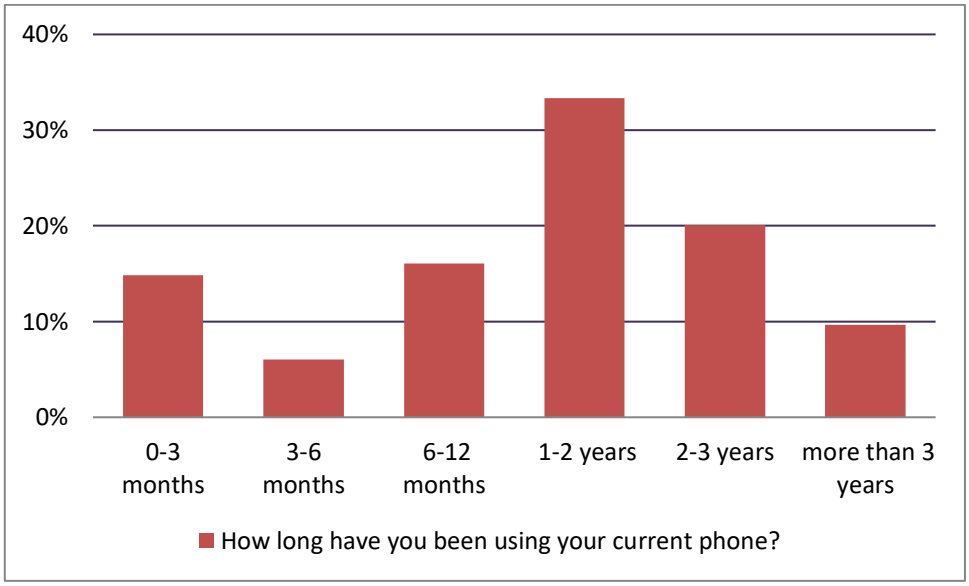


Fig. 5. How long have the students used their present phone

Fig. 6. shows also what the reason for replacing the phone was. The vast majority of the answers (84%) were "It went wrong." (41%) and "It was slow, there were no application running on it." (43%). From this it seems that the planned obsolescence is clearly dominant. The possible answers included "because I liked another one"; the affirmative answer to this shows ethical obsolescence: only 4% of them chose it. In a later question, asking about a phone case replacement similar reasons were given us yielding slightly higher percentages (often 10%, always 4.4%). This difference may be due to e.g. price difference between case and phone. Overall, the vast majority of students are not affected or only slightly affected by planned

obsolescence. With these questions, our goal was to make our students realize, by looking back, how often they switch phones. We presented these figures to a number of our students (about 10% of the students, 47 persons), who we had the opportunity to talk to during a course after their completing the questionnaire). Their typical reaction was "I never thought about how many phones I had destroyed in a short time."or "I've never counted it before." In our subjective opinion, based on the reactions of the students, they are somewhat aware of the frequent switching of devices, but this kind of awareness and confrontation with the facts still astounded them.

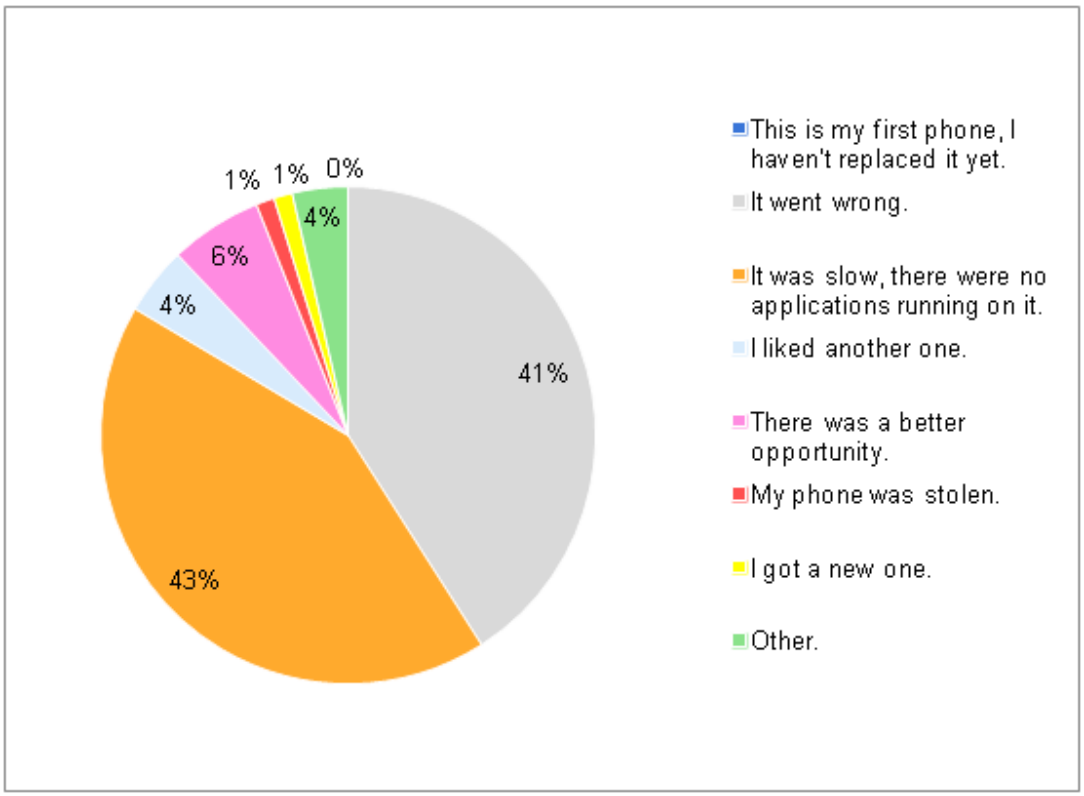


Fig. 6. The reason for students replacing their phone

The next set of questions explored the students' habits of using the phone (how much they save the battery, how much they pay attention to energy efficient use and how much they protects their phone). Students could answer a question on a four-point scale (never, sometimes, often, always).

96% of students do not or only rarely turn off the phone at night, compared to the 36% for those who mute their phonrs for the night (Figs 7 a,b.). We suppose that behind these figures there is an underlying students' need for round-the-clock availability.

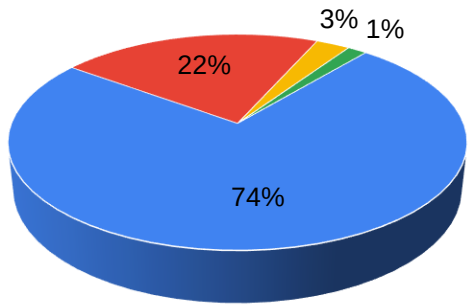
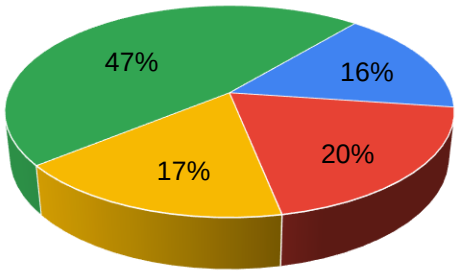
I turn the phone off at night.	I mute the phone at night.
	

Fig. 7 a. (left). Students turn their phone off at night, and 7.b. (right). Students mute their phone at night. Colour code never sometimes often always

Most (56%) do not use battery-saving mode or use it only occasionally. 47% of them do not or only occasionally turn off Wi-Fi or mobilnet, even though they do not use it (Figs. 8 a,b.).

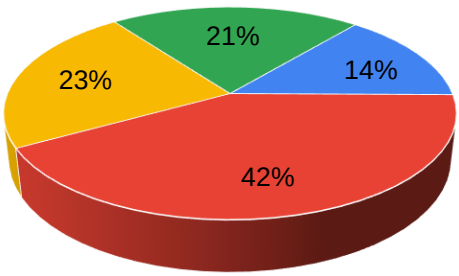
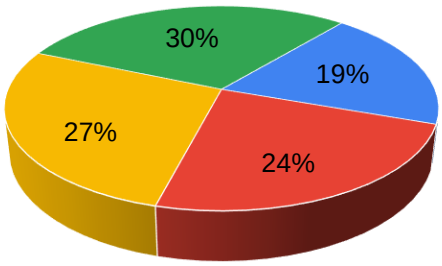
I'm using battery-saving mode	When I don't need internet, I turn the wifi or the mobil net off.
	

Fig. 8 a. (left). Students are using battery-saving mode, and 8.b. (right). When students don't need the internet, they turn the wifi or the mobil net off. Colour code:
never sometimes often always

Much more attention is being paid to the protection of the telephone in use (Figures 9 a, b). There is a very high proportion of students protecting the screen with foil or the phone itself with case. The use of phone cases or foil raises an interesting ambivalence in terms of environmental protection. It is worth discussing and arguing with students that produce a case

or foil is considered to be more harmful for the environment (so it is not worth protecting the phone for a short period of time), or changing the phone due to damage.

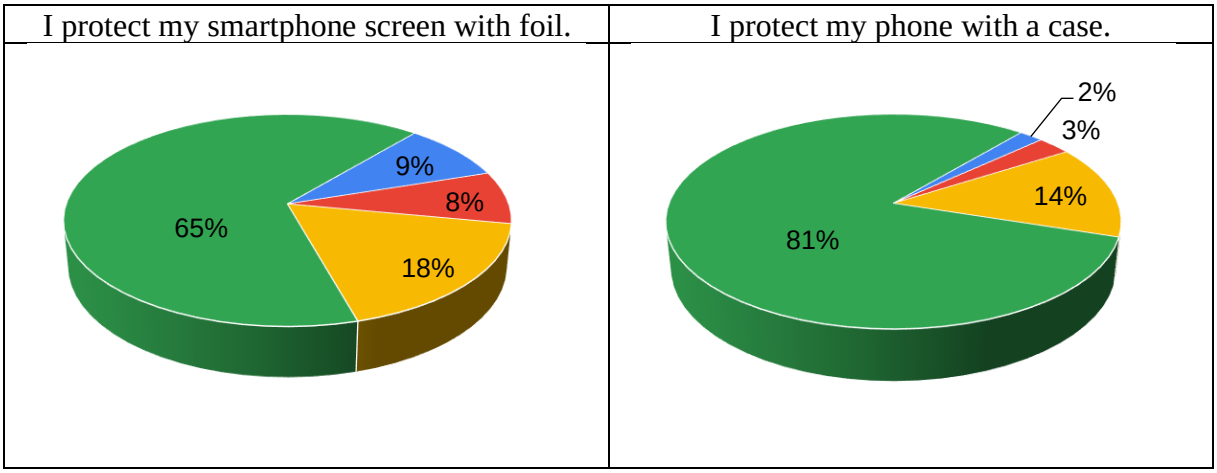


Fig. 9. Students protect their phone with foil (a, left), and with a case (b. right). Colour code: never sometimes often always

Summarizing the results, we find that students are less environmentally conscious in their use of the telephone. Although they protect it, they do not pay attention to energy conservation. From this we can conclude that mainly the high price of the phone is the reason behind the protection of the phone. We asked the students what they do with the phone that they no longer use (Fig 10). Nearly 30% of students chose the option of reuse (giving away or selling on).

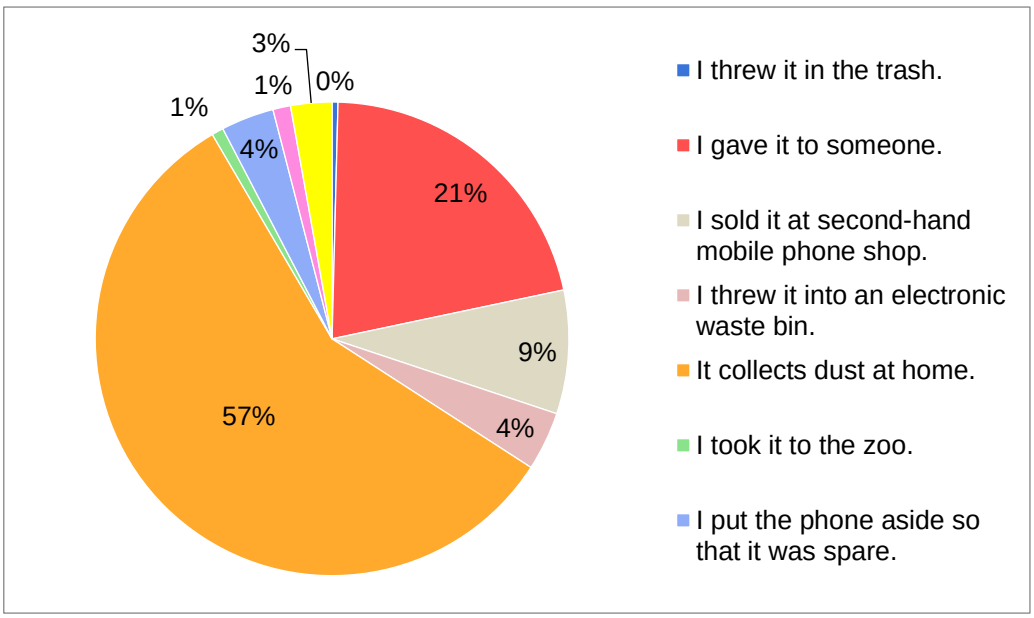


Fig. 10. The students do with the phone which they no longer use

Recycling can be realized by disposing of smartphones in the electronic waste bin, with only 4% of students opting for it. Our Faculty plan to join the "Pass it back bro" campaign

(http://janegoodall.hu/mobilkampany.html), where we plan to apply for phone collection boxes and draw the students' attention to the option.

There are boxes like this in the Budapest Zoo and Botanic Garden, so the answer "I took it to the zoo" probably refers to this. Numerous students (57.4%) wrote that their phones are getting dusty at home, so we trust that more students will bring them.

The last set of questions focused on students' knowledge and understanding of the life cycle of smartphones.

The table 1. shows what students have answered to the question of what raw materials are needed for a smartphone. 11.6% of students said they did not know. Our question was specifically about raw materials, but students did not distinguish raw materials from other manufactured materials (e.g. glass, plastic).

Table 1. According to students raw materials are needed for a smartphone

Students' answers		**value of% answers given**
I do not know.		11.6%
plastic		32.1%
glass		24.1%
sand		2.0%
petroleum		4.4%
carbon		2.4%
mentions metal	metal in general	41.4%
	specific metal mentioned	41.3%
ore	coltan	2.4%
	bauxite	0.4%

We found that 18.5% of the students could name one 19.7% two, and 51% three or more materials. Plastic, 32.1%, glass, 24.2% and metals were the most abundant, but sand, oil and coltan, bauxite as ores were also mentioned. When creating the survey, it is worth mentioning the metals separately. 82.7% responded that smartphones contain metal. 41.4% described it with “metal” accuracy only, and 41.3% listed specific metals. Individual metals are mentioned in the following percentages: aluminum 20.9%, gold 15.7%, copper 12.9%, lithium 10.8%, tin 10.4%, tantalum 8.8%, iron 5, 6%, cobalt 4.4% silver 3.2%, nickel, lead 2-2%, platinum 1.6%. Evaluating the answers, we can say that most of the materials in the phone, including most of

the different metals, came up in the answers. However, on the one hand, the individual components are found in very few responses, with a small percentage; on the other hand, half of the students could not, or could only name 1-2 materials. All in all, there is therefore a great need to develop this knowledge.

To the question of where the raw materials named by the students came from (table 2.). More than the half of the students (25.7%+28,9%) have some information about the topic, they can name a continent or a country. 30.9% of respondents were unable to name any raw material field and 7.6% believe that the raw materials required for cellphone production can be obtained anywhere on earth. Based on this, it seems that this part of the students are not aware that certain materials are found in very few places on earth, and, in addition, are in very small quantities.

Table 2. According to students where the raw materials named by the students came from

students' answers	value of% answers given
I do not know.	30.9%
Wherever.	7.6%
They can name a continent.	25.7%
They can name a country.	28.9%
Other.	6.8%

Some students, 2.4% generally described the extraction site as "poor" or Third World, with 25.7% responding with continental accuracy (Africa, Asia, South America, Europe) and 28.9% responding with country accuracy (e.g. Argentina, Chile, China, Bolivia, Australia, Democratic Republic of the Congo). According to the answers in the "other" category (6.8%), raw materials can be found in mountains, mines, and under ground. We cannot determine whether the student was simply superficial about the question or lacked the more precise knowledge to give a more specific answer.

The answers to the raw material extraction problem are given in Table 3. A very large percentage, 45.8% said they did not know. A total of 21.7% mentioned social problems (eg child labor, unpaid labor, inhumane working conditions, exposure to hazardous substances), while 44.9% mentioned environmental problems (e.g. endangering African chimpanzee habitats, over-mining, finite resources).

Table 3. According to students the problems related to extracting raw materials for mobile phones

students' answers		**value of% answers given**
I do not know.		45.8%
social	health	6.8%
	exploitation	14.9%
environmental	contamination	29.3%
	exploitation	15.3%
difficulties in extraction		3.2%

So students are more aware of the impact on the environment, than the social, e.g. human rights issues. It is interesting that in the case of social problems, exploitation is mentioned by approx. twice as many students (14.9%) as is health problem (6.8%).

The answers to the question regarding problems related to the manufacture of the smartphone are given in Table 4.

Table 4. According to students problems related to the manufacture of the smartphone

Do you know any problems or difficulties encountered during producing your smartphone? If yes, please name them.	
students' answers	**value of% answers given**
I do not know.	56.2%
social health	6.0%
social exploitation	14.5%
environmental	19.3%
planned obsolescence	3.2%
overproduction	1.2%

Unfortunately, the ratio of those who do not know the answer is even higher (56.2%). 20.5% mentioned a social problem (very similarly to the previous question), while 19.3% mentioned an environmental problem.

Overall, we can say that students' knowledge of the life cycle of the smartphone needs improvement at every stage. Our goal is not specifically to give students a full understanding of the smartphone life cycle, but rather to shape their broader global aspect and approach. Smartphones are a very good subject for this because almost all sustainability education goals are outlined and system thinking can be developed very well. We consider it important for students to be aware of the environmental, social processes, problems and their local and global impacts while living in Europe, which are far from us in space and time.

7. Conclusion

In our study, we outlined the life cycle of an e-product, the smartphone, from raw material extraction to waste processing. We discussed the sustainability of education related natural, social and economic problems in each phase. We believe that our study can be applied well in education, both to provide a basis for knowledge, to develop systemic thinking through the discovery of causal relationships, and to sensitize to problems that are global or away from us. The survey revealed, as expected, that almost all students had a smartphone that has become an integral part of their lives, making it a suitable tool for conducting a life cycle examination with this product. The aim of the survey was also to focus the students' attention on the topic and thus to start the attitude-forming. The phenomenon of planned obsolescence is also very clear with regard to the frequent replacement of mobile phones and the reasons behind it. Moral obsolescence is less pronounced on smartphones, which may be due to the high price of the product. In terms of consumer attitudes, we found that students are conscious of the protection of the phone, which may be due to the material value of the phone. On the contrary, energy-conscious use is much less prominent, and they do not pay attention to unnecessary power consumption. Their knowledge of life cycle phases is quite limited in both environmental and social terms. Knowing this, as a continuation of the research, our goal is to determine, based on our experience, what areas we should focus on for the future to build our students' competence (e.g. knowledge, critical thinking, global understanding, social decision-making) and sensitize them to environmental and social problems. This is not only important for shaping a responsible sustainable attitude of students, but also because of the multiplier effect of the future teacher. We also plan to develop a project methodology for mobile phone life cycle phases that can be adapted to any product.

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Appendix

Smartphone survey

1. Your gender

   male female

2. Your age:

   …….years

3. Choose which of the following is true of you.
   a. I don't have a mobile phone
   b. I have mobile phone but it is not a smartphone
   c. I have smartphone
   d. I have several phones, including smartphones
4. Choose which of the following is true of you.
   a. I got the phone.
   b. I bought the phone in one sum.
   c. The phone was bought for a down payment or on credit.
   d. I bought the phone for installment / loan.

5. How many phones have you had so far (including the present one)?

   1. 2. 3. 4. 5. 6 or more

6. How many smartphones have you had so far (including the present one)?

   1. 2. 3. 4. 5. 6 or more

7. How long have you been using your current phone?
   a. for 0-3 months
   b. for 3-6 months
   c. for 6-12 months
   d. for 1-2 years

e. for 2-3 years
f. for more than 3 years
g. I have no phone

8. How old were you when you got your first phone?
    a. before I was 6 years old
    b. between 6-9 years old
    c. between 10-12 years old
    d. between 13-16 years old
    e. older than 16 years old
    f. I don’t have a mobile phone
9. Why did you get your first phone?
10. At what age would you give (did you give) a phone to your child?
11. Do you have a smart watch or fitness bracelet?

    yes no

12. Why did you replace your previous phone?
    a. this is my first phone, I haven't replaced it yet.
    b. because it went wrong.
    c. because it was slow, there were no applications running on it.
    d. because I liked another one.
    e. because there was a better opportunity.
    f. other:
13. What did you do with your previous phone?
    a. I threw it in the trash.
    b. I gave it to someone.
    c. I sold it at second-hand mobile phone shop.
    d. I threw it into an electronic waste bin.
    e. It collects dust at home.
    f. Other:

14. Evaluate on a four-point scale how much of the following statements are true for you.

	never	sometimes	often	always
I turn the phone off at night.				
I mute the phone at night.				
I'm using battery-saving mode				
When I don't need internet, I turn the wifi or the mobil net off.				
I protect my smartphone screen with foil.				
I protect my phone with a case.				
I'll replace my phone if I find another one I like even better.				

15. List the raw materials needed to make your mobile phone!
16. Please list, from what part of the world the raw materials come from, (Those you mentioned in the previous question above)?
17. Do you know any problems or difficulties related to the extraction of raw materials? If yes, please name them.
18. Do you know any problems or difficulties encountered during producing your smartphone? If yes, please name them.
19. What do you think, what problems arise during the recycling of used smartphones?
20. Would you mind stop using your cell phone for 24 hours?

yes no