Supporting Information for the Article:

Motivating Students on ICT-related Study Programs to Engage with the Subject of Sustainable Development

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Content

Table S1: Result of the cluster analysis. The right column shows the original formulations of the clustered insights, including clerical errors (raw data). Formulations in German are accompanied by an English translation in brackets [] written by the authors. Motivating insights are marked with an asterisk (*). For more explanation see main article.

Cluster No.	**Cluster name**	**Insights contained in the cluster (original formulation)**
1	ICT Energy Consumption: Impact of Software	The impact of software on electricity consumption *
		Energy consumption caused by software is significantly bound to resource use *
		It gave me ideas and motivation to do optimization of power-consumption in operating systems *
2	ICT Energy Consumption: Facts and Figures	Verschiedene Interessen erschweren nachhaltige Cloud-Lösungen: Kosten Standort Verfügbarkeit Skalierbarkeit Support/Wartbarkeit Effizienz der Software etc. * [Different interests make sustainable cloud solutions difficult: costs, location, availability, scalability, support/maintainability, efficiency of the software etc.]
		The fact that the total ICT electricity consumption in Germany alone in 2010 consumes much more traffic than the Internet traffic. *
		Die CO2-Emissionen aus der ICT sind fast gleich hoch wie der gesamte Flugverkehr * [CO2 emissions of ICT are almost the same as the entire air traffic]
		ICT in total consumes much more GWh than Internet traffic. *
		the energy usage of a super computer in 1980 was 1000x higher than an actual Intel i7 CPU while its MIPS was 1000x lower *
		That Data Centres currently consume 1.5 - 2% of global electricity *
		Not only users are in charge of decreasing energy consumption of devices but also developers and engineers can contribute to lower energey consumption of electronic devices by implementing state-of-the art technology and code By shutting down workstations / optimizing their power use the savings of electricity can be up to 33%. *

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		Der Datenverkehr im Internet generiert nur einen vergleichsweise kleinen Anteil des Stromverbrauches. Die Endgeräte haben darauf einen wesentlich grösseren Effekt. [Internet data traffic only generates a comparatively small amount of the electricity consumption. Terminal devices have a greater impact.]
		Da Daten Emails und Webinformationen zusammen nur gerade Mal einen Drittel der im Jahr 2012 übertragenen Daten betragen die im Vergleich zu Streaming übertragen werden. [Data, e-mails and Web information together account for only a third of the data transmitted in 2012, compared to streaming.]
		Energy consumption per calculation power has decreased logarithmically in the past.
3	Rebound Effect: Vending Machine Example	Vending machines in Japan
		Intersting was that reducing the energy consumption of soft drink automatas highly increased the number of those. I.e. an example of the effects different changes can have on different stakeholders/systems etc. *
		more efficient vending machine rises absolute energy consumption
4	Rebound Effect: Energy	How much more power today's computers (servers) have and that they need a lot less energy than before (-> much more efficient). But with this comes an increased usage more power-consumption... *
		Developing something may (will) have impact of the opposite... (Machine to reduce electricity consumption uses at the end more overall energy) *
		That the energy efficiency is not sufficient to achieve sufficiency but sufficiency is sufficient for achieving efficiency which to me should be a very useful idea to improve efficiency *
		More energy efficiancy can lead to more energy consuption. *
5	Structural Change:	The question where our society stands right now: On the path of sustainable information society or on the path of

	Vision of a Sustainable Information Society	unsustainable information society. *
		Wir haben es in der Hand eine nachhaltige Informationsgesellschaft zu bilden. Werden wir das tun? (Problem: oft ist Nachhaltige Entwicklung teuer weshalb man z.B. auf alte umweltschädigende Technologien/Ressourcen/Systeme setzt). * [It's up to us to build a sustainable information society. Will we do so? (Problem: sustainable development is often expensive. That's why we count e.g. on environmentally distructive technologies/ resources/systems).]
		A Sustainable Information Society coud have a positive impact on the average consumption of material resources per person *
		Vision einer Nachhaltigen Gesellschaft. Seite 17 Punkt 2.3 (4/7) * [Vision of a sustainable society. Page 17, point 2.3 (4/7)]
		That the classic teriary sector can be devided into a quaternary sector which includes serveces that purely produce information. *
		The paths in "vision of a sustainable Information society" were really interesting.
6	Global Resource Consumption	Global material extraction vs. GDP *
		By using more "information per person" we could reduce the material ressources needed per person in the future. But its not clear how exactly and if it will be a sustainable substitution. *
		Logischerweise zwangsläufig nicht jedes Land zur Informationsgesellschaft aufsteigen kann da jemand die Materialien produzieren muss. [Logically not every country can become an information society since somebody has to produce the materials.]
		A 'perfect' sustainable information society has a low labor per person a low rate of material resources per person and a high rate of information per person. This also means that with low labor and low material use you want to distribute the information to as many people as possible.
		That the development of society which can be described by the axis "labor per person" and "resources per person" can be augmented by the axis "information per person" to visualize

		future development.
7	Structural Change: Decoupling	Manpower to industrial power *
		The importans of decoupling. *
		clark model *
		Colin Clark's sector model of the economy was interesting Because I think that we won't stop using material only that things will be more and more automated.
		Decoupling of Well-Being GDP Ressources and Environmental Impact is a very important concept to motivate people to be more sustainable because they do not want to lose their level of well-being. *
		The goal we strive for: Decoupling the resource use from GDP for instance. Or decoupling happiness from GDP. *
		Primary activities are getting less important eventhough they are essential to survive for human beings
8	Systems Thinking: Exponential Growth	People cannot easily imagine exponential growth *
		That unlimited exponential growth is impossible in closed systems and that there is a limit of growth somewhere *
		Exponential growth is underestimated
		It is very difficult for people to realize how fast explorative growth is
		Most people know only one tool to imagine the future behavior of a system: linear extrapolation.
9	Sustainability Concept	Sustainability *
		that there are more ways too count the benefits *
		that there is serious things we can do to make the situation better
		Preserving the present need of sustainability without affecting future needs is most important to me. *
		Human decision have impact to the environment the

		environment has impact to the humans. (Closed-)Loop system... *
		That social projects in coroprations are seldom self-sustaining e.g. projects are only successful until the corporation's funding dries out. *
		Sustainability is not only about meeting the current needs (present) but also acting with consideration for future generations (future).
		Das shon 1713 über nachhaltigkeit geschrieben wurde. [That already in 1713 someone wrote about sustainability]
		For sustainability activities corporations can typically tolerate lower or even negative profitability when the impact to sustainability is high enough.
10	Diffusion of ICT	It took 20 years for mobile phones to reach a certain amount of people but that fixed phones took more Than 100 years *
		I know a growing population in the world have access to mobile phones and I also know that one of the biggest markets is Africa but I did not know that 90/100 have a mobile phone! (I would expect that number to concern adults from a certain age)
		80% von letzlich verkauften TV Geräten in den USA sind "smart"-TV. Sie besitzen die Möglichkeit sich mit dem Internet zu verbinden. * [80% of the TV devices recently sold in the U.S. are “smart” TVs. They can connect to the internet.]
		439 million households with wireless home networks in 2011 *
		Der Wechsel von konventionellen Medien wie Radio TV etc. zu neuen Medien wie das Internet. [The change from conventional media like radio TV etc. to new media like the internet.]
11	ICT for Development	How ICT can enable people in poor countries to sell products and earn money (to live) with very simple tools such as smartphones laptops and the internet. Additionally I learnt about mobile payment (which I previously heard existed) but didn't really knew it was being used. *
		Shopsoko Video *

		IT can also support the poorest. (Video at the end) *
		ICT kann auch in Ländern mit Armut zu Verbesserungen verhelfen. * [ICT can bring about improvements also in countries with poverty.]
		ICT4D is not necessarily sustainable but it can even if only indirect have some influence on the sustainability.
12	Assessment Methods: Internet Example	The ability to measure the energy for internet traffic *
		Top down model approaches compared to bottom up *
		The comparison made between the various approaches that is the top-down and the bottom up approach was very useful when determining the energy intensity of digital services which this information would have been difficult to determine from one perspective and to give correct estimates for future studies *
		Verschiedene Vorgehensweisen um den internet energy footprint zu messen/schätzen. [Different approaches to measure/estimate the internet energy footprint.]
		With altered system boundaries the estimated energy intensity varies significantly.
13	Material Resources for ICT Hardware: Origin	The problems with resources in Congo *
		That 5 trilion dollar vorth of metal exists in Kongo *
14	Life Cycle Thinking Applied to ICT: Hardware Aspects	The technical development since 1970 regarding microprocessors we gone from 2000 to almost 2 billion transistors in a single processor. *
		The hardware life cycle becomes shorter. *
		That we've gone from 2300 transistors to 2 27 billions in 40 years. *
		The number of metals in an ICT product.
		The amount of metals used for computers *

		45 more metals are used than 25 years ago. *
		Approximately the half of the elements on the periodic table are contained in a mobile phone
		As the SSD storage solutions emerged a new chemical element is required to produce SSD storage solutions and new sustainability questions arise
15	Life Cycle Thinking Applied to ICT: Beyond Use Phase	The duration of use of products is relatively small so the production line should be seen more as taking raw materials and turning them to waste. *
		That green ICT mostly focuses only on the usage stage of a product and not so much on the production and recycling. *
		Developing something like a eReader etc.; keep in mind that the development or the production of such a device needs energy and maybe much more to produce such a device than this device could save during lifetime... *
		Nicht zu vernachlässigen ist dass die Gerätschaften die Überwachung und Steuerung gebraucht werden selbst wieder Energie verbrauchen und dieser Lebenszyklus in solch eine Überlegung miteingeschlossen werden muss. * [It should not be neglected that the equipment needed for monitoring and control consumes energy itself. And that this life cycle has to be included in such a consideration.]
		The environmental impact of a device used to access media is very hard to determine as the percentage of usage for this media on the devices must be determined.
16	Software and Obsolescence	Longer iterations between technical leaps would make ict product usefull for a longer period of time and force software developers to stay with older technilogy longer. The leaps would also have a larger improvement. *
		Software should be designed to work on older hardware in order to be sustainable. *
		How important it is as a software developer to keep

		sustainability in mind*
		Software engineers have big impact on how hardware is used and developed *
		the role of software in the future of global sustainability *
		the role of software in the future of global sustainability *
		The one with the three cats :)
		Making software which is not dependant on the newest hardware is more sustainable. *
		When new software (new updates etc.) is introduced also keep in mind that this should work on older devices. Today when new updates are available I also need to buy a new device (e.g. mobile phones) to have the same performance... *
		Obsolecence effects could become a great problem. *
17	Miscellaneous	Ich war überrascht dass ein dynamischer Preis für Elektrizität überhaupt exisitiert und sich Firmen darauf spezalisiert haben möglichst viel Energie in einer kurzen Zeit zu vernichten. * [I was surprised that there exists a dynamic price for electricity and that firms are specialized to destroy as much energy as possible in a short period of time.]
		Energy sufficiency not for everyone. Image Person A lives in a complete new flat and Person B in and old house. Person A needs not much energy to keep the room at 20 degrees but Person B needs a lot of energy to get to 20 degrees. Person A would be looked at Green one and Person B is just wasting energy and may he can not achieve the 2000 Watt Society... *
		Das die Convenience von vielen Personen immer noch höher gewertet wird als die Nachhaltigkeit von Ressourcen zu fördern oder den Eernergieverbrauch einzudämmen. [That the convenience of many persons still is weighted higher than supporting the sustainability of resources or reducing energy consumption.]
18	ICT as an Enabler: Saving Material and Energy: Business	2. Similarly the second case study showed a nice visual process of analyzing a large scale production system.
		Process optimization can be done in a very illustrative way and can show promising opportunities for corporations in order to

	Examples	be more sustainable and reduce cost. *
		Using material flow networks in modelling the energy usage pattern will help in sustainability development as it was noticed from the lecture how we can save a huge amount of energy by converting waste energy in a beer brew factory. *
		Actually it really astonished me that the production of bear needs so much water... *
		Ich war erstaunt wie einfach es wäre mit Material Flow Networks Abhängigkeiten zwischen Input und Output zu modellieren und die Auswirkungen zu visualisieren damit man sehr rasch Erkenntnisse ziehen und Optimierungen vornehmen kann. Nebenbei war das Beispiel mit der Bierbrauerei auch gut gewählt - es ist eindrücklich wie viel Wasser bei der Produktion verloren geht. * [I was surprised how simple it would be to model dependencies between input and output with material flow networks and to visualize the effects so that you can gain insights very quickly and make optimizations. Besides, the example of the beer brewery was well chosen – it is impressive how much water gets lost during production.]
		The office building where I work has such huge cold & hot water storage tanks *
		With MFN and simulation tools it is easy to find potentials for cost/energy/emission reducions. *
		With a system including dynamic electrictiy prices and some kind of tanks for storage you can save a lot of energy. *
		In a brewery 7% of production costs can be saved throuh a waste-heat recovery
		It is possible to model the material and energy flow. This is important to be able to implement adaptations for example if one is using a smart grid.
		The production of 1 liter of beer requires 5 liter water.
		How powerful Umberto is
		The tower in Altstetten has quite an elaborate cooling system.
		Using Software you can actually increase the energy savings within a building

		Das Beispiel mit dem IBM Hauptsitz in Altstetten [The example with the IBM headquarters in Altstetten]
19	ICT as an Enabler: Saving Material and Energy: Methods	How exact you can get ICT analysis of production. *
		Components in calculating effects of ICT on events *
		Material Flow Models useful for sustainability... Before already creating a end product a model should be created prior and analyze the material flow from the beginning to the end. This could improve sustainability much more. Takes more time at the beginning but at the end this model can be understood to everyone. People would be much more aware of sustainability when you can visualize it to them... *
		Dematerialization: With little further information (no sugar for me) we can already save resources. *
		Coffee-example gave perspective *
		Immaterial information can save material resources (example with coffee and sugar) *
		I learned something about Material Flow Networks.
		Das Modellieren von Material- und Energieflüssen ist sehr komplex wenn man etwas möglichst realistisch abbilden will. [Modelling material and energy flows is very complex if you want to map something as realistic as possible.]
		Energy and Material flows can be modelled in an MFN.
20	ICT as an Enabler: Saving Material and Energy: Videoconferencing Example	The possibility of acctually doing conferences at separate locations I thought that it would not be successful I thought there would have been lots of issues. *
		the amount of CO2 emisions that you can save by using a long distance conference instead of flying people to a specific location. *
		The savings we make from using the web for conferencing and lectures *
		The reduced co2 emmisions of holding two conferences. *
		The emissions saved by using video conferances. *

		How you could set up a video conference *
		How much you can save by doing a video conference. PS. Loved the brewery slides :) *
		Remote video conferences work well *
		1 the first case study provided a nice breakdown of the ICT analysis process. Helped to put the model in a real-life context.
		Video conferancing is a viable alternative to physical meetings
		A two-site conference saves a lot of CO2 emissions *
		IP-based videoconferencing can reduce emissions. *
		Durch technische Hilfsmittel wie Viedokonferenzen können vergleichsweise viel Emissionen eingespart werden aber es ist sehr schwer die effektiven Einsparnisse zu messen. * [Tools such as video conferencing can save quite some emissions, but it is difficult to measure the effective savings.]
		für Konferenzen ist der Nutzen von Video-Zuschaltung 'imens'. * [The benefit of video conferencing for conferences is immense.]
		more - site conferences can be a real alternative to a one - conference
		Enabling conversations during breaks of the two-site conference worked better than they thought
		virtual squint in video conferencing
21	ICT as an Enabler: Saving Material and Energy: Energy Management Examples	Regulate the temperature to save energy when for instance when vending machines are not used for instance at night *
		That the temperature in the vendingmachines were not as cold during the night *
		the "smart" vending machine in japan was an interesting example of improving the inefficient base case in a surprisingly simple way. *
		Regulate the temperature to save energy for instance when

		vending machines are not used
		GreenMind has the potential to save 28% of energy in buildings *
		Durch verschiedene durch ITC gesteuerte Massnahmen könnten rund 30% des heutigen Energieverbrauchs eingespart werden. * [Approximately 30% of the current energy consumption could be reduced through ICT-controlled measures.]
		Das im heutigen Stand der Entwicklung Licht immer noch eines der grössten Energiesparpotential aufweist. * [That at the present state of development light still exhibits one of the greatest energy-saving potentials.]
		Break-even in less than 4 years. *
		According to the paper 56% of electricity of used for lighting can be saved. *
22	Assessment Methods: Basic Ideas	Just how much one can do and hiw to analyze the carbon footprint of you actions *
		I learnt about one approach to calculate the energy consumption of a big event (i.e. a conference) and the importance to always have a 'baseline' (what are the effects of the change? direct/enabling/systemic effect). *
		Measurement of Energy consumption is very complicated is almost impossible to be performed in an objective manner. *
		That the service output of ICT can't be measured. At least not directly and that there a lot of alternatives how you could 'measure' it.
		Different approaches to measure energy efficiency
		Concept of sufficiency & idea of cap 'n trade
23	Rebound Effect: ICT Devices	The number of produced handheld devices massively outnumber the reduced mineral use for each device.*
		Die Herstellung von elektronischen Geräten (insbesontere Computer) verbraucht im Vergleich zu früher zwar pro Gerät weniger Material aber durch die höhere Anzahl der Geräte wird dieser Fortschritt um ein mehrfaches aufgewogen. *

		[The production of electronical devices (in particular computer) consumes less material per device compared to former times, but due to the larger number of devices this progress is balanced out manifold.]
		Die Abnahme des gewichts führte zur Zunahme des Konsums von Handys. * [The loss of weight led to an increasing mobile phone consumption.]
24	Rebound Effect: General Concept	Rebounding effects made me see problemsolving in a new light *
		There seems to be a missunderstanding/over-simplification in that echonomic growth --> efficient technology --> sustainability *
		I had never thought about the rebound effect before *
		Rebound effects. *
		The rebound effect can have a negative effect on a good solution. *
		Rebounds *
		The technology effiency increases the overall consumption of goods (~ rebound effect) *
		Increased efficiency does not neccessarily contribute to reduced overall consumption *
		According to the Jevons paradox the gain in efficiency leads to an even higher consumption *
		Eine Optimierung durch Technologie kann zu noch stärkerem Verbrauch von Ressourcen führen. * [An optimization because of technology can lead to an increased resource consumption.]
		Auch wenn man in guter Absicht eine Veränderung vornimmt kann dies das genaue Gegenteil bewirken (Jevons Paradox). * [Even if you make changes for the best, this can have the opposite effect (Jevons Paradox).]
		Rebound effect which comes from for instance generating more efficient machines. *

		Efficiency will not be sufficient for sufficiency but sufficiency will be sufficient for efficiency. *
25	Rebound Effect: Time and Convenience	Ease of use increases desire to use an item or a service and as such making something more effective might increase the usage frequency of the product *
		The travel time has not changed over the years and is the same for the majority of countries. *
		if a sevice can be consumed in less time it often leads to higher consumption *
		The Time-Rebound effect: If a service can be consumed in less time this often leads to higher consumption of the service. And the example with travelling. *
		Rich people travel longer distance but the time for traveling is same like for people which do not have lot of money *
		The time someone needs to consume a service has an effect on the amount of times the service is used by this person. *
		Someone living in Tanzania uses as same time for travelling as someone living in New York. *
		The richer you are the smaller is the world.
		People travel longer distances if they are faster instead of just using the time for something else
		Travel time is not influenced by income.
26	Material Resources for ICT Hardware: Informal Recycling	How bad the situation of backyard recycling is. *
		Different kinds of materials is extracted from ICT products in different parts of the world. Due to the fact that we don't have the ability to recycle it. *
		The Way they recycle electronics in india and other Asian countries. *
		the importance of recycling ict equipment in a formal way. the fact that some advanced countries knowingly export electronic waste to informal recycling activities in poor countries. *

		Family companies takes care of ICT WASTE *
		A lot of e-waste is recycled in developing countries *
		informal recycling *
		Family companies takes care of ICT waste
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		Family companies take care of ICT waste
		Informal recycling is not good
		That there is actually process of informal recycling and how it is being done. I knew already that in some countries there is not such a high standard of how to recycle and how to regain some materials.....but nevertheless that some countries do this in such a non sustainable way and pollute their environment so strongly really surprised me. *
		Hardware life cycle and specific Topics like the metals used by ICT or the description of hotspots of informal e-waste recycling *
		That computer waste is recycled in third world countries under bad circumstances for humans and the nature *
27	Material Resources for ICT Hardware: Recycling in General	That we must become better in recycling the material that we use *
		How small amount of the recyceled materia that can be reused. *
		The complexity of recycling. *
		Recycling is far from perfect but better than non at all. *
		Companies need to promote the concept of recycling and reusing already manufactured products. The compositions of such products have to be created to that recycling results in a higher output of raw materials. *
		The Composition of E-Waste. *
		The size decrease in todays electronics and the issues it poses with recycling *

		It's not possible to recylce the rare earth metals effectively from electronic waste
		Recycling of electronic waste is inefficient
		Electronic waste is a big problem
		There is more gold per amount of electronic waste than there is in gold ore.
28	Social Opportunities ad Risks	Edutainment equals playful learning and actually enables people to learn faster. *
		An answer given by a large group is mostly better than an answer given by individuals within the group. *
		Gaming for Good combines the most popular mobile applications games with sustainability ingredients. *
		Crowdsensing is used to gather regional environmental data and voluntary users can complement official measurements. *
		Gamification of sustainability can educate people and even make them change their behaviour
		GDSS are used to graphically show the discussion and the arguments around a sustainable topic. tbdis is an example of such a GDSS that is developed at IFI.
		that collective intelligence can help to understand the different meanings a group of people might have about a sustainable matter
		Manipulating GPS signals in a warzone is possible
		Einen Ansatz (PSM) wie man mit Expertengruppen mit verschiedenen Interessen eine gemeinsame Übersicht (Übereinstimmung zu einem Thema) erhalten kann. [An approach (PSM) to achieve a joint overview (accordance with regard to a topic) with expert groups with different interests.]
29	ICT Impacts on Sustainability	It gave me awareness of the impact that ICT has on the environment.*
		ict is important for sustainability *

		Models of how to look at sustainability and ICT *
		No model of ict and sustainability exist *
		That there is 3 different effects. *
		I like the idea to make sustainability a non-functional requirement and add it to security availability usability maintainability extensibility scalability. *
		ICT ist ein Teil des Problemes und der Lösung von nachhaltiger Entwicklung. Zum Beispiel kann eine Änderung mit einer guten nachhaltigen Absicht auch negative Folgen haben. Die Folgen (und verschiedenen Einflussfaktoren) sind aber sehr schwer einzuschätzen. * [ICT is part of the problem and solution of sustainable development. For example, a change with good and sustainable intention can have negative consequences. But the consequences (and the various influencing factors) are very difficult to assess.]
		Sustainable development can be put into a scientific context and linked to to area of Informatics *
		The n-order effects *
		3 levels of how ict impacts environment*
		Das ICT sowohl ein Teil des Problems als auch der Lösung sein kann * [That ICT can be part of the problem as well as part of the solution.]
		Sustainability is a topic in software engineering (for example sustainability as non-functional requirement) but it's (in my opinion) not yet clearly defined as requirement.
		The insight that the term sustainable informatics can also been seen as the sustainibility of data such that the today's data can be still read and used in 50 years. However this covers not only data but concerns also the maintanability of software in for example 50 years.
30	ICT as an Enabler: Systems	Growth through system thinking modelling and Simulation served as an important insights into predicting future sustainability activities which would not be very easy to guess

	Thinking	with human thinking. *
		Durch Computersimulationen können komplexe Abläufe welche auf den ersten Blick kontraintuitiv sind getestet und visualisiert werden * [Complex processes which are counterintuitive at first sight can be tested and visualized with the help of computer simulations.]
		With the Nagel-Schreckenberg Model you can simulate with using of 4 rules a traffic jam.
		The power of agent-based networks
		Casual-loop diagrams (CLD) seem to be very useful to easily visualize cause-and-effects of different influence factors. (PS: And I learnt that in (fish) biologoy recruitment means fish birth)
		You can use ICT to simulate environmental behaviour such as traffic jam behaviour simulation
31	Electronic vs. Print Media	That it is hard to assess if ICT used for media is better for sustainability because it is hard to assess to what degree a device is used for media consumption *
		Dass die Substitution von konventionellen Medien wie gedruckte Zeitungen zu E-Media nicht zwangsl ufig positive Auswirkungen für die nachhaltige Entwicklung hat. * [The substitution of conventional media such as printed newspapers by e-media has not necessary positive consequences for sustainable development.]
		The impact of a device decreases by the amount of a media consumed which would otherwise would have been consumed on paper. *
		Das ein e-Book Reader nicht nur praktisch ist sondern auch noch gut für die Umwelt sein kann. [That an e-book reader is not only practical but can also be good for the environment.]
32	Greenhouse Gas Emissions: Biofuels	Biotreibstoffe haben zum Teil sehr hohe Auswirkungen auf die gesamte Umweltbelastung (im Vergleich zu fossilen Treibstoffen). * [Biofuels to some extent have high environmental impacts (compared to fossil fuels).]

		That alternative fuels that one would expect as very sustainable are actually not really sustainable according to deep insight of some life cycle assessments *
		Biofuels: Biotreibstoffe 1. und 2. Generation * [Biofuels: Biofuels 1. and 2. generation]
		Das sehr viele "grüne" Energiequellen über den gesamtem Produktionsprozess gesehen der Umwelt mehr schaden als vorbeugen. * [Many “green” energy sources cause more harm to the environment over the entire production process than they contribute to prevention.]
		That biofuel is often envirnomentally less sustainable and sometimes creates more CO2 emissions than fossil fuel. *
		Biofuels usually have a very negative impact on the environment while reducing the co2 emissions only a little bit *
		Using Sucar cane imported from Brasil has a less negative impact on the environment than using rape oil from switzerland
		Die Grafiken zum Thema Benzinersatz besonders jener Teil mit den Richtigen Alternativen (Sonntagszeitung). [The graphics about gasoline substitute, in particular the part with the right alternatives (Sonntagszeitung).]
33	Greenhouse Gas Emissions: Global Distribution	North America releases more than twice as much green house gases than Europe *
		USA releases double as much green house gases as Europe does. *
		co2 emission by region *
		How big impact the westerns have compared to the asians etc *
		The impact on the environment from the West world compared to the rest. *
		North america produces way more greenhouse gasses than europe! *
		Co2 eemission in the world

		Developed countries with high-technology and sustainability in mind or less sustainable then underdeveloped countries... *
		The poplulation and the resource consumption is raising exponetiell if we dont do something against it. *
		One astonishing insight is the fact that Swiss People use that much energy per Person. *
		The Greenhouse gas pollution per person in Asia is not as high as I thought
34	Resource Consumption: Global Distribution	We use approx 40 tons of material per person and year *
		The material that we see to be consumed are just a fraction of the real amount. *
		Most of the resources used by us in Sweden are probably actually "used" in another country and we only ever see the reward from them. *
		67% of the resources from nature for one single person are extracted abroad. *
		Domestic extraction is stable since 25 years. *
		Mit dem momentanen Modell unserer Gesellschaft ist es nicht möglich dass weltweit alle auf den von uns vorgelebten Standard kommen weil die meisten unserer gebrauchten Materialien aus dem Ausland kommen. * [With the current model of our society it's not possible for everyone worldwide to reach our standard, because most materials we use come from abroad.]
		It was suprising to see that an average Swiss citizen needs 41 tons of material resources extracted from nature (but it is not 100% clear whether the use of infrastructure such as roads or public transport is also included) *
		How material-intensive is the swiss society? *
		That not all countries can import resources as much as Switzerland does... *
		Switzerland uses 2/3 of resources not produced in switzerland

		Dass jährlich eine riesige Menge (über 40 Tonnen) an verschiedensten Ressourcen verarbeitet wird für Schweizer Einwohner 2/3 davon mit ausländischem Material. Wir haben mehrheitlich Agrikultur (aber sehr wenig) und Steine ;) * [That annually a huge amount (over 40 tons) of various resources are processed for Swiss inhabitants, 2/3 of it with foreign material. We have mostly agriculture (but very little) and stones;)]

Q1 - Initial Questionnaire

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Sustainability is a clearly defined concept for me	○	○	○	○	○
I am interested in the topic of sustainability	○	○	○	○	○
I am interested in the link between informatics and sustainability	○	○	○	○	○
I am committed to sustainability	○	○	○	○	○
Each student of informatics should be familiar with the link between informatics and sustainability	○	○	○	○	○
During my studies, the topic of sustainability has already been taken up in other courses I attended	○	○	○	○	○
A course on informatics and sustainability is a necessary part of a master program in informatics	○	○	○	○	○
I think I will learn new contents in the field of informatics in this course	○	○	○	○	○

On which understanding of "sustainability" have your answers been based? Try to define the concept of "sustainability" or to characterize it with some keywords.

Why are you interested in the course "Informatics and sustainable development"?

Q1 - Initial Questionnaire

I expect to learn more about the following topics in the course "Informatics and Sustainable Development":

Topic 1

Topic 2 (optional)

Topic 3 (optional)

Topic 4 (optional)

Topic 5 (optional)

Q1 - Initial Questionnaire

The following information will only be used for statistical analysis. No personal information will be forwarded.

Sex

- male
- female

Age

Major subject (Master)

How many semesters have you been studying in this study program, including the current semester?

Minor subject (Master)

How many semesters have you been studying your minor, including the current semester?

Major subject (completed Bachelor)

Minor subject (completed Bachelor)

Please choose any pseudonym or nickname. Please keep it in mind, you will need it for further questionnaires.

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!

Q2a - Questionnaire on the slides presented

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Most of the slides were easy to understand	○	○	○	○	○
Some slides stimulated my thoughts	○	○	○	○	○
Students of informatics should know the contents of these slides	○	○	○	○	○
People interested in sustainability should know the contents of these slides	○	○	○	○	○
People interested in the relationship between informatics and sustainability should know the contents of these slides	○	○	○	○	○
From these slides I learned things I didn't know before	○	○	○	○	○
The slides motivated me to learn more about the topic	○	○	○	○	○
I learned things from the slides that were surprising to me	○	○	○	○	○
The slides provided content relevant for all informatics professionals	○	○	○	○	○

Kommentar (optional)

Q2a - Questionnaire on the slides presented

What was the most important insight you gained from these slides? Try to formulate it as a statement (such as "One in five Marsians owns a laptop") type the statement into the text field below.
On the succeeding pages of this questionnaire, you will have the opportunity to provide a maximum of two additional insights.

Insight 1

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 2 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 3 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Q2a - Questionnaire on the slides presented

Do you want to comment on this part of the lecture notes (slides) or on this questionnaire? (optional)

Please enter the pseudonym that you have chosen at the beginning of this course.

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!

Q3 - Questionnaire on the literature

Please fill in the following data to identify the article that was your mandatory reading for today:

Title:

Year of publication:

Name of the first author:

Q3 - Questionnaire on the literature

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Most parts of the text were easy to understand	○	○	○	○	○
Some parts of the text stimulated my thoughts	○	○	○	○	○
Students of informatics should know the contents of this text	○	○	○	○	○
People interested in sustainability should know the contents of this text	○	○	○	○	○
People interested in the relationship between informatics and sustainability should know the contents of this text	○	○	○	○	○
From this text I learned things I didn't know before	○	○	○	○	○
The text motivated me to learn more about the topic	○	○	○	○	○
I learned things from the text that were surprising to me	○	○	○	○	○
The text provided content relevant for all informatics professionals	○	○	○	○	○

Comment (optional)

Q3 - Questionnaire on the literature

What was the most important insight you gained from this text? Try to formulate it as a statement (such as "One in five Marsians owns a laptop") type the statement into the text field below.
On the succeeding pages of this questionnaire, you will have the opportunity to provide a maximum of two additional insights.

Insight 1

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified in the text in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 2 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified in the text in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 3 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified in the text in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○
…should be known to every informatics professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between informatics and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Do you want to comment on the text or on this questionnaire? (optional)

Please enter the pseudonym that you have chosen at the beginning of this course.

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!

Q4 - Final Questionnaire

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Sustainability is a clearly defined concept for me	○	○	○	○	○
I am interested in the topic of sustainability	○	○	○	○	○
I am interested in the link between informatics and sustainability	○	○	○	○	○
I am committed to sustainability	○	○	○	○	○
The literature I read in this course was helpful to understand the link between informatics and sustainability	○	○	○	○	○
The slides presented in this course were helpful to understand the link between informatics and sustainability	○	○	○	○	○
Each student of informatics should be familiar with the link between informatics and sustainability	○	○	○	○	○
This course as a whole motivated me to contribute more to sustainability in general	○	○	○	○	○
This course as a whole motivated me to contribute more to sustainability especially in the field of informatics	○	○	○	○	○

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
A course on informatics and sustainability is a necessary part of a master program in informatics	○	○	○	○	○
This course should be a mandatory part of my Master's program	○	○	○	○	○
More courses related to sustainability should be offered in my Master's program	○	○	○	○	○
After attending this course I feel able to contribute to a differentiated and critical argumentation in discussions about informatics and sustainability	○	○	○	○	○
I am able to relate the knowledge I aquired in this course to the core learning contents of my Master's program	○	○	○	○	○

Comment (optional)

To which other courses you attended in your study program can you relate the contents of this course?

- ◯ None
- ◯ To the following courses:

Q4 - Final Questionnaire

How can ICT contribute to sustainable development? Can you describe one or more ICT-related fields of activity that are important for sustainable development? (up to three fields of activity)

Field of activity 1

Field of activity 2

Field of activity 3

What do you think about your potential contribution to sustainable development in your professional life? Can you describe one or more fields of activity – related to your current or potential future job – that are important for sustainable development? (up to three fields of activity)

Field of activity 1

Field of activity 2

Field of activity 3

Q4 - Final Questionnaire

What do you think about your potential private contribution to sustainable development? Can you describe one or more fields of private activity – not necessarily related to ICT – that are important for sustainable development? (up to three fields of activity)

Field of activity 1

Field of activity 2

Field of activity 3

Q4 - Final Questionnaire

Please enter the pseudonym that you have chosen at the beginning of this course.

Q4 - Final Questionnaire

Please click "Done" to send the data.

End of questionnaire. At last... :-)

Thank you very very very much for your participation during this course!

Q1 - Initial Questionnaire - KTH

I expect to learn more about the following topics in the lecture today:

Topic 1

Topic 2 (optional)

Topic 3 (optional)

Topic 4 (optional)

Topic 5 (optional)

Q1 - Initial Questionnaire - KTH

The following information will only be used for statistical analysis. No personal information will be forwarded.

Sex

- male
- female

Age

In which of the following programs are you studying?

- CINTE (Master Degree Programme in Information and Communication Technology)
- TIDAB (Bachelor Degree Programme in Computer Engineering)
- TIEDB (Bachelor Degree Programme in Electronics and Computer Engineering)
- TKOMK (Bachelor's Programme in Information and Communication Technology)
- Other (please specify)

In what year are you studying in this program?

Please choose any pseudonym or nickname. Please keep it in mind, you will need it for further questionnaires.

Q1 - Initial Questionnaire - KTH

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!

Q2 - Questionnaire on the slides presented - KTH

This questionnaire refers to Part 1 "A Brief History of Resource Use and ICT" and Part 2.1 "The ICT Life Cycle"

Q2 - Questionnaire on the slides presented - KTH

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Most of the slides were easy to understand	○	○	○	○	○
Some slides stimulated my thoughts	○	○	○	○	○
Students of ICT should know the contents of these slides	○	○	○	○	○
People interested in sustainability should know the contents of these slides	○	○	○	○	○
People interested in the relationship between ICT and sustainability should know the contents of these slides	○	○	○	○	○
From these slides I learned things I didn't know before	○	○	○	○	○
The slides motivated me to learn more about the topic	○	○	○	○	○
I learned things from the slides that were surprising to me	○	○	○	○	○
The slides provided content relevant for all ICT professionals	○	○	○	○	○

Comment (optional)

Q2 - Questionnaire on the slides presented - KTH

What was the most important insight you gained from these slides? Try to formulate it as a statement (such as "One in five Marsians owns a laptop") type the statement into the text field below.
On the succeeding pages of this questionnaire, you will have the opportunity to provide a maximum of two additional insights.

Insight 1

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 2 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 3 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Q2 - Questionnaire on the slides presented - KTH

Do you want to comment on this part of the lecture notes (slides) or on this questionnaire? (optional)

Please enter the pseudonym that you have chosen in the first questionnaire.

Q2 - Questionnaire on the slides presented - KTH

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!

Q3 - Questionnaire on the slides presented - KTH

This questionnaire refers to Part 2.2 "ICT as an Enabling Technology" and Part 2.3 "Rebound Effects and Structural Change"

Q3 - Questionnaire on the slides presented - KTH

Please rate the following statements on a scale ranging from "strongly agree" to "strongly disagree"

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Most of the slides were easy to understand	○	○	○	○	○
Some slides stimulated my thoughts	○	○	○	○	○
Students of ICT should know the contents of these slides	○	○	○	○	○
People interested in sustainability should know the contents of these slides	○	○	○	○	○
People interested in the relationship between ICT and sustainability should know the contents of these slides	○	○	○	○	○
From these slides I learned things I didn't know before	○	○	○	○	○
The slides motivated me to learn more about the topic	○	○	○	○	○
I learned things from the slides that were surprising to me	○	○	○	○	○
The slides provided content relevant for all ICT professionals	○	○	○	○	○

Comment (optional)

Q3 - Questionnaire on the slides presented - KTH

What was the most important insight you gained from these slides? Try to formulate it as a statement (such as "One in five Marsians owns a laptop") type the statement into the text field below.
On the succeeding pages of this questionnaire, you will have the opportunity to provide a maximum of two additional insights.

Insight 1

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 2 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Insight 3 (optional)

This insight...

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
...is surprising to me	○	○	○	○	○
…is plausible to me	○	○	○	○	○
…is justified on the slides in a convincing way	○	○	○	○	○
…motivates me to learn more on the topic	○	○	○	○	○
…is a necessary part of this course	○	○	○	○	○
…motivates me to contribute more to sustainability in general	○	○	○	○	○
…motivates me to contribute more to sustainability especially in the field of ICT	○	○	○	○	○
…should be known to every ICT professional	○	○	○	○	○
…should be known to every person interested in sustainability	○	○	○	○	○
…should be known to every person interested in the connection between ICT and sustainability	○	○	○	○	○
…should be generally known	○	○	○	○	○

Comment (optional)

Q3 - Questionnaire on the slides presented - KTH

Do you want to comment on this part of the lecture notes (slides) or on this questionnaire? (optional)

Please enter the pseudonym that you have chosen in the first questionnaire.

Q3 - Questionnaire on the slides presented - KTH

Please click "Done" to send the data.

End of questionnaire.

Thank you! We appreciate your participation!