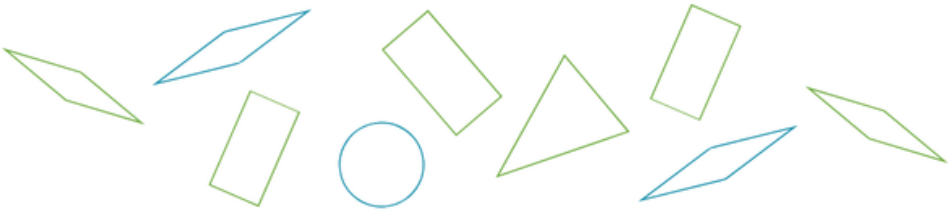

C-FLEX

Analyzing the Sustainability of ICT in Higher Education through an Analysis and Self-Evaluation Tool for Universities

Erasmus+ KA2 C-FLEX Result 2

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Contributing authors: all partners of the C-FLEX project

www.c-flex.eu

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Section 1: Analyzing the sustainability of ICT solutions for teaching and learning

Summary

This section examines the sustainability challenges of ICT use in university teaching, focusing on energy use across online platforms and strategies to reduce environmental impact.

Chapter 1: Introduction

1.1 Background

The digital transformation has changed our lives completely. It has made information available for almost everyone at any time at the tip of our fingers. It has also made it possible for anyone to communicate with almost any other person in the world either directly and personally or by platforms which most people can access. This trend started some 40 years ago with the invention of the internet, but accelerated exponentially after the introduction of smart phones some 15 years ago. In many ways information technology has facilitated our lives, and it has the potential to also increase our quality of life. Further, it has the potential to save energy or other resources and contribute to a more sustainable world. We can easily start and maintain friendships with people from all over the globe, thereby increasing the understanding of other people's cultures and living conditions and get first hand news about their daily lives. We do not have to do business-trips to other countries to have short face-to-face meetings when we can meet through web-meetings and webinars. We can easily keep the family together even if we temporarily are at different locations.

However, we should also be aware of the negative aspects of information and communication technology (ICT). The possibility to access, and to distribute, any type of information has increased the risks of polarization in society. We do not any longer listen to the same news through quality-certified sources. On the contrary, we can search for the information which interest us and which supports our own way of thinking, and we cannot be sure of the correctness of the information. We can get scammed and lose our savings while in our own homes. Our integrity is constantly at stake and private information and photos may be distributed worldwide without our knowledge or consent. ICT can also be used by evil powers to de-stabilize our society, influence democratic institutions and processes and to create chaos and economic losses by disrupting or destroying our infrastructure.

There is also a more direct cost in terms of money and environmental damage caused by our use of ICT. Several different estimates of the present and future effects have been published in the literature. According to (Enerdata, 2018) ICT accounted for between 5 and 9% of the total electricity consumption in 2018, and they predict a possible increase to up to 20% in 2030. Already in 2015 ICT (including consumer electronics and TVs) was estimated to be the cause of about 3% of the total global carbon emissions (Andrae & Elder, 2015). In a recent review study, (Freitag, o.a., 2021) it was found that according to scientific publications in the literature the % of GHG emissions from ICT vary between 1.8 - 2.8%. However, the authors conclude that the global emissions from ICT could be as high as 2.1 to 3.9%. A recent industry report (Ericsson, 2023) states that the ICT sector in 2020 consumed about 4% of global electricity and that this represented about 1.4% of the greenhouse gas (GHG) emissions.

This source also include a graph of both electricity use and GHG emissions, see Figure 1. The effect of ICT on sustainability has been a topic of very high interest in the last decade. A recent review article (Charfeddine & Umlai, 2023) investigated in total 166 scientific articles examining 297 associations between ICT/digitalization and environmental sustainability only!

During the last couple of years, Artificial Intelligence, AI, has become available for anyone. AI allows analysis of extremely large amounts of data and can therefore be an important tool for solving social and scientific challenges, like developing new medicines, new materials or finding solutions to the energy crisis. However, it also could pose a threat to society by facilitating "deep fake", spreading of disinformation and supporting criminal actions. Another aspect of AI is that it requires extremely high computational power, which already is increasing the energy use of the ICT sector exponentially. According to a study by IEA (2024), the slow increase of total energy use in computer centers during recent years is likely to be exchanged for a very rapid growth due to AI, with a doubling of the energy use from 2022 to 2026 only.

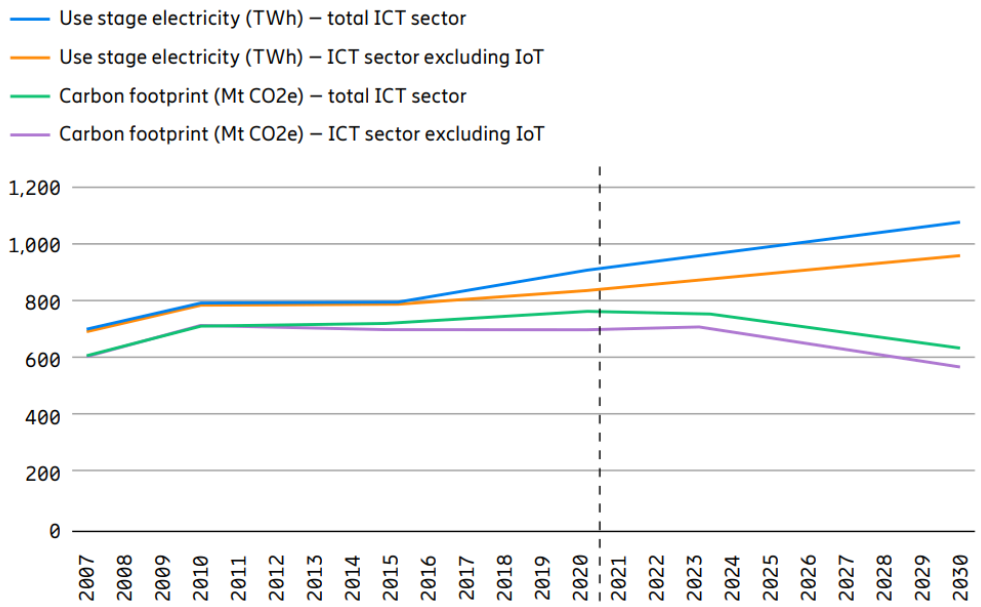

Figure 1: Electricity use and CO2 emissions of ICT sector, historic and predicted. Source: (Ericsson, 2023)

During the pandemic, ICT became an indispensable tool also for teaching, in schools at all levels as well as in universities. In particular, video-conferencing platforms were used so that teachers and professors could educate students without physical meetings. The pedagogical experiences were mixed, but this forced, gigantic natural experiment showed us that distance education is indeed possible and this realization opens up new avenues for how we teach and how we learn. However, we still need to be aware of the negative effects in terms of environmental as well as social impacts the use of distance education may have.

1.2 Description of the purpose of the report

The purpose of this report is to present information about the sustainability issues related to the use of ICT in teaching. The focus is on teaching at the university level, but the results may be applicable also for teaching at other levels. In particular, different platforms for online teaching has been investigated and differences between them in terms of energy use is presented. Also, some advice on how to use the platforms in order to reduce the environmental impact is given. This report is part of Results 2 of the C-flex project. In parallel to the writing of this report, a Tool has been developed by which users and decision makers can evaluate their own awareness concerning sustainability issues related to ICT based teaching, and get some advice on how to develop their awareness and their skills. Even though there is a focus on environmental sustainability, the report also includes the effect on social and economic sustainability related to the use of ICT in teaching.

1.3 Description of the work done in general

Results 2 is divided into the following tasks, as stated in the application:

Task 1: Information search and compilation

In this task, information about available platforms (DEIs) has been collected and compiled. The aim was that functionalities as well as differences in the basic technology which may have impact on energy use and greenhouse gas emissions should be covered. However, as the platforms are steadily developing, and the number of platforms increasing, it has not been possible to cover these differences in any detail. In parallel, experiences from teachers and students using the platforms has been collected through testing of the Tool developed in Task 2.

Task 2: Development of the benchmarking tool

Based on the information gathered in Task 1, the benchmarking tool was developed. The tool was inspired by the existing HEInnovate tool. It focuses around a questionnaire and the answers will help the users to benchmark their own performance as DEI users, but it also gives feedback and suggestions to the user on how to enhance the performance, and inform the user about possible differences in terms of environmental impact/energy use and other sustainability issues related to the use of the platforms. It is also intended to give the user the possibility to give feedback which can be shared with other users of the platform.

Task 3: Guidelines writing and evaluation

The work on the platform, and the findings after some time of usage has been collected and included in this report. Excerpts of the report are also connected to the Tool through links, so that the users of the Tool can read selected parts of the report as Guidelines directly after finishing the Tool/questionnaire. These Guidelines will also include recommendations to users in the stage of selecting a platform.

1.4 Division of work

The main responsible partner of the C-flex project for Results 2 has been KTH. KTH has also been responsible for leading the energy sustainability dimension. Other partners have contributed as follows:

- UniTN: integration with R3 and R4; contribution to all dimensions
- TUD: integration with R1; leading of ethical/social sustainability dimension; co-development of tool specifications
- TU/e: co-development of tool specifications
- UR1: pedagogical dimension; integration with R3 and R4
- JA: co-development of tool specifications

Chapter 2: Methodology – literature review

The work within Results 2 has primarily been based on a literature review identifying scientific publications related to the sustainability of ICT in teaching in general and, particularly, in web-based teaching. Apart from the scientific literature, other sources, mainly from the web, has been searched for.

Chapter 3: Results and findings from literature review

3.1 Understanding the sustainability effects of using personal ICT equipment

The energy consumption of teaching platforms is influenced both by the user behavior and by the technology behind. Some of these effects are obvious, but may need to be mentioned here. Many years ago when electricity was comparably expensive it was a habit to switch off the lights when you left a room. Nowadays we like to have the welcoming light switched on everywhere as long as we are home. Similarly, it is quite common to leave our computers and other ICT units connected and running even when they are not used. Encouraging users to switch off devices, or put them in sleep mode, is therefore a first step which may also be a form of nudging to educate users towards more sustainable behavior.

When travelling, without access to the electric grid, most of us are aware that the battery will last longer if we reduce the brightness of the screen. Adjusting the brightness is of course a way to reduce energy use also when connected to the mains. The screen resolution will also have an influence on the energy use. Higher resolution requires more computational power out of the graphical processing unit (GPU). Also, higher resolution tends to require higher brightness of the screen for the user to appreciate the high resolution and thereby indirectly affecting the energy use. The size and type of the screen also has effect on the energy use. LCD displays generally require more power than LED and OLED, but all the technologies are developing constantly towards lower energy use. It should thus be expected that products recently put on the market require less energy than older designs.

However, it is not only during the use phase that we should consider sustainability aspects. It is when we buy new equipment that we determine the possibilities we will have to reach low environmental impact during the use phase. When purchasing a new computer, new monitor, other peripherals, modems etc. we should consider the energy consumption and other sustainability aspects. The energy use of most products is tested by independent institutes or agencies and given a rating such as the EU Energy labelling, US Energy Star, EPEAT or similar. Checking these ratings is an easy way to evaluate different products during purchase. Of course, other sustainability aspects should also be considered which are not evident from the energy labelling. Such aspects are low content of environmentally damaging materials, if the unit can be easily taken apart and components or materials re-circulated, reasonable working conditions for the labor involved in the production, low and responsible use of resources during production, environmentally safe production etc.

All production has an effect on the environment, so before buying new equipment we should consider if it is really necessary to upgrade or if we can do with what we have some more time. In fact, according to Circular computing (2021) more than 75% of the carbon footprint of a PC comes from the production phase. Other studies, e.g. (Arushanyan, Ekener-Petersen, & Finnveden, 2014) have concluded that the use phase is dominating, perhaps with the exclusion of energy efficient low weight products. Delaying the purchase of new equipment is anyhow extremely important if we want to minimize the environmental impact. Also, when buying new equipment it is important what we do with the old. Can the old units find a second life with someone else or for some other purpose? And if not, how do we dispose of the unit so that the valuable components and materials inside can be recycled in the best possible way? Can the units be remanufactured or components re-used? Remanufacturing is performed by several companies, in particular in developing countries see e.g. (Rentwise, u.d.). The quality of such computers, the advantages from sustainability point of view as well as different ways of remanufacturing are discussed in (Fatimah & Biswas, 2015).

In general, we should be responsible consumers when considering updating our equipment as such a large share of the environmental impact is caused in the manufacturing process. Closing the loops, contributing to a circular economy, is the best way to minimize the impact of the use of ICT products. And when we finally buy new equipment we should make sure that the manufacturing has been sustainable, that the quality is high so it can be used for a long time, that the use of the equipment require a minimum amount of energy and that when the equipment is scrapped it is possible to disassemble and re-use components or extract valuable or dangerous materials.

3.2 Sustainability effects of using the internet

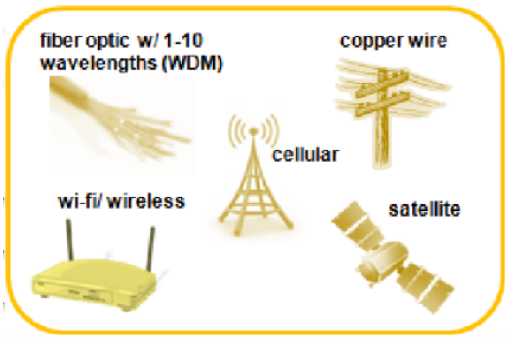

Figure 2: Modes of data transfer. From (Costenaro & Duer, 2012)

To be useful, our PCs and mobile phones need to be connected to the internet. The direct connection can be by wire or wireless, which can be through WiFi or cellular networks of any of the generations GSM (2G),UMTS (3G), LTE (4G) or 5G. Wired connections are usually by optical fibers from a data center to a router near the user and then by electric connections to the computer.

Wired connections generally require less energy for transmitting the data compared to wireless. WiFi is short ranged and can only be used from the router to the individual computer. The energy use of WiFi is higher than the direct cable connection from the router to the computer, (Ericsson, 2023) but using WiFi still requires less energy than any of the generations of cellular networks. Comparing the cellular networks, the capacity of transferring data is increasing substantially between each generation. In parallel, the total energy consumption of the networks have increased from each generation to the next, even if it seems there is a possibility to break this trend, see Figure 1 (Ericsson, 2020). However, the energy use per data bit is decreasing for each generation. This can be seen in Figure 3 or by comparing the total electricity consumption from Figure 1 with the data traffic in Figure 4. With increasing capacity of 4G and 5G and decreasing cost per data bit, wireless data communication through the cellular networks has become a realistic option for any consumer and is sometimes used instead of wired networks.

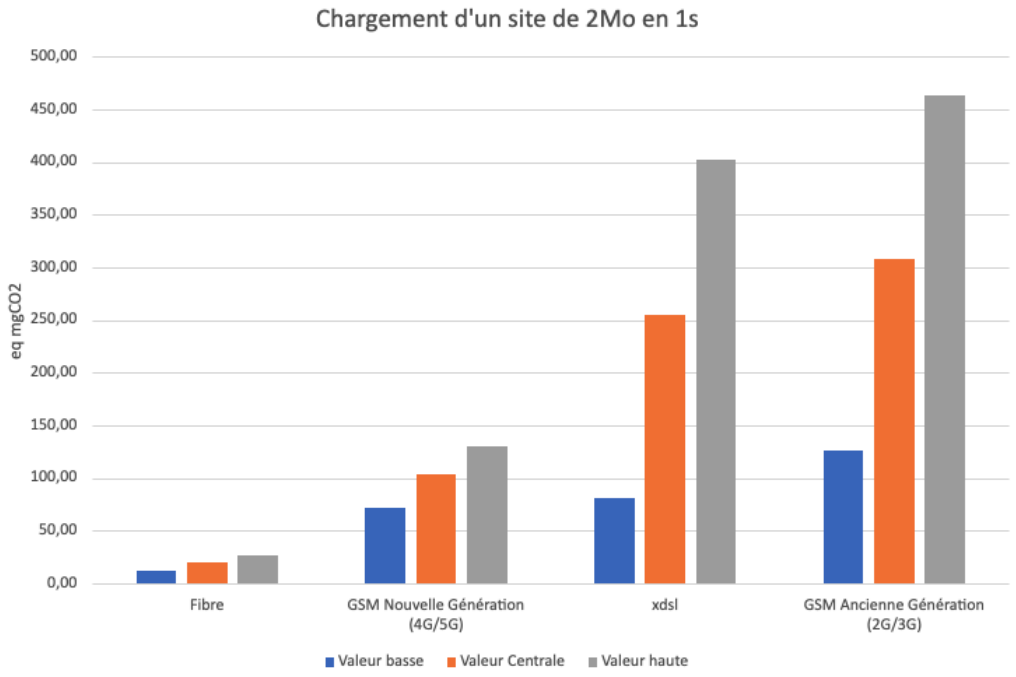

Figure 3: CO2 emissions from transferring 2MB in 1 second with different technologies. From (Philippot, 2023)

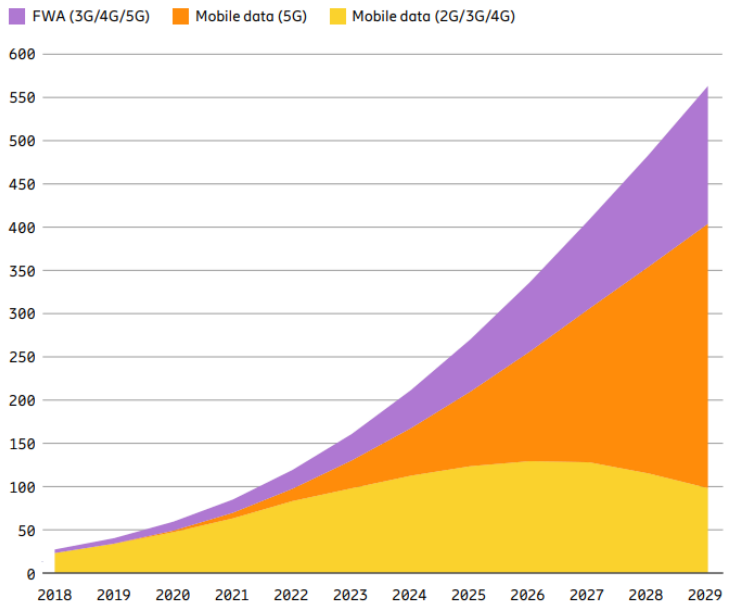

Figure 4: Historic and expected development of data traffic in EB per month. Source: (Ericsson, 2023)

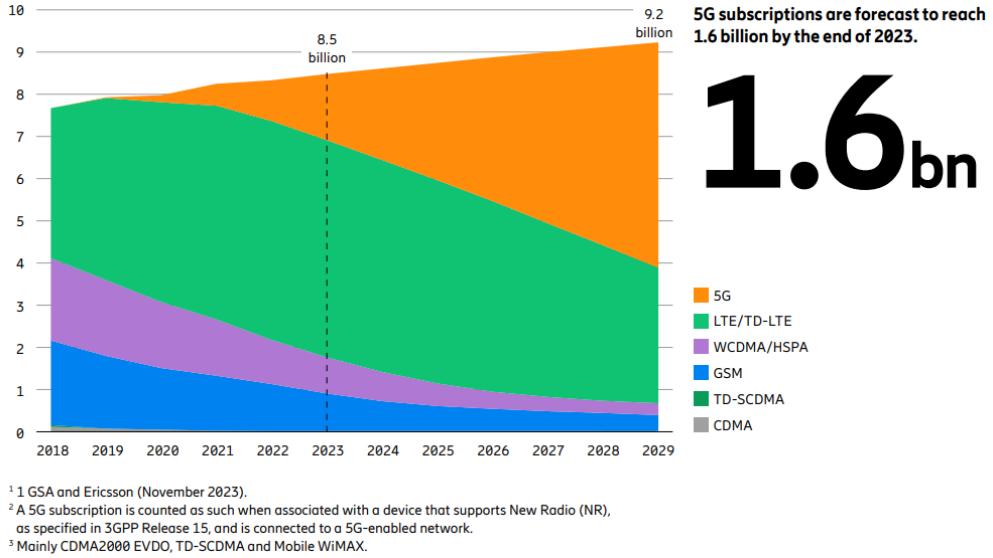

Figure 5: Historic and forecasted number of mobile subscriptions worldwide. Source: (Ericsson, 2023)

Figure 4 shows the historic and expected development of data traffic from 2018 to 2029 (Ericsson, 2023). As shown, the data traffic has increased by a factor of six the last five years and is expected to increase by a factor of 20 (!) within the complete 11 year period. According to the same source, the number of subscribers only increases by about 20% during this period, see Figure 5. It is also quite interesting that by far the largest share of the traffic is video, estimated to correspond to 73% (!) of the traffic in 2023 according to (Ericsson, 2023).

From the data in Figure 4 and Figure 5 it is obvious that the traffic per customer is increasing considerably over time. The main cause is the increased use of video, which has been made possible by the faster and less expensive connections. In spite of this increase, the GHG emissions per subscriber has consistently decreased over time, see Figure 6.

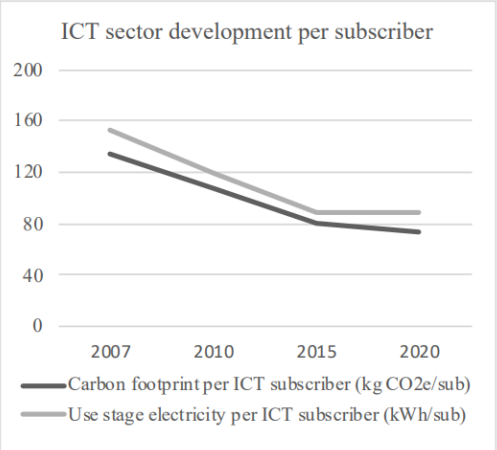

Figure 6: Development of carbon footprint and electricity use per subscriber. From (Malmodin, Lövehagen, Bergmark, & Lundén, 2023)

An important question is in which stage the energy consumption and the environmental impact is the largest. Some different sources have tried to estimate this. Malmodin, Lövehagen, Bergmark, & Lundén (2023) conclude that the user devices have the dominating impact, both considering electricity use and GHG emissions. According to this source, the embodied GHG emissions of the user devices are slightly lower than the GHG emissions during the use phase. This is quite different from the networks and the data centers, for which the GHG emissions during the use phase is totally dominating (about 80%).

ICT sector part	Use stage electricity (TWh)	Total GHG emissions (Mtonne CO_2e)	Percentage of embodied GHG emissions	Percentage of use stage GHG emissions
User devices [A]	421	436	47%	53%
Networks [B]	247	186	17%	83%
Data centers	223	125	24%	76%
Enterprise networks	25	16	18%	82%
Total [C,D]	915	763	36%	64%

[A] Including IoT and surveillance cameras, [B] Including telecommunication satellites, [C] Rounded values
[D] These results refer to the reference unit "The overall GHG emission generated by the global ICT sector (as detailed in the scope) over one year (2020). More specifically this refers to one year of operation and embodied emissions associated with the sales volumes of that year.

Table 1: ICT sector use stage electricity consumption and GHG emissions in 2020. Source (Malmodin, Lövehagen, Bergmark, & Lundén, 2023)

The GHG emissions are also shown in the diagram in Figure 7, where the carbon footprint of the ICT sector is also compared with other related sectors.

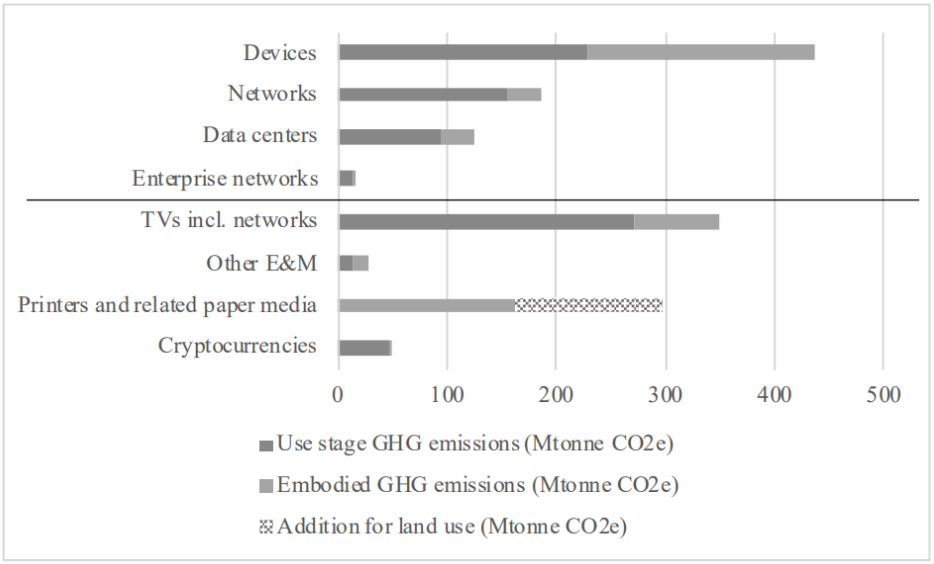

Figure 7: Carbon footprint of the ICT sector compared to related sectors. From (Malmodin, Lövehagen, Bergmark, & Lundén, 2023).

This can be compared to an older paper (Costenaro & Duer, 2012) according to which the energy use in the data center is dominating, while the networks have a low share, 14%, and the devices of the end user 38%, see Figure 8. The paper is interesting as it tries to raise the awareness about the energy use connected to using the internet and gives some advice on good habits to limit the amount of data transferred and thereby the energy use.

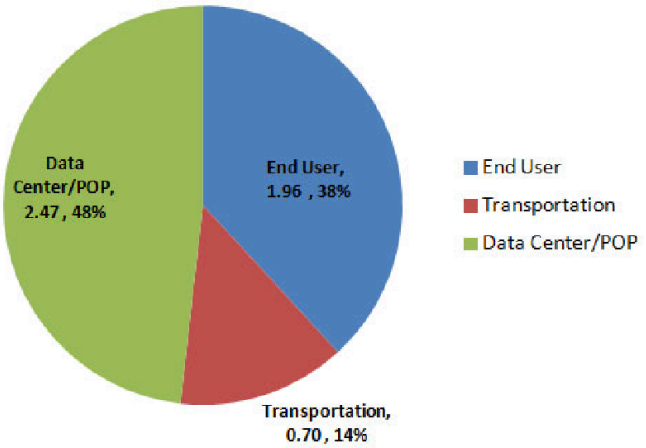

Figure 8: Internet energy breakdown (kWh per GB). Source: (Costenaro & Duer, 2012)

A tool for investigating the impact of using ICT has been presented by Shien et al. (2022). In the introduction to the paper they discuss the difficulties of assessing the emissions of internet services “due to the fast-changing and complex supply chains”. They also state that the suppliers are reluctant to share information about the environmental impacts of their services. They refer to Mytton (2020), stating that the existing standard for evaluating GHG emissions from the ICT sector (Carbon Trust, 2017) is impractical for estimating the emissions related to internet services. Instead, they propose what they call the DIMPACT tool, which is part of the membership-based DIMPACT project. They claim that this tool is based on previous protocol as well as on academic research publications. It is based on classical Life Cycle Assessment (LCA) standards. For the moment, only the Climate Change category (kgCO2) is in operation, and only for the use phase. Specific modules are available for Video Streaming, Web Publishing and, in the near future, Video Conferencing. The tool is unfortunately not open to the public but seems to require membership in the Dimpact project. More information is available on the organization´s web page (Dimpact, 2024). The page also include links to some interesting reports.

An interesting report about the carbon footprint of streaming video is presented by the International Energy Agency, IEA (Kamiya, 2020). According to this, some other investigations have over-estimated the energy use of streaming considerably, leading to erroneous publicity in public media. This report also points out the effect of using different types of devices for viewing, and the very large effect on CO2 emissions depending on the electricity mix assumed in the calculations. The web page where the report is found has an interactive CO2 emission calculator where the user can select the type of device, the resolution/bitrate, the type of WiFi network and the country, determining the CO2 mix, and based on this the CO2 emissions of 1 hour of streaming is calculated. Some results using this calculator is seen in Figure 9. In the first four graphs, the world average electricity mix is used while in the fifth, the mix of Sweden is used as an example of a country where the electricity to only a small extent comes from fossil fuels. In each graph, the CO2 emissions of boiling a kettle of water is shown for comparison. Comparing the first and second graph, we see that the laptop requires much more energy than the mobile phone, and that with the laptop the energy use of the device completely dominates. For the phone, the data transmission, through 4G, dominates. If the phone had been connected through WiFi, the transmission part would have been smaller and similar as for the laptop. In the third graph, the resolution of the screen is increased from Standard Definition to Ultra High Definition/4K. As seen, this has a large influence on the Data Center part, but has a very small effect on the transmission and laptop part. The increase in emissions is substantial, from 12 to 18 g. In the fourth graph, a higher energy use of the WiFi connection has been used, which could reflect a longer distance between the router and the laptop. This has a large effect on the transmission part and the total emissions are now 25g for one hour of streaming. Finally, if a large 50” screen is used for viewing, the CO2 emissions increase a lot, to 71g, and the energy use of the device is completely dominating.

The last graph shows the same configuration but for the Swedish energy mix, and the CO2 emissions are now only 3g. Of course, several assumptions have to be made for this type of calculations and the reader is referred to the source for more information about this. A general conclusion is that the device used, the resolution and the type of connection all have a large effect on the energy use and thereby on the CO2 emissions.

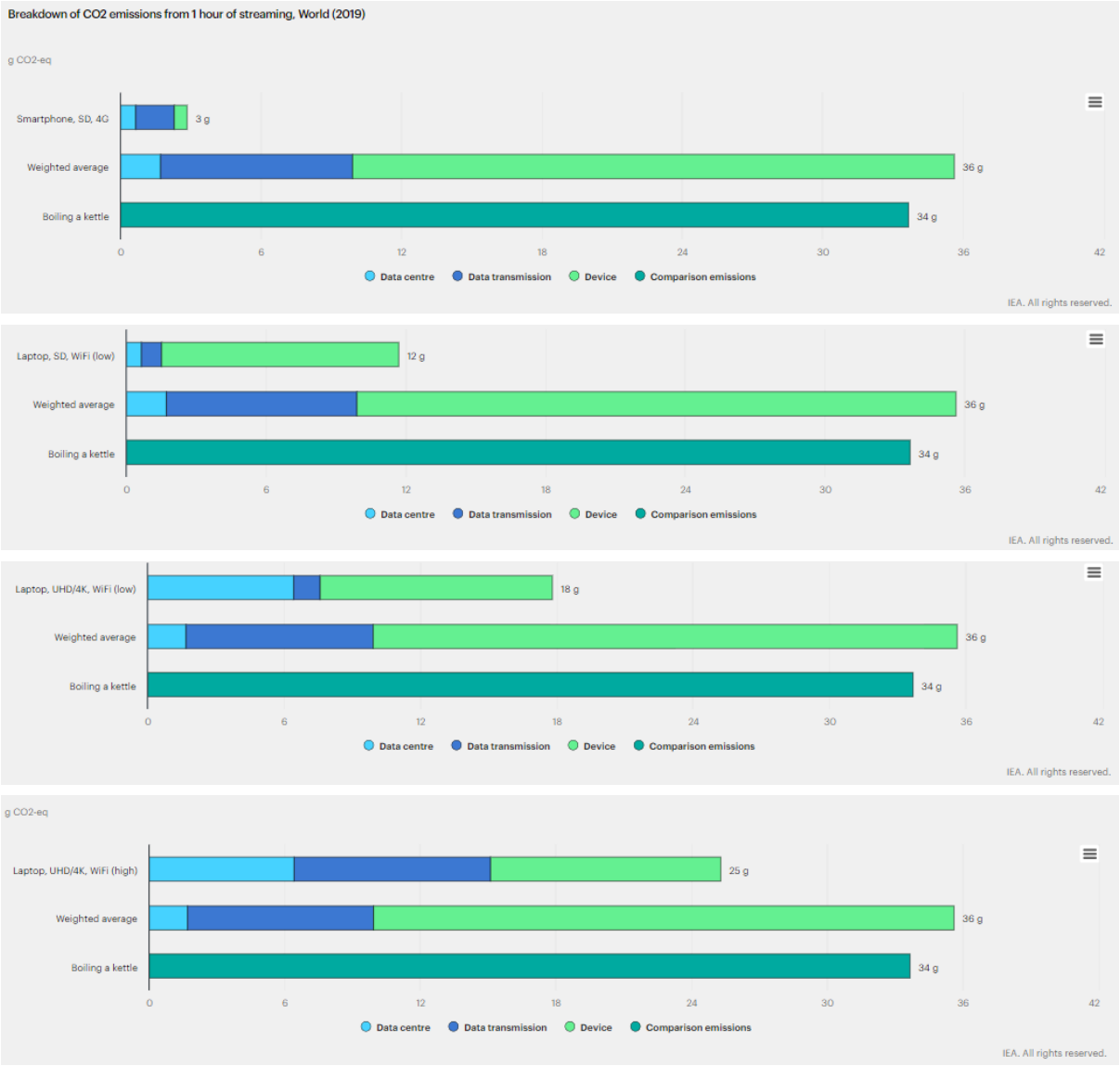

Figure 9: Distribution of energy use in streaming data depending on the type of screen, resolution, network type and country/electricity mix used in the calculations. Source: (Kamiya, 2020)

3.3 Sustainability effects of the selected teaching platforms

The sections above have not been focusing in particular on comparing different teaching platforms in terms of energy use or sustainability. Only few sources have been found where such comparisons are made. One such source is the web page by Greenspector (Corcuff, 2023) where results from actual tests of energy use by 10 different video conferencing apps are compared, when running on a mobile phone and when running on a computer. The apps compared were Zoho, Teams, Whereby, Zoom, JITZI, Skype, Bluejeans, Google Meet, Webex and Go To Meeting. The results are given in terms of mAh, i.e. energy use measured, per minute of videoconferencing. They are also given as CO2 emissions, but in this case, the authors have used a model to estimate emissions due to the manufacturing as well as the use, of the whole chain of equipment from the computer center to the local computer or mobile. Figure 10 shows the results on a mobile phone (Samsung Galaxy S7) connected by WiFi to a nearby router. All tests were done using the standard settings of the phone and the downloaded apps. The camera was on and there was video traffic in both directions. As shown the calculated CO2 emissions of the platforms are quite different, with Go To Meeting resulting in more than twice as much emissions as Zoho or Teams per minute of video conferencing. It is not clearly stated what electricity emission factor was used, both the world average and the factor of France, where the study was made, are mentioned. In either case, the graph shows the relative effect of using the different platforms.

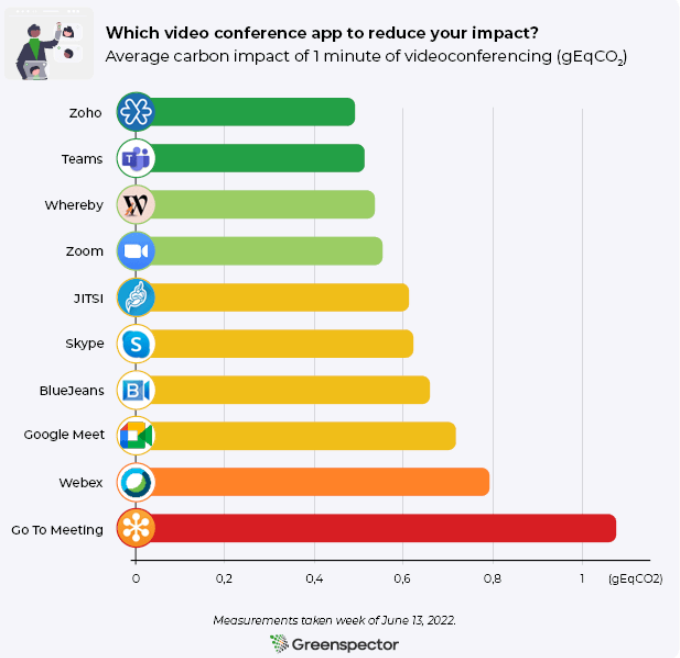

Figure 10: Comparison between the carbon impact for videoconferencing one minute on a mobile phone using different tools.
Source: Corcuff, 2023

Comparing just the energy use of the phone, the differences are smaller. This is shown in Figure 11. For each app, the energy used is displayed for three different cases: only using audio, audio + video and finally audio + screen sharing. The diagram should be understood as comparing the sum of one minute of each mode for the ten apps. Clearly, there is a lot to save by going from video to audio only, but this may not be the purpose of a video conference. However, during a presentation, with mostly one-way communication, energy could be saved if the passive partners turn off their cameras.

Figure 11: Comparison between the energy use for videoconferencing one minute on a mobile phone using different tools.
Source: Corcuff, 2023

When performing the tests with a PC, apps were also downloaded to the computer rather than using web-versions. The direct measurements of energy consumption in terms of mAh are shown in Figure 12. First, we note that the energy use is about twice as high as with the mobile phone. Second, the advantage of turning off the camera is less in this case. According to the source, the decrease in energy use is on the average 27%. Also, there is only a small difference between audio + video and audio + screen sharing. The difference between the apps is somewhat smaller than on the mobile, with the highest value, for Go To Meeting, being about 45% higher than for the lowest, Zoho.

The source also compares the data traffic required for each minute of videoconferencing. The results are shown in Figure 13, which shows that the differences are very large. Even if Go To Meeting, having a quite different value for screensharing, is excluded, there is a factor of four between the lowest, Whereby, with 5 MB and Webex, with about 21 MB and being second highest. Again excluding Go To Meeting, it is very clear that the video traffic dominates.

Figure 12: Energy use of PC used for videoconferencing, per minute. Source: Corcuff, 2023

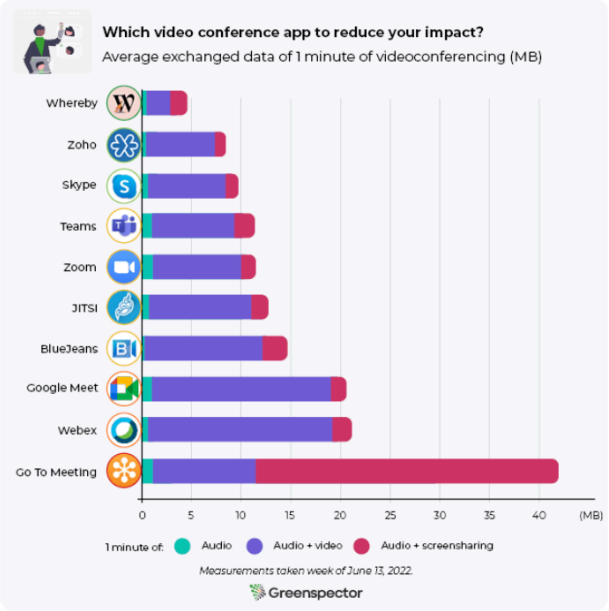

Figure 13: Data exchange during 1 minute of videoconferencing, only audio, audio + video and audio + screen sharing. Measurements done on mobile phone. Source: Corcuff, 2023

3.4 Conclusions

Some conclusions can be drawn at this stage about the energy use and the CO2 emissions from distance education using digital platforms. First, the main energy use may very well be on the user side, not in the servers or the networks. At least this is true if a PC or a TV is used for participating in the meeting. As the power use of a PC is only a very minor part of the electricity consumption in a home, it is obvious that distant education is only a very small share of the total electricity use in society.

Second, the study shows that it is possible to decrease the energy use, by using a mobile phone rather than a PC, by turning off the camera when not active, by using cable connections rather than WiFi, and WiFi rather than mobile connections.

Third, different platforms do require different amounts of energy, and the difference may be up to a factor 2 between the best and the worst, using a mobile phone.

Fourth, the origin of the electricity has a very large impact on the outcome. This means that if the server is located in a country with high share of fossil fuel in the electricity production (high emission factor), while the user is located in a country with electricity mostly from renewables, then the balance in terms of environmental impact from server, network and user will be shifted considerably.

Chapter 4: Description of similarities and differences between commonly used platforms

4.1 Compared platforms

As a first stage in comparing the functionalities of different platforms, information was collected within the participating universities concerning the platforms used. The following is the result of this query:

Most frequently used digital education platforms at KTH:

- Zoom for meetings and classes
- Canvas for communicating, sharing information, administration of hand-outs and hand-ins
- Teams (and other tools) only for meetings outside of KTH

Most frequently used digital education platforms in UniTrento:

- Zoom (for lecturing, fully outsourced)
- Google Meet (as a backup, for lecturing)
- Google Suite (for docs, slides, etc)
- Moodle (self-hosted)
- Discord
- Miro

Most frequently used digital education platforms in TUDelft:

- Microsoft Teams (for lectures, outsourced)
- BigBlueButton (for lectures, self-managed, stopped after 2 years)
- Brightspace (Learning management system, outsourced)
- Zoom is not a preferred tool at TU Delft since Zoom is not GDPR compliant, and hence not supported by the TU Delft helpdesk.

Used tools at TU Delft can also found at TUDelft's web page (TUD1, TUD2) (TUDelft, n.d.) (TUDelft, n.d. 2)

Most frequently used digital education platforms in TU Eindhoven:

- Microsoft Teams
- Canvas
- Zoom
- Coursera (few cases)

Most frequently used digital education platforms in U Rennes:

- Klaxoon for pedagogical activities
- Zoom for meetings and classes
- Teams for meeting, classes and drive
- Moodle for classes and drive.
    - Before the COVID only Moodle.
- Each teacher can use the solution she or he wants.

As a second method of identifying frequently used platforms, GetApp was used. The following is a listing of the top hits (highest points) identified in this way. The listing is only a small part of the available alternatives, and for video conferencing only.

- ClickMeeting
- FreeConferenceCall
- Big Marker
- MyOwnConference
- Conferize
- Slack
- Zoom Meetings
- TeamViewer
- GoogleMeet
- GoTo Meeting
- Microsoft Teams
- Webex
- GoTo Webinar
- Join.Me
- Workplace from Meta
- Cisco Jabber
- Zoho Meeting
- vFairs
- Dialpad Meetings
- Livestorm
- Adobe Connect
- BlueJeans
- RingCentral Video
- Webinar Geek
- Blackboard collaborate

From the listing above it is obvious that there are many options when selecting the platform for distant teaching. It is also obvious that it has not be possible to include all platforms in the present investigation.

For the purpose of this report, it was decided to focus on the following tools:

- Zoom
- Teams
- Google Meet

4.2 Functional similarities between the investigated tools

The three platforms have several features in common:

- All are video conferencing platforms suitable for teaching as well as for meetings
- All have the possibility to share screen with the other participants
- All have the possibility of sharing documents during the meeting
- All have the possibility of recording the sessions
- All have apps for Android and for IOS

4.3 Specific features of each of the three platforms

Zoom:

Strengths:

- Considered to be very user friendly
- Good video quality
- Can be used with up to 1000 participants
- Internal chat which can be used both for bilateral and multilateral messaging
- Response functions, like raise hand, clap hands etc.
- Allow breakout sessions
- Free for individuals, but meeting length is limited to 40 minutes (for meeting organizer)

Weaknesses:

- Security/privacy concerns: As noted above, Zoom is not used at TUDelft for these reasons
- Compared to Teams, it has less possibilities of integration with the MS Office suite
- Advanced features may require extra payments

Microsoft Teams:

Strengths:

- Well connected to the Microsoft Office suite
- Internal chat function
- File storage
- Designed to cover the requirements of businesses

Weaknesses:

- The many features makes it more difficult to learn
- Can be expensive

Google Meet

Strengths:

- Free to use for individuals, with limited functionalities, but without limitation in the length of the meeting
- Well integrated with other Google tools
- Easy to use

Weaknesses:

- Some of the advanced features found in Zoom and Teams are missing
- Offers fewer customization options compared to the other two platforms

Chapter 5: Recommendations related to energy use and environmental sustainability

Based on what has been found through the literature review and searches on the web, the following recommendations can be given in order to minimize the environmental impact of distant education and the use of digital platforms.

5.1 Your personal equipment and its use

- Use the energy-saving settings of the computer and the monitor
- Activate powersave and sleep mode on your equipment.
- When purchasing a new ICT product, consider sustainability aspects, i.e. low energy consumption, low content of environmentally damaging materials, reasonable working conditions for the labor involved in the production
- Adjust the screen resolution to the lowest necessary level for the task
- Adjust the light of the screen to a low but comfortable level
- Limit the amount of streamed media to the least necessary levels
- Consider if you need to have your camera on when not active
- Open tabs in your browser may cause a constant and unnecessary flow of data.
- Connect all equipment to the same power strip so that all units can be switched off in one move.
- Use mobile phone rather than PC
- Use PC rather than a TV-screen

5.2 Network equipment and its use

- The location of the server may be important as the CO2 emissions related to electricity production is very different in different regions
- Cable/fiber connection is better than WiFi
- WiFi is better than 3G/4G/5G
- When using WiFi, sit close to the router

5.3 Platforms and their use

- There may be a factor 2 between the energy use of the best platform and the worst
- Of the three platforms compared above, Teams require the least power and Google Meet the most

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Section 2: Tool for self-evaluation of the use of distant learning platforms

Summary

This book introduces a self-assessment tool designed to help users and decision-makers assess their sustainability awareness and practices in ICT-based teaching. The tool provides personalized advice to enhance awareness and skills, promoting more sustainable approaches to digital education.

Introduction

The main outcomes of Results 2 was a) a report on the use of digital platforms in teaching and b) a Tool/survey for self evaluation of the performance as a user of such platforms. This section of the report describes the development of the Tool, the implementation of the test version of the Tool, the evaluation of the Tool and the final adjustments done for the final version of the Tool.

The main purpose of the Tool developed was to allow persons who are familiar with platforms for distance education to do a self-evaluation of their status as users. At the same time, the purpose was to make the users aware of advantages/disadvantages of using these tools, from a pedagogical, social and sustainability point of view.

The Tool is primarily developed for universities, university staff, teachers and students as this is the environment where distance education through the use of platforms is most common. However, the Tool could also be used in schools and by teachers at other levels where digital platforms are used for distance education. The Tool may also be of interest for other organizations or persons interested in these platforms.

As far as we have found during the project, no other similar tool is available for self-evaluation for user, or for comparison of digital teaching platforms. The expectation from the start was that the Tool would survive the project and continue to be used and developed. We still see this as a possibility, but the future maintenance of the Tool has not been solved at this point.

Chapter 1: Developing the Tool

At the meetings with the whole consortium, the purpose of the Tool was discussed as well as the format and methodology. It was agreed from the beginning that the Tool for self evaluation developed within the HEInnovate project should be seen as a model for the development of the new Tool. However, it was made clear that the resources within the present project are very small compared to the HEInnovate and that it would be impossible to reach the maturity of the HEInnovate Tool within this project.

Figure 14: Example of pages from HEInnovate, which was considered as a baseline and inspiration for the Tool to be developed in the present project (from [Get started | HEInnovate](#))

The main responsibility for the development of the Tool was on KTH as leaders of Results 2 of the project. However, all other parties were expected to contribute with their expertise. The following was the distribution of the work as expressed in the application:

- KTH: result lead; leading of energy sustainability dimension
- UniTN: integration with R3 and R4; contribution to all dimensions
- TUD: integration with R1; leading of ethical/social sustainability dimension; co-development of tool specifications
- TU/e: tool prototyping; co-development of tool specifications
- UR1: leading of pedagogical dimension;
- JA: integration of stakeholders and user feedback; co-development of tool specifications

During the development of the Tool, all parties were thus involved in suggesting questions to the survey and in discussing the overall layout of the Tool. Different platforms for creating the Tool/survey were considered, but finally it was decided to use the commercial platform Surveymonkey[1], as their interface is easy to work with while at the same time the functionalities offered were in good agreement with the requirements of the project.

The Tool was divided into sections as follows:

Section 1: Background of the person using the tool, their experiences as users and considerations in selecting the tools.

In this section, the respondent is asked about in what position they have experience of the platforms, e.g. as teachers, students or as responsible for purchasing the platform. The respondent is also asked to evaluate his/her own maturity as users. As part of the background, the respondent is also asked about the freedom to select the platform, and who takes the decisions about this. Further, the respondent is asked about which platforms he/she has experience of and which platform he/she is most familiar to. For this platform, the user is asked to rate it in terms of ease of use, ease of learning, number of features, first cost and cost of use. The respondents are also asked to specify which aspects they would consider most important when selecting a platform for video-based distance education. The respondents were also asked about how long they had used the platforms, and if they have seen any developments during this time.

[1] https://www.surveymonkey.com/home/

Section 2: Sustainability aspects of using digital platforms and web meetings

It was decided at an early stage not to try to compare the environmental impacts of using distant learning with ordinary classroom teaching. Comparing the effect of travelling depends on local conditions and may not even be a viable option in some cases. Instead, the questions focused on the habits while using the platforms. The first question posed is if the users are at all concerned about the environmental impacts of using video conferencing tools. In the following, teachers and students are asked if they try to decrease the energy use by turning off the camera when not active, by decreasing resolution of video, if they consider using cable connection rather than WiFi, if they consider sitting close to the router when using WiFi, or if they use low-power device e.g. mobile phone to decrease energy use. Respondents are also asked what features related to the environmental impact they would consider if they were in the position to select a tool for use in their organization. Finally they were asked to suggest other features related to the environmental impact of using the platforms.

For the development of questions in this section, the literature survey done and reported on in the written report from Results 2 was extremely important. This helped in developing an understanding for the effects of different habits of the user and of different features of the platforms on the environmental impact.

Section 3: Pedagogical aspects

In this section the respondents were asked several questions related to the use of digital platforms as compared to classroom teaching. First, they were asked about which pedagogical aspects they would consider most important when selecting a platform for distance education. This was followed by a question about which features of the platforms they actually use in the teaching, the typical number of students in the courses where the platforms were used, and the percentage of students actually attending. A few questions were related to the habits of the students, e.g. how large share of the students that have their cameras on during lectures, how large share are interacting, e.g. by asking questions. All respondents were also asked what pedagogical features they would like to see in the future. A group of questions were finally related to the situation of mixed classes, i.e. that some students participate through the web-based platform and some in the classroom. First, the respondents were asked to rank the reasons for having mixed classes. Second, the respondents were asked if the local students had a choice to participate through the platforms or in the classroom. The respondents were also asked to select the main advantages and disadvantages of mixed sessions from a list. They were also asked which students they would expect to get the best grades in a written exam at the end of the course. In the case the students had a choice, they were asked which group of students they thought would participate in the classroom, the most motivated, the ones in highest need of support, students living close to the university, the more social students or students who feel alone when following from home. The respondents were also asked how large share of the students would come to the classroom if they could decide by themselves. Finally, the

respondents were asked to suggest measures to increase attendance and active participation in the lectures.

Section 4: Social/ethical/legal aspects

Only one question was posed in this section. In this, the respondents were asked to select which criteria from a list they would consider before selecting a platform/video conferencing tool for distance education. The following options were given:

- Ensure accessibility for hearing/seeing impaired users
- Ensure all students have internet access from their homes
- Ensure operating system independence of the tool
- Check for live captions/subtitles
- Check for live translation
- Check for individualized user settings
- Not relevant as I do not select the tool.

In total, version 1 of the Tool had 40 questions. Some of these gave “points” indicating the respondent’s awareness and/or concern about sustainability issues.

Chapter 2: Test of Tool

Version 0

As a first step in the development, a version zero of the Tool was developed and distributed to colleagues in the group. This gave valuable feedback on the formulation of the questions, and several of them were reformulated to avoid possible misinterpretations.

Version 1

Based on the feedback of version zero, version 1 was developed and distributed to all partners in the consortium. Each partner was asked to distribute the Tool to ten selected members of their organizations, with a letter urging them to support the C-flex project by responding to the Tool. Each respondent was also asked to send feedback on the Tool as such to the responsible person at KTH. It is estimated that about 60 persons got these invitations to use the tool, and of these 28 completed the questionnaire.

The analysis of the responses to the Tool/survey is found in Appendix 1 of this report. A few comments are given here.

The first result shown in Appendix 1 is the score of the participants. The average score is 37% and the distribution is somewhat as could be expected, with a standard deviation of 12%. The exception from the even distribution curve is that few respondents had scores between 41 and 50%. The reason for this is probably that the number of respondents was limited, only 28 persons. The relatively low average indicates that the questions were “hard” meaning that the respondents were not using all potential measures described to decrease the environmental impact of the use of the platforms. An obvious reason is that some suggested measures have a minor impact on the energy use etc. and may therefore not be considered relevant even for respondents who are much concerned about the environment. However, it should be noticed that the Tool can be used several times and the score then compared to the previous result. In this way the Tool can serve as an instrument to nudge the respondents towards a more sustainable behavior.

A weakness of the Tool in its present form is that it is not possible to differ between points of different categories. Only a total score is shown in the analysis.

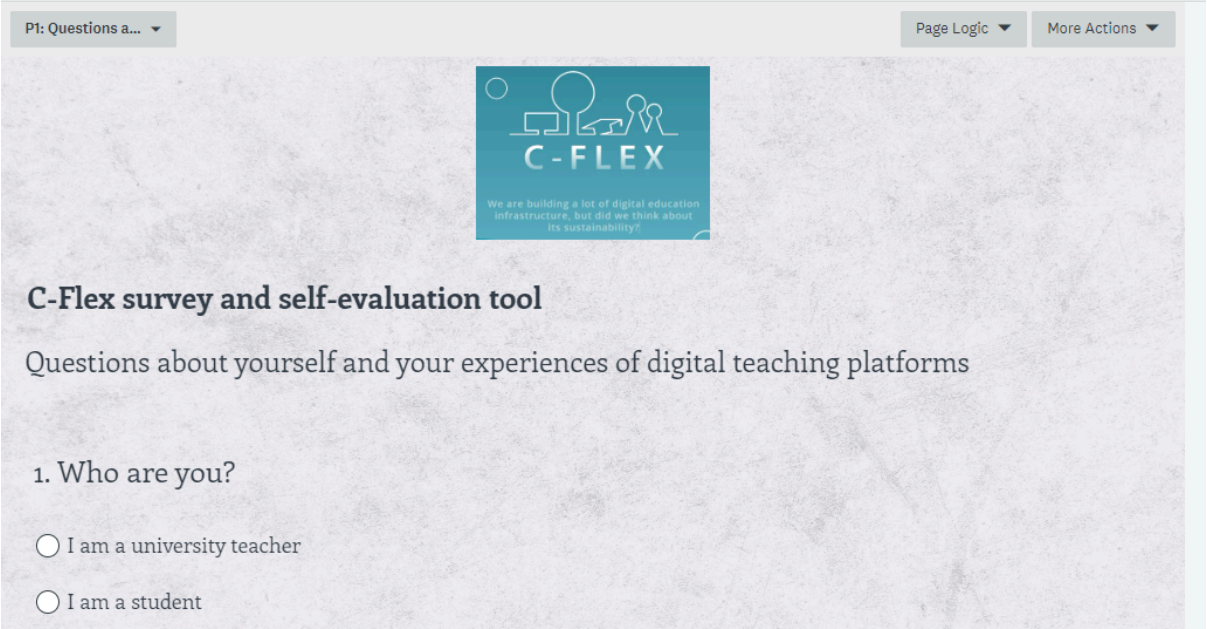


Figure 15: First page of the Tool, version 1

Questions in the tool

Q1: From the answer to Q1 it is obvious that the respondent were mainly university teachers. No student answered, even though a group of students were invited.

Q2: Most respondents classified themselves as “normal” or “advanced” users of the platforms, which is perhaps not surprising for a group consisting mainly of university teachers.

Q3: Concerning the control of the choice of teaching platforms, a vast majority, 60%, answered that this is handled by the central administration of the university. Only in a few cases the local teachers could select the platforms.

Q4: This question asked which platforms are used now. Several responses were possible. The by far most commonly used platform is zoom, used by about 92% of the respondents. Second, with 46% was MS Teams. The only other platform with more than 10% was Google Meet.

Q5: Related to the previous question, most respondents stated that they were most familiar with Zoom, with MS Teams as the second.

Q6: The respondents gave the most used platform (Zoom in most cases) a high rating of 4/5 concerning the ease of use.

Q7: Concerning ease of learning, the rating was slightly lower, 3.6/5

Q8: The number of features of this platform was rated 3.7/5

Q9: The first cost was rated 3.0/5 but only 4 respondents gave an answer while the majority were not aware of the cost.

Q10: Similarly, only 4 respondents rated the cost of use and gave the average rating 2.8.

Q11: When asked to rank different features when selecting platforms, ease of use and ease of learning was selected as no 1 and 2. Cost aspects were least important.

Q12: When asked about other aspects in an open question, some of the responses were:

- Tested by teachers panel
- To be easy to use via deskstop & mobile
- (Web) Security
- Possibility of using the platform via browser
- Content: Large course/program offerings
- Tested by students panel

Q13: When asked about other tested platforms the top responses were:

- Webex
- Blackboard
- Google Meet
- Moodle
- Microsoft Teams
- Mural
- Zoom
- Sakai

Q14: When asked about if they follow the technical development of the platforms, 70% answered NO, and 25% answered “When I see articles on the subject I read them”

Q15: Most respondents have been using the platform for long. 40% answered 2 – 4 years and 40% answered more than 4 years.

Q16: When asked about the changes of the platforms since their first experience, the most common replies were More features (42%) and More stable (38%)

Q17: 57% of the respondents answered that they were concerned about the environmental impacts of the conferencing platforms, while the rest, 43% had no such concerns.

Q18: In this question the respondents were asked which of several measures they would suggest to the students to decrease the energy use/environmental impact. The most common response was to suggest the students to turn off their cameras when they were not active. Nearly 60% of the respondents gave this answer. As 30% answered that they are not teachers, this means that almost all teachers recommend the students to turn off the cameras! About 12% also suggested the students to decrease the resolution of their video, and the same share suggested them to use cable connection instead of WiFi.

Q19: The same question was also posed to the respondents in the case they were students. Only few responded (as the majority were teachers), but turning off the camera when passive got the highest score. Using cable connection and decreasing resolution was also getting a few responses.

Of course, there may be other reasons than environmental concerns for turning off the camera. It is difficult to evaluate from the responses if this was really the prime reason.

Q20: When asked to pick the most important features when selecting video conferencing platforms, the option most commonly selected was to consider the power requirement of the server (59%). The power requirement of the platform and that on the equipment on the user side got equal support, 41%.

Q21: In an open question about what “environmental” features the respondents would like to see in the future, some of the answers were:

- Would be interesting to see how much power it costs to store stuff on the platform
- Pop ups with suggestions for lower consumption
- More explicit information about its energy consumption
- Energy meter
- Suggestions to minimize power consumption at various points (tool, server etc.)
- Energy usage meters server side
- Some energy related rating
- Power use of the server related to video conferencing in a dashboard
- Would be interesting to see how much power it costs to interact via the platform; i.e. some kind of environmental footprint measure.
- Explicit and easy to select "low power" modes
- CO2 emission
- Energy usage meters client side
- Power use reporting on the participant's side

Q22: In this question, the respondents were asked to rate another set of statements regarding the selection of the platform. Again, the result pointed to the importance of ease of use for both teachers and students. Possibility for students to interact also was rated high.

Q23: When asked about which pedagogical features they liked to see all suggestions given were highly ranked, but Breakout sessions and Chat were at the top, picked by 70% of the 85% of the respondents being teachers.

Q24: The number of students in the classes where the platforms are used was the topic of this question. The range from 20 – 50 students got much higher numbers (70%) than any other size range, all being about 10%.

Q25: The share of the students attending was asked for here, and the responses Arount 50% and Around 75% both got the same number of responses, about 47%. Only about 5% answered Close to 100%.

Q26: The response to this question shows that it is most common that the students do not have their cameras on during lectures. 58% of the respondents answered that less than 25% of students have their cameras on.

Q27: This question asked how large share of the students are giving feedback during the lectures. More than 50% of the respondents answered that less than 25% gave feedback. Even though the feedback/questions may be scarce also in classroom teaching, this gives an indication that the interaction is less using web based education than in ordinary classroom education.

Q28: This is an open question where the respondents could suggest pedagogical features they would like to see in the future. Some of the responses were:

- Ways to measure participation/interaction on individual level in a way that is transparent to students.
- Easy and smooth connection to shared canvas/virtual blackboards
- Active screen/ window for adding notes by students
- Easily set up questionnaires using smart phones (app)
- Menti-like features
- AI Support - automatic sounding board for students
- More integration with other infrastructure in the classrooms (high quality audio, high quality video)

Q29: This was the first of a set of questions related to mixed sessions where some students participate in the classroom and others through the web platforms. In this question the respondents were asked to rank three reasons for using mixed sessions. The highest ranked reason was to make the session accessible to students who are sick. The second to allow the students to chose by themselves, and almost as high rating was given to the reason of having students coming from far away who are dependent on participating through the web.

Q30: This was an open question where the respondents could give their own reasons for having mixed sessions. The responses were:

- Include more easily international students
- Increase of the participation during lectures
- Also involve teachers that are far-away (saving travel costs)
- If lectures are recorded it makes sense to also have a Zoom link open
- With the right technique, the hybrid form could perform as well as a blended form, but with more freedom for students.
- Scalability of classrooms and courses
- Increases efficiency of teachers
- Increases freedom of students

Q31: Here we asked if local students were allowed to participate through the web. The most common answers were, Yes but only if they are sick, and Yes, they can do as they like, both answers getting 32% of the responses. Only 5%, corresponding to one respondent, stated that only distant students could participate through the web.

Q32: In this question the respondents were asked to select from a list of selected advantages of having mixed sessions and arrange them from most important to least important. The most important reason was that by this, everyone can participate even if they are sick or travelling. The second most important reason was that the number of participating students increase if they can join from home.

Q33: This question was similar to the previous one, but concerned the disadvantages of mixed sessions. The respondents answered quite differently and all statements were favored by some respondents. The most commonly selected disadvantage was the difficulty for the teacher to direct the attention to both the students in the room and on the screen.

Q34: This was an open question where the respondents could state disadvantages with mixed sessions. The responses were the following:

- Teamwork problems, miscommunication between students
- It is easy to forget the online ones if they are few.
- Connection problems
- Didactical choices require time from teachers; other approach
- Limited contact with students
- Technical glitches almost always happen, and there's always extra time that we need to spend on fixing those (but not on teaching itself)
- Sound uptake from room. Lack of cameras.
- Dependent on technology of the students

Q35: Here we asked for tips and tricks to make the students active during web-based sessions. The following are some of the responses:

- Polls, quizzes
- Asking questions
- Address them now and then
- Question them regularly
- Include in the teaching material team works
- Group works
- Breakout sessions with group discussions
- Break out session every 15/20 min
- Polls and breakout rooms
- Discussion tasks with written feedback online
- Use the chat simultaneously and have a student assistant gather the information
- Have in some part of the class interactive sessions (Q/A, short presentations..)
- Mentimeter
- Questionnaires
- Apply assessments that count for the final mark at the exam.
- Polling/voting

Q36: Here we asked which group of students the respondents would expect to get the best grades, or if they believe there is no difference. It is noticeable that none of the respondents thought that the students participating through the web would get the highest grade. On the other hand, 43% thought the classroom student would get the highest grades. Almost as many, 38%, answered that the outcome depends entirely on how the sessions are structured. The remaining 19% answered that there would be no difference between classroom students and web-students.

Q37: Here the respondents should order the group of students which would be most interested in participating in the classroom, if they had the choice to join through the web. The most common first choice was the most motivated students.

Q38: In this question we asked the respondents how large share of the students they thought would come to the class room if they were free to choose. The by far most common answer was around 50%.

Q39: This was an open question where we asked what could be done to increase attendance and active participation. Most of the responses are listed below.

- Giving suggestions for the final exam
- Instruments to measure activity
- Not mimic classroom setting but make sure it has added value
- More interactive lectures
- Perhaps have specific sessions meant only for IRL and some others only web-based, with interactive activities also planned accordingly (that indirectly forces them to be present in the intended mode)
- Good scheduling
- Make interesting lectures that engage the students
- Engage students with tasks during "lecture"
- Use teaser videos to introduce the course/lessons
- Use interactive tools like breakout rooms
- Group works
- Have graded assignments on the sessions 'in question'. Always works :)
- High quality (of lecture)
- Involve students a lot and periodically ask for their feedback
- Connecting lectures to assignments
- Exchange experiences with other teachers

Q40: This question was the only one in the Tool related to social sustainability. The respondents here had to select the most relevant features to consider related to social sustainability from a list. The most common answers were ensuring all students have internet access from their homes and ensure operating independence of the platform. Third came accessibility for hearing/seeing impaired users.

Observations

Studying the responses from the test of the Tool, it is obvious that some of the questions should be rephrased in order to be completely clear. Additional conclusions can be drawn after studying the comments sent by mail from the respondents. This is covered in the next section.

The length of the Tool seemed reasonable. The typical respondent used about 19 minutes to finalize. The completion rate was 65%.

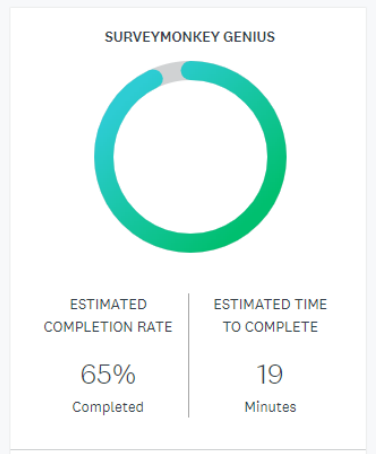
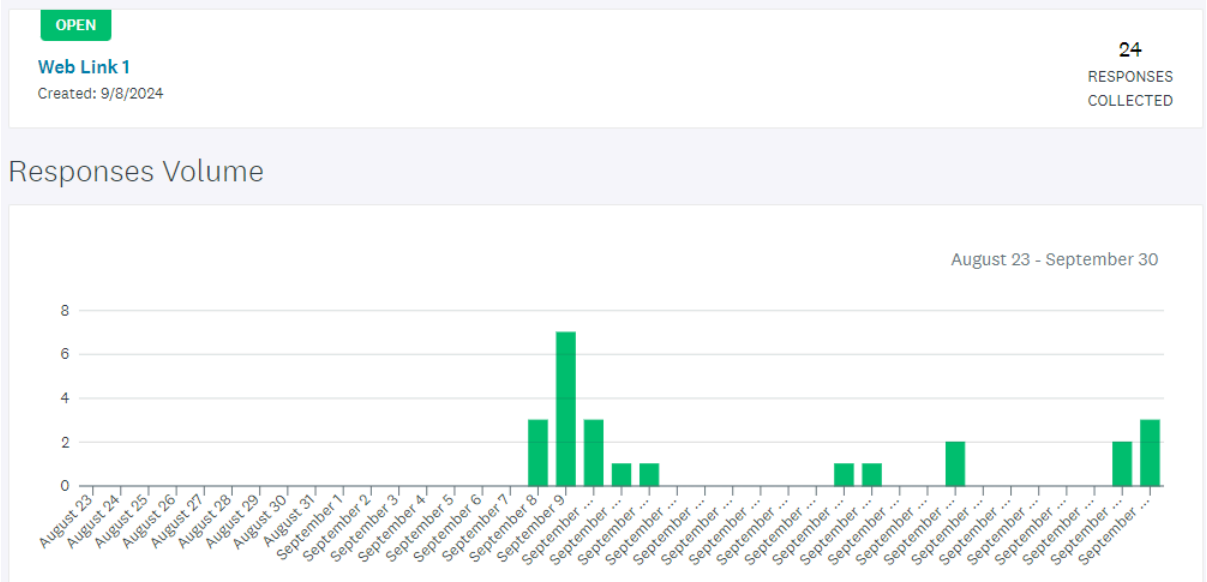


Figure 16: First analysis of the results of the Tool/survey

Chapter 3: Comments from test group

As mentioned above, the test panel, consisting of colleagues in the participating partners' organization, were asked to send comments to the Tool by mail. Seven colleagues sent comments, and excerpts from these can be read below. After each comment, a response follows also including any changes done to the Tool based on the comment.



Person 1

I was nice to have the questions divided into different categories based on the dimensions. One comment for the report: hybrid session might be a better term than blended session, at least it's more commonly use at TU Delft. But it's up to you of course. Also, in question 9, it might be clear what first cost means. That could be explained in the report.

Response: The term blended has been changed for hybrid. A clarification is inserted to explain the term first cost

Person 2

The last question (nr 40) there might be a bug. I chose the last box ("not relevant") but when I then wanted to finish the system kept insisting I had not filled out question 40. When I left it blank though the exclamation mark disappeared and I was able to finish it. Also I find the answers to choose from very good. From the teacher's perspective I haven't been able to judge it all, but I think it covers a good range of possible opinions. The only thing I miss: it is good to mention how the feedback one gives will be used. Often a lot of feedback is asked from employees but organisations forget to be specific what will be done with it and how.

Response: Q40 is changed to avoid the problem mentioned. The Tool is also changed so that the user gets feedback and comments on the results.

Person 3

Looks good. Some remarks: Q29: " If you have blended sessions (students both in the class room and participating through the web): What are, or do you think are, the main reasons? Please rank?. I think it would be better to call this hybrid sessions instead of blended (Q29-Q43); it is a more accurate description of the situation you put forward.

Response: The term blended has been exchanged for hybrid.

Person 4

[...] it had a good structure and I just miss instructions or information about the purpose in the beginning. We could also have a last open question if anyone wants to leave comments. In general, the questions were very good and very relevant for post-covid teaching.

Response: Some information about the purpose has been added in the beginning. A final open question has been added to allow respondents to leave comments.

Person 5

We could add more legal aspects e.g. about who is the owner of the data, the computer program etc. Q20 would need a "neither" alternative.

Response: An additional option has been added to Q39 asking if personal integrity has been considered in the choice of platform. For a future extension of the Tool this is a good idea to include more questions related to legal and integrity-aspects. In Q20 a "neither" alternative is not necessary as it is possible not to select any of the options.

Person 6

Just completed the survey and here are some thoughts I had while reading/responding to questions. I've numbered them to match the questions.
7. How would you rate this platform concerning ease of learning?
This one I find difficult to answer because I don't fully understand how students rate it now that we are past the pandemic. It is appreciated to have a remote option, so I always have the lectures open in Zoom and record them, but I don't usually use any other advanced features like breakout rooms or polls. So it is literally just making the lecture available remotely and it is hard to rate how easy that makes learning with regards to Zoom as a platform.

Response: The question was intended to ask about how easy it is to learn to use the platform. It is now re-formulated to avoid the misunderstanding of this colleague.

8. How would you rate this platform concerning number of features?
Good question, but really hard to answer if you've only ever used one platform. I mean, Zoom works and there isn't really so much more I wish it did, but perhaps there is another platform that has some killer feature that I just never realized I wanted.

Response: A new alternative has been added to this questions e.g. for respondents who have nothing to compare to.

18. Using your video conferencing tool as a teacher, which of the following options would you say is true?
I didn't mark any of them but there was no option to say I don't do any AND I am a teacher. I would even say the opposite is the case where I am more likely to ask students to turn their cameras on during a lecture to create a better presence in the Zoom room.

Response: Another option, stating "none of the above" is now added.

20. If you have the chance to select the video conferencing tool, which of the following would be true?
I guess all of the environmental questions suggest that we have thought about or have a quantitative understanding of the environmental impacts of digital teaching. I have heard that turning the camera off reduces energy consumption, but have no idea to what level or how it compares to other alternatives (like students physically moving themselves to a classroom). My assumption is that it could have a high relative impact on the Zoom session to have cameras off given how much larger image data is relative to audio, but that it is very small compared to transportation. So when it comes to selecting a tool, I guess I would consider these aspects if they were quantified, but I don't think it would be such a huge driver over other aspects of what the tool should do.

Response: The Tool is intended for self-evaluation and for making the respondents aware of options which may be better from sustainability point of view. The reports prepared as part of Results 2 would be the material the colleague is asking for for learning more.

25. When you use the platform, how large share of the students in the course are typically attending?
This could be read a few different ways. If I do an IRL lecture and have the Zoom room open, then usually around 50% of the attendees are in Zoom and 50% IRL. Usually 75-80% of all students attend, so then you could also say that 40% of all students in the class join IRL, 40% in Zoom, and 20% don't show to that session. If the lecture is given only in Zoom, then I still usually see around 75-80% attendance.

Response: This question has been re-formulated to clarify what was meant.

27. When you use the platform, how large share of the students are giving feedback, e.g. by asking questions?
This could be read a few ways, and I read it as the share of students on the platform giving feedback, not the share of students in the class. This ratio varies a lot by class so is hard to generalize. It is not uncommon to have around 10-15 active students in any given course, but if you have 30 students in the room the participation rate is much higher than if there are 100.

Response: This question has also been re-formulated as it was obviously not clear.

Now I've submitted and find it funny that my responses are scored. It is not clear to me what the score is supposed to represent. Apparently I did poorly, scoring 12/43 = 28%, but I lost points for things that don't really matter or are out of my control. Perhaps this points thing is not relevant to anything, but if that were the case why show it? I guess I leave the survey feeling confused and a little bit shamed for not thinking about the energy consumption of Zoom.

Response: A comment has been added at the end of the Tool explaining about the score and that the tool is mainly for self-evaluation. By doing the survey again later, the respondent can compare his or her development.

Person 7

The Tool in my opinion was not so good. It seems to be designed to clamp down on the respondents, and all alternatives are extremely one-sided. Q18 is the most problematic. A lot of statements with exclamation marks and all are obviously to point the respondent in the "right" direction. Similar questions follow.

Response: One of the purposes of the Tool was to nudge the respondents towards more sustainable behavior and use of the platforms. It is unavoidable that some respondents will be offended.

Then you get a rating, about what? If I get a rating I also would like to have an explanation why and perhaps a question if I want more facts about e.g. environmental impact or digital tools.

Response: A comment has been added at the end of the Tool to explain the rating. As suggested, links to sources with more facts about sustainability issues related to distance education have been included.

Nowhere was mentioned the alternative energy use by reduced travelling. Probably a student can be sitting in front of the screen quiet long before the energy use exceeds that connected to travel, food, heating required if he/she travels to participate in the lecture IRL.

Response: Comparison to travel has not been within the scope of the plan for the Tool.

Appendices

Appendix 1: Evaluation of the responses of version 1 of the Tool

At the link below, you can find the raw responses that were given to our questionnaire in the Surveymonkey platform.

https://drive.google.com/file/d/1vlba2XbL6Px9ZP_L-y36oLIZiPwfS47L/view?usp=drive_link

Appendix 2: Final version of the Tool

At the link below, you can find the final structure of the evaluation questionnaire.

https://drive.google.com/file/d/1vXzq1Uqh-qTKGA_ASxImgkFNrWHlGhuQ/view?usp=drive_link