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DIGITAL RESPONSIBILITY INSIGHTS FROM A CROSS-CULTURAL DESIGN THINKING WORKSHOP FOR CREATIVITY

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Abstract. To be digitally responsible, one should be aware of the current issues in the digital world; therefore, raising awareness on digital responsibility and data privacy is important in the public and private sectors. This study aimed to raise awareness on digital responsibility and help students understand the importance of utilizing the design thinking process for generating creative ideas. The authors facilitated a design thinking workshop where 62 students from different cultural backgrounds (Korean and Swiss) and majors collaboratively explored data privacy issues and presented their novel, creative solutions. The data gathered from observations and interviews were analyzed using qualitative content analysis. These students of the digital age developed remarkable ones, such as keeping data safe from social networking services and protecting voice data from being recorded by a third party. The cross-cultural, interdisciplinary team rapidly implemented their creative and globally applicable solutions with visually feasible, diagrammed prototypes, which is an effective tool of the design thinking process. The article demonstrates how design thinking techniques could be applied in university classes and could inspire teachers to use the five stages of design thinking in their teaching.

Keywords: creativity, data privacy, design thinking, digital responsibility, interdisciplinary design education, rapid prototyping.

Introduction

Design thinking (DT) is a powerful, effective tool in promoting creativity. We conducted a workshop on digital responsibility and information security. The participating university students applied the DT process to present a solution to these social problems of the current era of technological advancement. This topic was also expected to motivate students' interest, especially those of the digital generation. The advancement of digital technology has enabled a variety of systems with different capabilities. However, with this unprecedented power,

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ethical dilemmas have arisen; for example, smart devices continuously record data (Lobschat et al., 2021), citizens' online activities are monitored and tracked, and corporations sell users' personal data for commercial benefit (Flyverbom et al., 2019). Data breaches – accessing data repositories without the authorized consent of the data owners – are another ongoing issue (Srinivasan, 2015). It has become almost impossible to perform daily activities without using digital technologies; therefore, businesses and consumers increasingly lack realistic options to lead their daily lives without digital technologies or to avoid interconnected devices tracking their behaviors (Lobschat et al., 2021). A fundamental problem brought about by these technological advances is that the internal workings of the Internet and other digital technologies leave much larger data paths than most people expect, some of which more companies can access than most people expect. A vast amount of personally identifiable user information is shared online, such as people's addresses, mobile phone numbers, dates of birth, user identifiers, and passwords, and can thus be "stolen" (Srinivasan, 2015). Rainie et al. (2013) conducted a survey on "anonymity, privacy, and security online" and found that 68% of Internet users thought that current laws are deficient in protecting people's privacy online. This study clearly showed that people desired control over their information. Indeed, the number of Internet users worried about their personal information being collected online is growing; 86% of Internet users try to avoid being observed and to minimize the visibility of their digital footprints (Rainie et al., 2013).

We conducted a workshop to determine whether students could come up with more creative ideas if they worked in cross-cultural teams to discuss issues while applying the DT methodology. One co-instructor of the workshop was a professor of information systems at the University of Geneva (UG) in Switzerland and an expert in the fields of digital policy management, information security, and digital rights management; and the other was a professor of culture and design management (CDM) at the Yonsei University (YU) in South Korea (SK), who specialized in DT. Based on their specialties, the workshop topic was chosen as digital responsibility and information security. The DT methodology provided the students with a discussion structure.

Based on this background, the authors devised the research questions below:

- Research question 1: What are the outcomes of DT related to digital responsibility?;
- Research question 2: What problems and solutions related to digital responsibility do students define?

This study aimed to investigate the collaborative work processes of students from SK and Switzerland and offer them the opportunity to use DT for generating creative ideas. The findings provide insights into how the participating students perceived the global issues of digital responsibility and how they collaborated with each other to find solutions. Moreover, we examined whether cross-cultural collaboration enhanced their creativity, and we present their ideas and solutions to digital-responsibility problems to show not only the workshop's outcomes but also values and concerns of students of the digital age. We used five stages of DT of the Hasso Plattner Institute of Design (HPID) (2021), Stanford University, California, United States to catalyze innovative ideas, because the DT methodology enables the creation of innovative ideas to tackle complex problems.

1. Literature review

This section discusses the importance of digital responsibility and its role in organizations, the meaning of corporate digital responsibility (CDR), and the reasons for applying DT to seek joint creative solutions regarding online privacy and to foster creative ideation in cross-cultural teams.

1.1. Digital rights and responsibilities, and corporate digital responsibility

According to Andersen (2020), while companies address ecological, social, and consumer issues with corporate social responsibility (CSR), CDR complements corporate responsibility and considers the social impact of a company's digital products and services. CDR is both a strategy and execution tool used by companies to promote positive perspectives on digitalization. Therefore, CDR is an essential prerequisite for companies to successfully operate under the conditions of digitalization. Furthermore, there are advantages and disadvantages to the development of digitalization; "datafication", for instance, is the mass of digital traces that people leave behind in online spaces, data patterns, and user-generated content that are commercialized and monetized (Flyverbom et al., 2019). Additionally, photos that have been uploaded to social networking services (SNSs) are not necessarily kept private. Comments are searchable, and hidden posts can still be found on servers. Essentially, nothing is private on the Internet (Singh, 2019). According to Lobschat et al. (2021, p. 2), CDR requires users of digital technologies or data processing (technology companies, individual developers and designers, and all corporate actors) to be aware that the code they produce and data they collect and process "inherently create an ethical responsibility for them". Lobschat et al. (2021) suggested that digital technology is not only a linear development on previous technology but also a leap forward that brings new, concrete challenges to corporations' ethical behaviors that transcend CSR. Moreover, Wade (2020) defined CDR as a set of practices and behaviors that help a company use data and digital technologies in a socially, economically, technologically, and environmentally responsible manner. CDR became more crucial with rapid technological changes, as new questions arose for companies about their social responsibilities (ConPolicy: Institut für Verbraucherpolitik, 2021). Many companies strive to comply with environmental and social standards; however, CDR is still in its early stages of development. CDR benefits customers, citizens, and companies; therefore, society must participate in technological progress that questions its development and limits its use, if necessary. CDR enables companies to combine the complex requirements of digitalization and user expectations of data protection, security, and transparency such that users can trust and benefit from innovative technological applications (Andersen, 2020). It also provides a mechanism by which companies can heighten social trust in the use of data, algorithms, and bots (Osburg, 2017). Organizations should use ethical considerations as criteria for software selection and perform the corresponding due diligence. The source of and the conditions under which the data are created must be considered when working with secondary data; it must be asked whether users had fair opportunities to consent to the collection and use of their data (Lobschat et al., 2021). The author of this study conducted a workshop on digital responsibility and determined that the DT methodology was an appropriate instrument to facilitate the creation of digital-responsibility solutions. Section 1.2. below describes DT in greater detail.

1.2. The design thinking process

The DT methodology is a solution-based approach to solving problems (T. Kelley & D. Kelley, 2013), aiding "teams to actively leverage their differences in positive ways" (Liedtka, 2015). In the past, design was considered as a driver of economic growth and competitive advantage; however, contemporary discourse on design has gravitated toward social and environmental responsibility (Ceschin & Gaziulusoy, 2016; Findeli, 2001). DT enlivens the active interplay between problems and solutions (Dorst & Cross, 2001) and plays a central role in modeling social inclusion (Stegall, 2006). Furthermore, it is an approach to "tackling complex socio-ecological problems" (Buhl et al., 2019). Companies increasingly apply DT, because it facilitates innovative ideas and solutions (Beyhl & Giese, 2016). As Brown (2008) stated, DT is a speedy approach that can be applied to discover the best ideas and actionable solutions when a "human-centered, creative, iterative, and practical approach" is required. The HPID, commonly known as the d.school, describes DT as a five-stage process (*i.e.*, empathize, define, ideate, prototype, and test). Importantly, these stages are not always sequential. "Empathy is the foundation of a human-centered design process" (The d.school. Hasso Plattner Institute of Design at Stanford, 2021), and observation, engagement, and immersion are necessary steps of empathy. A "human-centered mindset" and understanding the needs of students are also critical for empathy. Brown (2008) suggested that, by empathizing, DT strengthens teamwork and motivation. The defining stage then synthesizes the results of this first stage (empathizing) and develops a deeper understanding of user needs. To be a successful solution, one must understand the critical challenges that must be addressed as well as the actionable insights. The ideation stage generates a diverse set of radical design alternatives, and prototyping gives ideas visual form (visualization), thereby building a better understanding thereof. Useful feedback and unexpected insights can be drawn in the testing stage where solutions can be refined (The d.school. Hasso Plattner Institute of Design at Stanford, 2021). Hence, DT was applied in our workshop, because it is a powerful tool that helps students from different cultures gain insights and collaboratively seek workable solutions.

1.3. Creativity and teamwork in cross-cultural groups

Csikszentmihalyi (2013, p. 114) explained that the creative process "begins with the goal of solving a problem that is given to the person by someone else or is suggested by the state of the art in the domain", that is, creativity is only possible when we can focus on a problem. Creativity plays a role in many fields, such as education, business, and the sciences, and in problem-solving and learning (Runco, 2014). Ka-yee Leung et al. (2008) believed that the expansion of multicultural experiences is positively related to both creative performance and cognitive processes, which enhance creativity. The term *multicultural experience* denotes all direct and indirect experiences of interacting with and encountering people of foreign cultures. Paulus et al. (2016) examined the role of cultural diversity and creativity in teams and claimed that teams comprising members of diverse cultural experiences and backgrounds produce a wider range of ideas to share. They also referred to Blot et al. (2003) who suggested that people have more unique ideas to share with their group and may be more creative if they have different cultural and linguistic backgrounds. According to Paulus et al. (2016),

ideas shared within groups can stimulate additional ideas through associative processes; and since collaboration enhances creativity, diverse groups tend to generate more creative ideas. The process of generating ideas requires group members to search their memories for relevant knowledge (Paulus et al., 2016; Shin et al., 2012). Knowledge in certain categories may be easily accessible on a particular topic, whereas other categories may be less developed (Paulus et al., 2016). In contrast, when an individual is exposed to only one culture, that culture's learned routines and conventional knowledge can limit the range of creative conception. Immersion in a foreign environment is an important source of inspiration, a "multicultural muse" for creative craft (Ka-yee Leung et al., 2008). Therefore, sharing ideas in a cross-cultural team can enable team members to more effectively use their knowledge about a particular problem. In addition, team members can create ideas by combining or modifying each other's ideas, likely raising the number of generated ideas and their novelty (Paulus et al., 2016).

Given this background, we applied DT in a workshop for its synergistic benefits of ideation in cross-cultural groups. Furthermore, DT helps students get to know each other and build empathy (The d.school. Hasso Plattner Institute of Design at Stanford, 2021), as the first step of DT is to "empathize". Another advantage of DT is accelerating the generation of creative insights and prototyping, enabling the students to quickly build prototypes.

2. Materials and research methodology

The data for this study comes from a collaborative course held jointly by the Information System Department of the UG in Switzerland and the CDM and Business Departments (BDs) of the YU in SK. Swiss graduate students came to SK to collaborate with undergraduate Korean students. English was the official language of the workshop; however, there was no language barrier between the students, because the CDM and BDs are a part of an international college at the YU. First, students were provided a context for framing design problems (Schön, 1984). Second, they reflected on the concerns of tackling SNS security problems regarding privacy by using sustainable guidelines to protect human rights through the DT workshop. Third, we applied Erlingsson's and Brysiewicz's (2017) procedure for analyzing qualitative data to analyze the participants' responses. This approach draws on Hsieh's and Shannon's (2005) traditional content analysis, Elo's and Kyngäs' (2008) induced content analysis, and Graneheim's and Lundman's (2004) qualitative content analysis of interview text. To specify meaning units, interview content is interpreted as presented, and key text is selected for coding. Then, codes are assigned to categories, and the abbreviated meaning units are labelled. Depending on the purpose of the study and the quality of collected data, categories or themes are selected as the highest level of abstraction when reporting results.

2.1. Workshop process and timeline

During the study, the students were divided into teams, and they used DT to work on assignments in five phases (Figure 1). Each team included five Korean students (design majors), three Swiss students (information studies majors), and one Korean business major from the

Figure 1. The design thinking process, and the timeline of the workshop (source: created by authors)

BD. Professors from both the UG and the YU instructed and supported the groups. The goal was to frame a problem in the SNS and present a solution to it. Table 1 breaks down the five stages of the DT process used in the workshop.

In the first stage, "empathize", students researched the issue and became acquainted with one another, emphasizing their concerns and viewing the problem from each other's perspectives. In the second stage, "define", students unpacked the findings from the first stage as needs and insights. In the third stage, "ideate", students generated radical design alternatives and explored various solutions and ideas. In the fourth stage, "prototype", the students

Table 1. The process applied in the workshop (source: created by authors)

Five stages of the DT process	Duration	Description
1. Empathize	30 minutes	Gaining an empathetic understanding of the problem that needs to be solved (here: digital responsibility), typically through research (The d.school. Hasso Plattner Institute of Design at Stanford, 2021).
2. Define	30 minutes	Accumulating the information created and gathered in the first stage and analyzing and synthesizing observations to define the core problems the team has identified (The d.school. Hasso Plattner Institute of Design at Stanford, 2021).
3. Ideate	30 minutes	Thinking outside the box and generating ideas based on the solid background of knowledge from the first two stages, seeking alternative ways of viewing the problem, and identifying innovative solutions to the problem (The d.school. Hasso Plattner Institute of Design at Stanford, 2021).
4. Prototype	60 minutes	Storyboarding and prototyping the best possible solutions for problems identified in the first three stages (The d.school. Hasso Plattner Institute of Design at Stanford, 2021).
5. Test	30 minutes	Gathering feedback and refining solutions if necessary (The d.school. Hasso Plattner Institute of Design at Stanford, 2021).

finalized their concepts and presented their prototypes. The final stage, "test", allowed students to gather feedback and refine their solutions. After these five stages, students had one hour each to present their results. In the meantime, educators supported student-centered learning experiences.

2.2. Participants

The participants comprised 62 students majoring in design, business, and information systems; 22 Swiss students from the UG, majoring in information systems; 30 Korean students from the YU majoring in CDM; and 10 Korean students from the YU, majoring business. The study involved a four-hour intensive course focusing on multidisciplinary teamwork in solving SNS and digital-responsibility problems with DT. All the participants were in the same age group, and the authors anticipated that working in multidisciplinary teams on a global scale would provide synergy and spark. Figure 2 is a picture of students focusing on the workshop instructions.

Figure 2. Students focusing on the workshop instructions (source: photo by Hyun-Kyung Lee)

2.3. Content analysis

Following Erlingsson's and Brysiewicz's (2017) procedure, the content analysis identified nine categories within three larger themes as displayed in Table 2.

Table 2. Results of the qualitative content analysis (source: created by authors)

Theme	Category	Code	Meaning units (the responses of the students)
Students' reactions to the topic	Awareness	I should give more attention to the ethics of technology.	"I realized that I should give more attention to the ethics of technology rather than just being attracted by the rapid development".
	Realization	Digital responsibility is a non-profession area, not having much knowledge.	"Digital responsibility was a familiar yet non-professional area for me. I didn't have much knowledge in this subject, and I've definitely learned more about this area thorough the workshop".
	Interest	Interesting topic.	"It indeed is an interesting and important topic to work on and to think about".

End of Table 2

Theme	Category	Code	Meaning units (the responses of the students)
Advantages of applying the design thinking process	Learning the five stages of design thinking	Applying design thinking helped the working process.	"Professors have given us the exact same amount of time for each stage of design thinking, where we had to move on to the next phase regardless of our working process"; "It took some time to adapt to different working styles since the method used in this discussion was freely writing down anything that came to mind, but it did help to narrow it down to a more tangible and logical idea".
	Empathy	Empathizing with others.	"I could wear someone else's shoes about issues on social networking service".
	Rapid prototyping	Producing ideas more quickly, and rapid prototyping.	"This method has definitely helped us to come up with more ideas quickly and to get the flow of thoughts more easily"; "After participating in this workshop, our group had a feasible prototype to show which was made in a very short period of time".
Strengths of working as a cross-cultural group	Discussion and communication with other students	Effectively communicating with others.	"Through constant discussion and debate, I could also develop my communication skills, which includes putting ideas and thoughts into words to effectively communicate with others in a collective group"; "As a collective group, we tossed around ideas in no particular order"; "Working as a team encouraged and enhanced the process"; "It was very surprising to see how all the students, who have never met before, collaborate and freely communicate their ideas".
	Cultural diversity	Hearing diverse opinions based on different cultural backgrounds (multicultural, interdisciplinary).	"It was interesting to hear diverse opinions from different participants and to have discussions on different online cultures based on differing national situations".
	Interaction	Discussion with international students led to more creative ideas.	"Interacting and discussing with other members from different cultures and with different ideas seemed to facilitate the flow and exchange of more creative ideas"; "Diversity is a plus point and can have a huge positive effect in sharing and finding creative ideas".

2.3.1. Students' reactions to the topic

As displayed in the content analysis (Table 2), the participants were exposed to technology and were aware of digital rights and responsibilities: "I should give more attention to the ethics of technology". Therefore, they could describe the current crucial issues and problems in the digital world and suggest unique, efficient solutions. After the workshop, students were visibly concerned about the use of digital technology, and they discussed what must be changed to build a healthy digital culture with trustworthy, sustainable digital technologies.

2.3.2. Advantages of applying the design thinking process

The second theme related to the advantages of using the DT process. Among the five stages of DT, two were particularly powerful in the workshop: "empathize" and "prototype". Both have advantages in enabling students to empathize with others, understand people's needs, and solve problems: "It really helped us to come up with more ideas quickly and make prototypes fast". In modern society, where the online world is invisible and pervasive, many systems require modification to protect human rights and digital footprints. The DT process is efficient in solving these problems.

2.3.3. Strengths of working as a cross-cultural group

The final theme concerned co-working as an interdisciplinary and cross-cultural team. As one student said, "It really helped hearing diverse opinions based on different cultural backgrounds". It was effective in terms of enriching the overall skills related to communication and ideation. They could share different mindsets and thinking styles, and collaboration with other students from different majors and diverse cultural backgrounds ultimately led to creative discussions and solutions. We found that cross-cultural teams produce a wider range of ideas; different cultural and linguistic backgrounds can expand creative conception, whereas a mono-culture can limit such conceptions given that culture's conventional routines and knowledge.

3. Findings

DT aims to improve or transmute the world (Simon, 1969) and entails a continuous dialogue between thinking and doing (Schön, 1984). Our findings suggest that engaging with the world and its complexities with reciprocal trust among team members generates global solutions that serve a wider audience. As such, our findings serve as the basis of a framework that illustrates how different pedagogical structures can be utilized to help students nurture a sense of cross-cultural thinking as they develop design capabilities and find complex solutions. Communicating interdisciplinary knowledge was also perceived as a factor influencing the development of design solutions.

Overall, the findings promote an understanding of systems, people, and problems and how they interconnect in society. While engaging in DT, some students mentioned how their proposed solutions challenged the societal preconceptions and expectations of fellow

students. The study itself was a great opportunity for students to critically analyze and emphasize contemporary issues. Students produced brilliant ideas, such as re-designing corporate data privacy policy since most users do not actually read it before clicking the "agree" button. Students thought that user awareness of data collection was important; therefore, they wanted to include illustrations and videos as parts of privacy policies and create a quiz section to make sure that users understood the terms and conditions. Another idea was to create a publicly available service that detects facial characteristics and uses artificial intelligence to alert individuals to sign-on activity. Besides these ideas, the following sections present three outstanding cases among the concepts developed by the participants.

3.1. Case 1: *Muffler*

Team 1 reported concerns about data privacy and audio features in smartphones. Recent trending posts on social media have shown that simply mentioning certain keywords while a computer or smartphone is turned on results in users receiving targeted advertisements based on those audio inputs. This common occurrence is processed by the audio data collected through users' phones. Many web and mobile services and large social media services, such as *Instagram*, collect user data from audio surveillance and gather personalized information. For many people, this violates user privacy and security and is a major concern for those who were unaware of this passive tracking method and already agreed to give corporations access to their microphones. Being aware and conscious of applications collecting audio data would improve users' sense of security. Team 1 generated ideas to prevent and safeguard against audio data collection. Their idea was based on blocking the audio-input function of smartphones. Similar to the workings of a virtual private network, the user would open the application and manually turn off the audio-input function by clicking off a microphone button as shown in Figure 3. This would completely disable microphone access. Quick settings and flag icons would also be provided for easy use. The students proposed a paid application called *Muffler* – inspired by the muffler of a car – to muffle microphones whenever the user wants. *Muffler* would not only notify the users about which and when applications record their voices but also allow them to control how applications access their audio (Figure 3). It would synchronize with the phone settings to disable or enable microphone access for each application or for all applications with just one click. The application would increase the overall usage of digital privacy services. By suggesting tips beyond the application functionality, the application would also gain users' trust, which is crucial in the field of cyber security. As a result, *Muffler* would enhance privacy by preventing applications from gathering microphone data without the users' intentional consent.

The key functions of *Muffler* (Figure 3) are as follows:

Lock screen: Users are notified when an application is recording.

Settings #1–1: Users can control which applications have and do not have permission to record;

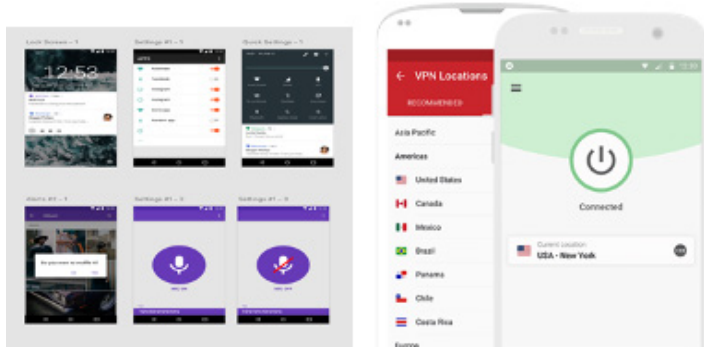

Figure 3. *Muffler*: a privacy application for manually turning off the audio-input function (source: created by authors)

Settings #2–1: "Do you want to muffle it?" means "Would you like to turn the microphone off?";

Settings #1–2: This is when the microphone is turned on;

Settings #1–3: This is when the microphone is turned off.

3.2. Case 2: *Comment Checker*

Digital responsibility in writing comments (cyberbullying) generates ideas to reduce the frequency of aggressive comments. Team 3 proposed a technology to encourage users to rethink their commenting habits. The purpose of this technology is to build a healthier Internet culture by reducing the number of aggressive comments that can have disastrous consequences. The students were directly responding to a Korean celebrity's recent suicide attempt after a vicious case of cyberbullying.

At the defining stage, the students intensively discussed the causes, effects, and realities of cyberbullying in SK. Koreans are comparatively insensitive to personal information matters; however, freedom of expression should always be considered when dealing with cyber problems. While this team considered many options, they focused on the balance between free speech rights and regulations. As their solution could face criticism that it violated the right to free speech, they crafted a service designed to manipulate media technology to have Internet users voluntarily engage in healthy commenting practices rather than forcing them to use non-abrasive words. Simultaneously, the usage of the service would cultivate the public's sense of responsibility for a positive online culture and the self-regulation of online behavior. The expected impact of the service was to establish user habits that support peaceful online communication. To that end, they proposed two technologies. First, an add-on would show a list of suggested alternatives when aggressive words or phrases were detected.

This technology is related to the technology already used by *Grammarly*, an online program that corrects writing mistakes. The service would cover tone, connotation, and word usage and provide alternative expressions for aggressive words in a list of recommendations next to the draft text. Users would be able to choose whether to use the recommendations.

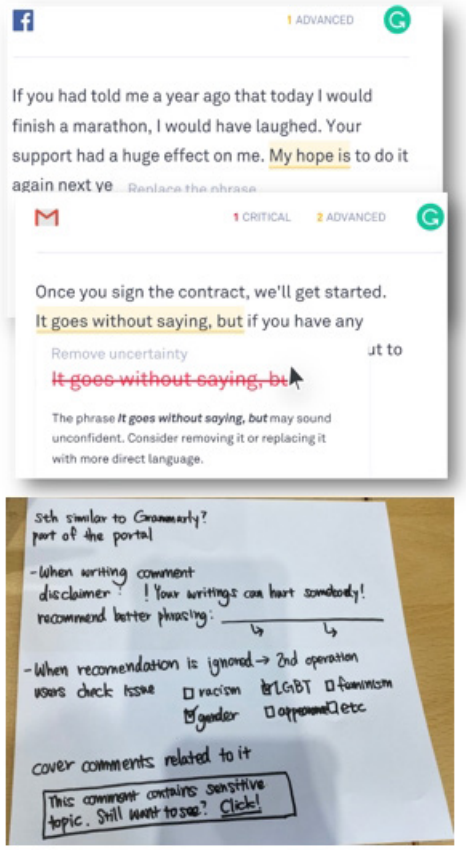

Figure 4. *Grammarly* and the *Comment Checker* (source: created by authors)

Such a feature would allow people to be more cautious in their word choices. Figure 4 shows the functions of *Grammarly* and the proposed *Comment Checker*.

Second, warning signs would identify aggressive comments according to their own criteria to easily filter comments to be shown (or not). This would moderate the visibility of aggressive comments for users who could use a portal to pre-select sensitive topics, such as racism, lesbian, gay, bisexual, and transgender+ issues, and feminism. The program would automatically choose comments that include such topics and evaluate them. If the user were to choose to read aggressive comments hidden with a warning sign, they could read a filtered version of it. If the user were not offended by the comment and still wanted to see the original, the user could click the filtered one to see the original comment. In summary, the students proposed two filters for aggressive comments: one that would completely hide potentially aggressive comments and another that would offer edited versions of potentially aggressive comments. The program would still have to manage information ethics and its lack of a solution to the basic problem of preventing hate speech.

3.3. Case 3: *Shield*

Team 5 discussed the issue of plagiarism and intellectual property protection as major problems in the field of digital responsibility. A breach of copyright occurs when someone steals ideas, writing, music, or other intellectual property on the Internet and appropriates authorship without authorized consent or acknowledgment of the original creator. As multimedia technology develops, it becomes easier to access creative works on the Internet and to violate implicit copyright protections. Privacy is also a significant issue. In contemporary society, many people use SNSs, such as *Instagram*, *Facebook*, and *Snapchat*, to freely express themselves; however, these services risk malicious actors acquiring personally identifiable information through "skimming". A primary concern of uploading posts on *Instagram*, for example, is the possibility of photos and videos being saved by an anonymous user, which can

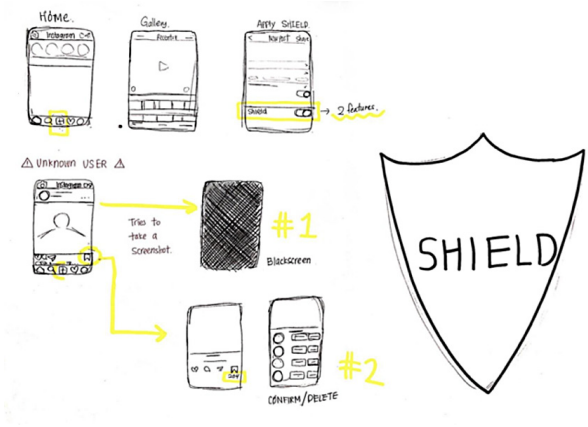

Figure 5. *Shield* application: protecting individual privacy on social networking sites (source: created by authors)

seriously violate the original uploader's portrait rights. Furthermore, if the captured photos are spread to other SNS platforms, the possibility of irreversible violations exponentially increases.

Considering privacy concerns, Team 5 devised a method to offer privacy assurances to original uploaders and to avoid leaving that responsibility to social networking companies. The *Shield* application would allow users to protect their privacy on SNS platforms. Team 5 drafted the slogan, "It is time to *Shield* our privacy!". The main function of the application is to convert screenshots to black screens: when an unknown user tries to take a screenshot of another user's photo, the photo would be saved as a black screenshot (Figure 5). This guarantees more protection than a simple notification that is sent when someone takes a screenshot of a message or photo. *Shield* would simultaneously provide an alarm and moderate protection. Moreover, users would have the option to simply not activate *Shield* and allow posts to be completely public; this might be appropriate for posts of celebrities and influencers who want content to go viral. Before posting content, users could slide a toggle button right or left to activate or deactivate *Shield*, respectively; once activated, it would prevent other users from taking screenshots of the post unless the uploader granted their request.

In the three cases above, the *Muffler* team proposed turning off the audio-input function to strengthen user privacy and to have control over applications that access users' microphones. The *Comment Checker* team focused on digital responsibility in writing comments and proposed a technology to reduce aggressive comments to build a healthier Internet culture. First, they considered simply sorting and moving offensive comments to a "bad comments section" that could also be blocked. During the prototyping phase, they suggested another system to overcome the limitations of the first idea: automatically changing offensive words in comments and recommending alternative phrases. Finally, the third team proposed *Shield* to protect user privacy. To prevent the misuse and unauthorized dissemination of uploaded photos and videos, the team thought of converting screenshots into black images whenever an anonymous user tried to screenshot social media content.

Conclusions

Students from different countries gathered and discussed topics related to data privacy and digital responsibility, tried to define topical problems, and suggested possible solutions to them by applying DT. They discussed the uncomfortable fact that personal data can be collected by businesses and unknown third parties without our awareness or consent, and they produced creative ideas to secure personal data from third parties, even on a SNS, as many users are unaware of the fact that their private information can be leaked online. The answer to the first research question *What are the outcomes of DT related to digital responsibility?* is that students' creativity was much more increased after particular facilitating stages of DT process. The answer to the second research question *What problems and solutions related to digital responsibility do students define?* is that students were visibly concerned about the use of digital technology, and they defined what must be changed to build a healthy digital culture with trustworthy, sustainable digital technologies after the workshop. We could conclude that working as an interdisciplinary team was effective in terms of sharing different mindsets and thinking styles, and collaboration with students from different majors and cultural backgrounds led to unique discussions and solutions.

Per the content analysis of students' comments, the groups took time to adjust and adapt to the different working styles of each member, which included cross-cultural differences that obstructed discussion and ideation. However, they empathized with other team members' ideas and collaborated using DT, which enabled them to narrow their focus to more tangible and empathetically. Students from different backgrounds could speak on the discussion topics based on their own experiences. They developed three application concepts: *Muffler*, *Comment Checker*, and *Shield*. Based on these three cases and the content analysis, we assert the following two positive effects of using DT in this study:

1. Students' creativity was enhanced by DT, as it helped them brainstorm and produce novel ideas. For example, one team named their prototype *Muffler* by analogizing its functioning to the muffler of a car, and another team named theirs *Shield*, which conveys the impression of protection. The fourth stage of the DT process, rapid prototyping, enabled the students to visually share ideas so that they could receive feedback from each other and iterate on their ideas to develop feasible prototypes;
2. When each student's culturally distinct knowledge and ideas were combined and DT was applied to foster creativity, cross-cultural synergy was created. Exposure to different cultures and backgrounds stimulated the development of more creative ideas.

As SNSs and other media have great influence over young people, we tried to raise awareness about global cyber security and digital-responsibility issues in this workshop and observe how students collaborated on cross-cultural, interdisciplinary teams to produce creative solutions and propose practical, easily applicable prototypes.

Simultaneously, this study has a limitation; the findings are not sufficient to be generalized, because the data was collected from specific participants and in a short amount of time. Thus, future studies should conduct qualitative research regarding efficient and intangible prototyping in other areas.

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