Digital Self-Control in Danish High Schools: A Pilot Intervention Study

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To support learning, students need to be able to control their time and attention when using digital devices like smartphones and laptops for study-related tasks. However, self-regulation skills are rarely discussed as a basic part of digital literacy. Research suggests that being able to adjust digital environments to suit personal needs is essential for self-regulation, and typically requires use of digital self-control tools (DSCTs) such as distraction blocking and productivity timers. We explored how students in Danish high schools view ideal device use, and how DSCTs might help them achieve their desired use. In six pilot deployments of a workshop intervention in Danish high schools (41 participants), students reflected on their challenges and goals, and explored a curated selection of DSCTs. Ideal use related to staying focused and feeling in control, and managing when and how much they used devices. Participants said the workshop provided good solutions to their challenges, and those who applied DSCTs after the workshop reported a large increase in digital self-control.

CCS Concepts: • **Human-centered computing → Field studies**; **User studies**; **Empirical studies in HCI**.

Additional Key Words and Phrases: Attention, digital well-being, distraction, self-control, self-regulation, high schools

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1 INTRODUCTION

Over the past decade, digital devices like smartphones and laptops have become ubiquitous in the classroom [3, 8, 9]. In class, however, students frequently use their devices for off-task purposes (e.g., social media, watching videos [17]), which one recent study of US university students suggested accounted for about 20% of class time on average [26]. As a result, there are debates at all educational levels about how to ensure that digital devices support learning rather than distract students [2, 13, 15, 27, 33]. In Denmark, high schools are legally obliged to support students' 'digital literacy' [30]. However, curricula typically focus on information search and disinformation, as well as ethical behaviour online (e.g., cyberbullying), with little attention given to the ability to self-regulate device use [14].

Students' ability to control their time and attention in digital environments has been argued to be foundational to digital literacy [21]. Indeed, many students develop their own self-regulation strategies, such as closing their laptops to avoid visual distraction, or using digital tools that block access to distracting apps partly or fully [1, 12]. How might training in 'digital self-control'[1] be integrated in digital literacy curricula, and what practical skills would it include?

[1]We will use the term 'digital self-control' to refer to students' ability to self-regulate use of digital devices. That ability might be improved by use of DSCTs that e.g., help students remember to stay mindful and control themselves (e.g., via pop-ups that remind them of their usage goals) or alternatively

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(a) Reflection phase. The first of the four question prompts.

(b) Exploration phase. One participant's sorting of strategy cards.

Fig. 1. Illustration of workshop materials. Using the whiteboard tool Miro, participants respond to four questions on challenges and goals for digital device use (1a). Afterwards, they sort 14 cards that represent different strategies to support self-regulation, from productivity timers to browser extensions that hide distracting website elements (1b).

Research into 'digital self-control tools' (DSCTs) suggest one approach: over the past decade, a growing number of studies have shown that modifying digital environments to suit people's needs, for example by blocking or delaying access to distracting apps or websites, providing goal reminders, or adding rewards for intended use, can help people change their behaviour and feel more in control [19, 20, 32]. Recent work with university students in the UK further suggests that supporting students in reflecting on their challenges and goals around digital device use, and support subsequent self-experimentation with relevant DSCTs, can effectively help support self-regulation of device use [24].

Our pilot study extended this previous work, focusing on the context of high schools in Denmark, where widespread student challenges with digital distraction have already been demonstrated [1, 3]. Whereas the previous work focused on university students who actively sought out the intervention, our current study collaborated with high school teachers to offer the workshop to all students in a class. We expected this approach to be closer to how digital self-control might be integrated in digital literacy curricula. Our study was guided by the following research questions:

- RQ1: What do Danish high school students think ideal use of their devices would look like?
- RQ2: Can a workshop that combines reflection on personal goals for change with exploration of relevant DSCTs improve digital self-control?

2 METHODS

2.1 Materials

2.1.1 Workshop. The design of the workshop intervention was inspired by research in personal informatics, N-of-1 studies, and behaviour change [7, 18, 22, 23, 28]. The workshop had three parts: *reflect*, *explore*, and *commit*, and lasted about 1 hour. Participants carried out interactive workshop tasks using the whiteboard tool Miro (https://miro.com/). The study received ethical approval by the European Research Council, as part of continuous reviews of the ERC H2020 project in which the research was embedded.

Reflect The first part helped participants articulate actionable and realistic goals for their digital device use [6, 28]. Participants were encouraged to analyse their challenges in terms of *external triggers* in their digital environment (e.g., notifications or clickbait-filled recommender feeds), and *internal triggers* related to their own emotions or impulses

by DSCTs that reduce their need to control themselves in the first place, such as by removing potential distractions from their devices [reference removed for anonymous submission].

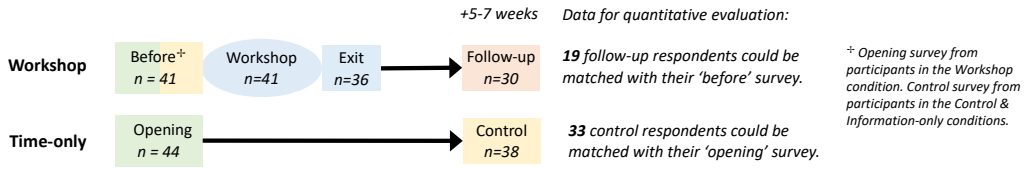

Fig. 2. Study design. We originally set out to pilot an experimental design where each class was assigned to one of three conditions. However, few students attended the workshop at the scheduled time (outside of school hours) in the treatment condition. Therefore, we aggregated before-and-after survey responses from all students who participated in a workshop, which we compared to responses from participants who had received no intervention when they filled in the control survey.

(e.g., feeling sad, anxious, or bored). On virtual post-its, they wrote down their thoughts in response to four reflection prompts [22]: (i) "What challenges do you experience around controlling use of your smartphone / tablet / computer?", (ii) "What external (e.g., notifications) and internal triggers (e.g., emotions) drive your challenges?", (iii) "What have you already tried to address your challenges? How did that go?", and (iv) "Imagine your use of digital technology is exactly as you want. What would that look like? (Be specific about context, time of day, apps...)".

Explore The second part provided specific, actionable options for how they might restructure their digital environments to better support their ideal use [7, 22]. A facilitator introduced four categories of DSCTs: *block or remove distractions* (e.g., blocking apps or using browser extensions to remove distracting website elements), *self-tracking* (e.g., visualising time spent, or using productivity timers), *goal reminders* (e.g., extensions that place to-do lists on new browser tabs), and *making usage goals more attractive* (e.g., apps that provide rewards for not using one's smartphone, or making the phone greyscale). Participants sorted 14 cards representing specific strategies within the categories, to indicate whether they had tried it, and whether it had been/might be useful for them (Figure 1b, [25]). Finally, they looked up how to apply the strategies they were most interested in, using the workshop website, which contained instructions for specific operating systems and browsers.

Commit The last part nudged participants to make specific and realistic plans for what they would try [18]. Participants were encouraged to choose 1 or 2 strategies, and wrote on a 'commitment card' on the Miro board how they would apply it (e.g., *"Put all my social media in a folder and turn off the red notification dots on app icons'* for the strategy 'Moving distractions out of sight')

2.1.2 Surveys. All surveys were deployed using a locally hosted version of the survey framework 'formr' [4, 5].

Opening Included basic demographics, devices used, challenges experienced, and the Brief Digital Self-Control Scale, which assesses ability to ignore unwanted digital distractions and urges across all of a person's digital devices (sample items: *"In the past week, my digital devices distracted me from my long-term goals"*, *"In the past week, my digital devices made it difficult for me to concentrate"* [24]). Respondents also self-estimated daily time spent and number of times they checked their phone, and provided corresponding numbers from Screen Time or Digital Wellbeing (if available).

Exit & reminder At the end of the workshop, participants indicated which strategies they would try, how confident they were that they will be helpful, and how useful and easy they found the workshop tasks. One week later, they were sent an email reminder of what they decided to try.

Follow-up / control (~5-7 weeks after previous survey) Participants again filled in the Brief Digital Self-Control Scale and self-estimated vs actual time spent / checks. If they had participated in a workshop, they indicated what strategies they ended up trying, how they had applied them, and how useful they were.

2.2 Participants & study design

Participants were students from four classes in a high school (*Egedal Gymnasium*), approximately 30km north west of Copenhagen, Denmark, and all were in their final year[2]. We visited all classes in person in early November 2021, where students signed up to participate and filled in the opening survey. We originally set out to pilot a controlled study design where each class was assigned to one of two conditions [3]. However, because few students attended the workshop at the scheduled time in the treatment condition, we had insufficient data to evaluate the results as an experimental design. Since participants in the control conditions also participated in a workshop, only after they had filled in a control survey, we aggregated before-and-after data from all students who had participated in a workshop. We compared those to responses from participants who had received no intervention when they filled in the control survey (see Figure 2). For how participant data was joined across surveys, and our analysis of workshop data, see Appendix A.

3 RESULTS

Across all participants (n=86), 92% were 18-23 years old, and 8% younger than 18. 64% identified as women and 35% as men (1 participant identified as non-binary). Everyone used a smartphone (92% iPhone, 8% Android), and nearly all (97%) also a laptop computer (78% Mac, 18% Windows, 4% Chromebook or 'other'). A smaller proportion used a desktop computer (19%), tablet (17%), and/or smartwatch (8%). For time spent see Appendix B. 88% of participants reported that their devices often made them less productive, and 28% that they negatively affected their mood or mental health. 30% found it 'very' or 'extremely' important to get better at handling their challenges, and 44% found it 'quite important'. For 52%, their challenges related only to smartphone use, and for 43% they related to **both** smartphone and computer use.

3.1 RQ1: What do Danish high school students think ideal use of their devices would look like?

Students' notions of ideal use were captured by four themes that mirrored their challenges (see Appendix C): two themes related to control (themes 1 and 2) and two to time management (3 and 4).

Theme 1: Being able to focus on an intended activity without digital distraction Most commonly, participants simply wanted to be able to stay focused without being distracted by their devices (mentioned by 49% of participants). This was often mentioned in relation to schoolwork (*"I am able to sit concentrated for several hours and do school work – so I don't have to spend days on it"*), but also in relation to social interactions (*"That I am able to control by myself when I use my phone, and not do it when I am doing schoolwork or spend time with others"*).

Theme 2: Not feeling controlled by one's devices Participants wanted to feel in control over how and when they used their devices (39%). Specifically, many wanted to feel comfortable with not checking their devices (*"[that] I don't feel an urge or pressure to check my phone"*) or being without them for some time (*"That I easily go without my phone for an entire day"*). Some wanted their digital environments to make it easier to stay in control, for example by filtering information better, so that only 'useful content' was available, or so they knew what notifications were important (*"That there was a special warning notification so that I knew when my family/friends wrote something important that I had to respond to"*).

Theme 3: Having clear boundaries around time and place of use Many wished that they were able to allocate specific times of day for specific use (27%). This often related to limiting use in the evening (e.g., *"Not using too much TikTok in the evening"*, *"I don't use my phone one hour before I go to bed"*), or in the morning (*"I don't use my phone as the*

[2]Third year for the three classes who were working towards the general academically-oriented 'gymnasie' degree; second year for one class working towards the shorter 'HF', or 'higher preparatory examination program'
[3]See the supplementary materials for a description and figure of the original experimental study design.

first thing when I get up"). Others wished they were able to dedicate specific times of day for school-related device use, or, conversely, for 'distracting' leisure use.

Theme 4: Limiting overall time spent Finally, some participants expressed a more general wish to limit time on their devices overall (21%). This was mentioned specifically in relation to the smartphone (*"I would avoid looking at my phone for more than 3 hours a day"*) and social media use (*"My use of especially TikTok, Snapchat, and Instagram would be less in general"*).

3.2 RQ2: Can a workshop that combines reflection on personal goals for change with exploration of relevant DSCTs improve digital self-control?

At the end of the workshop, participants indicated if they found good solutions to their challenges. On a scale from 1 (*not at all*) to 5 (*to large extent*), the modal response was '4' (3: 25%; 4: 56%; 5: 19%). Participants also indicated to what extent they thought their chosen strategies would help them make a positive change. On a 4-point Likert scale from "not at all" to "to a large extent", 9% selected "to a lesser extent", 74% "to a moderate extent", and 17% "to a large extent".

3.2.1 Strategies tried. Figure 3 summarises participants' descriptions in the follow-up of what they had tried, how useful it was, and whether they were still using it. The most commonly tried workshop strategies were **limiting notifications** (15 of the 30 participants who filled in the follow-up survey; e.g., *"Removed notifications from all the apps I didn't really need notifications from. So I only had the most important ones turned on"*), **writing under time pressure** (6/30), **reward/punishment** (5/30, e.g., *"I punished myself by saying that I wasn't allowed to be on social media for half an hour (...)"*), and **moving distractions out of sight on their device** (4/30, e.g., *"I moved the apps I felt took up too much of my time to another page on my phone"*). The third most commonly tried strategy, which was not actually discussed in the workshop, was simply *deciding* to use devices and apps only when necessary and important (e.g., *"I only used technology that was necessary"*).

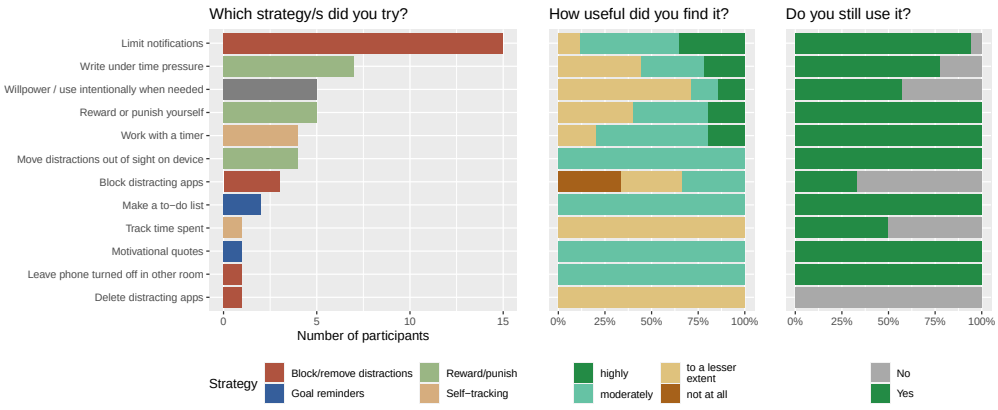

Fig. 3. A summary of participants' responses to the follow-up: the strategies tried (based on respondents' own description of what they specifically did), how useful they found them, and whether they were still using them.

Some strategies seemed broadly useful, whereas others saw more variation in usefulness ratings. Thus, limiting notifications was almost invariably found 'moderately' or 'highly' useful (16/17 cases[4]). Other strategies, like writing

[4]Two participants each tried two different ways of limiting notifications. Therefore, this adds up to 17 rather than 15 as in Figure 3

under time pressure, had respondents split: some found it really helpful, whereas others felt it simply stressed them and lowered the quality of their work.

3.2.2 Brief digital self-control scale. Workshop participants scored significantly higher on digital self-control at the follow-up compared to before the workshop (mean increase = 3.5[5], t(19) = 1.89, $p = 0.037$ (one-sided), $d = 0.42$). However, those who did *not* participate in a workshop *also* scored significantly higher, with a similar effect size (mean increase = 3.24, t(33) = 2.42, $p = 0.02$[6], $d = 0.42$), suggesting that an increase in subjective digital self-control could also be driven by e.g., what time of the academic year they filled in the surveys. The lack of advantage to the workshop seemed partly explained by the fact that many participants did not actually try out the strategies they intended. Thus, 11 out of 30 respondents in the follow-up survey said they "not at all" tried their intended strategies, and 9 that they only tried them "to a lesser extent". 8 out of 30 tried the strategies "to a moderate extent", and just 2 "to a high extent". When we excluded participants who "not at all" tried the strategies, the effect size of the increase on the digital self-control scale was $d = 0.69$ (mean increase = 5.9, t(13) = 2.6, $p = 0.01$). For participants who either "to a moderate extent" or "to a high extent" tried the strategies, the effect size was $d = 1.2$ (mean increase = 9.8, t(5) = 2.9, $p = 0.02$).

3.2.3 Time spent and daily checks on the smartphone. Daily **time** on smartphone (as measured by Screen Time/Digital Wellbeing) did not change significantly after the workshop (before: median = 5hr, IQR = 4hr 15m to 7hr 27m; after: median = 5hr 15m, IQR = 4hr 29m to 6hr 18m; $p = 0.78$[†], $r = 0.06$), nor did the difference between participants' own guess and what was provided by ScreenTime/Digital Wellbeing change significantly (before: median difference = 29m, IQR = -7m to 1hr7m; after: median difference = -1m, IQR = -19m to 1hr 23m; $p = 0.83$[†], $r = 0.06$).

Similarly, daily smartphone **checks** did not change significantly after taking part in the workshop (before: median = 150, IQR = 114 to 186; after: median = 132, IQR = 98 to 239; $p = 0.32$[†], $r = 0.23$), nor did the difference between participants' self-estimated number of checks and the number provided by ScreenTime/Digital Wellbeing (before: median difference = 57, IQR = 25 to 97; after: median difference = 29, IQR = -27 to 74; $p = 0.51$[†], $r = 0.16$).

4 CONCLUSION

About nine in ten of our participants said digital devices often made them less productive, and three in four that it was 'quite' to 'extremely' important to get better at handling their challenges. Although the workshop therefore seemed to address a clear need among our participants — with most stating that the workshop provided good solutions to their challenges — most students were apparently not sufficiently motivated to attend a workshop outside of school hours, nor to remember to apply the solutions they had identified in the workshop. On the other hand, those who attended a workshop and at least 'moderately' tried the strategies they had committed to, reported a large increase in digital self-control, with an effect size comparable to what has been observed in deployments with self-selected university students [24].

Overall, our pilot suggests that educating students in principles by which to restructure their digital environments to suit their needs, using DSCTs, may be a promising way to include self-regulation skills in digital literacy training [16]. However, future research on what this should look like in practice in school curricula should carefully consider how to scaffold the application of DSCTs in practice, to ensure that *all* students benefit, rather than only those who are highly self-motivated and/or technologically savvy [29, 31].

[5]Lowest possible score = 13, highest possible score = 65.
[6]Paired-samples t-test
[†]Paired-samples Wilcoxon test.

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APPENDIX

A DATA AND ANALYTICAL APPROACH

Survey data Each survey began by asking students to provide their email address. After data collection was complete, we replaced each email address with an anonymous ID (e.g. 'P1'), which we used to link survey responses. Survey responses that could not be matched (students might have been absent at one of our visits, or entered different email addresses) were kept in the data set, as not all analyses required us to compare responses to different surveys.

Workshop data Two authors (UL & MM-J) conducted inductive thematic analysis of qualitative data from the Miro boards [10, 11]. First, these authors independently read through participants' notes from the boards and conducted initial coding of recurrent patterns of meaning relevant to the research questions. Afterwards, they discussed emerging themes, and iteratively sorted codes into themes and recoded excerpts. We used NVivo v1.7 for thematic coding; we used R v4.2.1 for all quantitative analyses.

B TIME USE

Participants' self-estimated average daily time was roughly similar on laptop computer (median: 5 hours/day, IQR[7] = 4hr to 7hr 30min) and smartphone (median: 5 hours/day, IQR = 3hr 18min to 6hr 30min). The median subjective estimate of daily time spent on their smartphone the previous day was 4hr 30min (IQR = 3hr 11min to 5hr 30 min). This was close to the number provided by Screen Time or Digital Wellbeing (median time spent: 4 hrs 36 mins, IQR =

[7]Inter Quartile Range, i.e. the values at the 25 to the 75th percentiles of the distribution.

3hr 17min to 6hr). Asked how many times they checked their phone the day before, the median guess was 50 times (IQR = 30 to 104 times). This was substantially lower than the number given by Screen Time/Digital Wellbeing (median number of checks: 150, IQR = 90 to 183).

C CHALLENGES EXPERIENCED

In the opening survey, only 7% of participants ticked "I experience no challenges" (compared to 88% ticking 'I often experience that my devices make me less productive' and 28% 'I often experience that my devices put me in a bad mood / affect my mental health). 11% ticked "I experience other challenges", for which free-text responses included disturbed sleep patterns, and being less attentive in social situations.

For participants in the workshop (n=41), notes in response to the question "What challenges do you experience around controlling use of your smartphone / tablet / computer?" provided more qualitative detail. Commonly, participants **struggled to stay in control of device use** (51% mentioned this on at least one post-it on their Miro board). Specifically, they struggled with unwanted checking habits, being unable to stop use after they had started, and/or losing track of time (*"It is impossible to stop scrolling on TikTok and Instagram videos"*). 27% of participants mentioned that their devices made it **difficult to concentrate and stay focused** (*"my attention span is pretty bad (especially after TikTok arrived)"*, and 15% that they spent **too much time on their devices** (*"because of the high use of social media, I am not always able to do the things I want to be able to do. For example exercise, friends, etc."*). They also felt **unable to opt-out of use**, because of the essential role of the internet in daily life (*"we always use the internet for something"*), and because social pressures made them feel that they needed to be constantly available.

As a result, participants were concerned about **lost productivity** (mentioned by 46% of participants), because their digital devices made it harder to stay focused on their schoolwork and took away from the time available to complete it. They were also concerned that their device use was **bad for their mental and physical health** (27%). Specifically, constant connectivity left many feeling stressed, overwhelmed, and unable to relax (*"My phone often makes me feel pressured and stressed because I feel like I have to respond to people immediately, and therefore never gets the time to just relax"*), and loss of control over nightly use made them lose sleep.

Students' concerns were mostly related to use of social media and messaging apps (mentioned explicit by 50% of participants). Specific services mentioned included TikTok (15%), Instagram (12%), and Snapchat (10%).

D TRIGGERS

In response to the question on what outer and inner triggers drive their challenges, participants mentioned two main **external triggers**:

- **Receiving notifications or messages** (68% of participants)
- **Too easy availability of digital distractions** (17%; *"I feel it is way too available for me to grab my phone and let myself be distracted"*)

They mentioned three main **internal triggers**:

- **Digital distractions as the route of least effort** (39%). This involved distracting use feeling more 'exciting' or 'fun' than the alternatives (such as homework), as well as device use happening automatically out of habit.
- **Escaping from negative emotions** (56%). Here, nearly half specifically mentioned 'boredom' (46% of participants), but a range of negative states applied (e.g., *"when I can't find the energy to do anything, when I need an unnecessary break, when I am lonely, sometimes also just bad mood"*).

- **Wanting to be available and up-to-date** (41%): participants often described using their devices out of fear of missing out on what their friends were doing. They also often mentioned wanting to — or feeling pressured to — be constantly available (*"I feel that if I don't have my mobile on me 24/7 someone might write something important that I would miss"*).