Aiki - Turning Online Procrastination into Microlearning

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ABSTRACT

This paper presents and evaluates *Aiki*, a simple browser extension designed to redirect a user to a learning platform for a fixed amount of time before accessing websites defined as 'procrastination' or 'time-wasting' websites. The goal of the extension is to enable the user to *exchange* time spent on pages they believe contribute less to their own productivity for *microlearning* activities, defined as small or short-term learning activities. The paper describes the design and development of Aiki and evaluates the extension with a group of $n = 10$ participants studying the Danish language. Based on a two-week study, we conclude that this type of extension, even in its preliminary version, has the potential to improve language skills in a lightweight manner and that redirection is an important alternative to *blocking* for procrastination management.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**.

KEYWORDS

procrastination, microlearning, focus, language learning, browser extension

1 INTRODUCTION

The internet provides rich opportunity for idle browsing, which leads many people to feel distracted and become interrupted during their normal working day [9, 22, 29]. Maintaining focus while working on a computer is a major challenge for many, and people often feel that they use their time ineffectively [51]. Conversely, the internet also provides ample opportunities for knowledge acquisition and self-driven time management. The availability of information on the internet has never been greater, leaving our browsers a potential minefield for focused attention management; most workers need the internet browser to complete their work tasks, but this is also where the most attention distractors are offered. This paradox led us to ask the question: Can we design an intervention where the worker benefits from their own detours to websites they find less productive?

Deliberately blocking and controlling distractions with different digital interventions has been been a popular direction in research, drawing on work in HCI such as using appropriate timing and mode of the presentation of interruptions, e.g. [26, 28–30, 32, 51]. While such interventions have generally led to favorable outcomes in terms of increased experience of focus and productivity, there appear to be large individual differences; the individuals who reported the greatest increase in focus when distractions were blocked were also the individuals who were more susceptible to social media distractions [29, 30]. Some workers incur costs and experience increased stress when distractions are blocked completely, because distractions can provide much needed breaks from work [29, 30, 45]. To avoid adverse effects of blocking potentially necessary breaks, we designed an extension to *intercept* a visit to a distracting website and redirect the user towards an easy but useful task, rather than to completely block any websites.

Aiki is a martial arts principle that allows a conditioned practitioner to negate or redirect an opponent's power. [1] Aiki, in the context of this paper, is a browser extension designed to redirect a person's *attention* from a "time-wasting"-website to a website perceived as more productive. In short, in the settings of Aiki, a user can choose any number of websites they wish to have intercepted, how long they would like an interception to last, and another website which they would like to be directed to during that time. The user thus exchanges time spent browsing sites they perceive as less productive for activities they perceive as more productive.

> **A practical use example:** Eve, a researcher, finds herself often browsing the news on The Times, rather than studying Japanese – a language she has always wanted to learn. Eve uses Aiki to have the URL https://www.thetimes.co.uk/intercepted. She chooses a time span of two minutes which she would like to spend on Duolingo, completing small exercises in Japanese. Now, every time Eve types thetimes.co.uk in her browser, Aiki leads her to her own profile on Duolingo, where she has to spend a minimum of two minutes before being able to proceed to thetimes.co.uk. Eve also chooses that if she spends more than six minutes on her news site afterwards, she will be redirected

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[1]https://en.wikipedia.org/wiki/Aiki_(martial_arts_principle)

to Duolingo again, for another two minutes of language exercises. Eve has set Aiki to be active every day between 8AM and 8PM, but otherwise inactive.

Which sites are considered "time-wasting", and which are considered productive, is entirely up to users themselves. In the study this paper presents, we chose language learning as the learning subject, but a user could choose to study all kinds of topics, from cooking to coding, or even use the interceptions to nudge themselves to catch up on personal correspondences by e.g. asking Aiki to redirect them to a Google doc containing personal letters.

With the development of Aiki, we were primarily interested in exploring a browser extension as a catalyst for procrastination redirection and microlearning. The paper contributes to the high-level research question: **How might we design digital systems that turn procrastination behavior into productive learning experiences?**, where both *procrastination* and *productive* depend principally on and are defined by the individual user.

We conducted a two-week experiment with 10 knowledge workers using Aiki and a designated learning environment to investigate two factors: 1. Whether microlearning is possible in a setup where a visit to a site is intercepted by a learning environment, and 2. Whether interception via a browser extension is experienced as a good way of either *reducing procrastination behavior* or *at least offering a more productive alternative in those situations where procrastination-behavior actually represents a needed break*. As described, this study investigates language (vocabulary) learning as the subject, but the overarching research question invites experiments with many other types of learning; music, cooking, coding, or even studying formal course curricula.

The paper offers practical contributions to researchers and practitioners in HCI interested in facilitating attention management for workers who depend on their computer as a primary workstation, but who also sometimes experience the computer as a catalyst for detours and time-wasting activities.

2 RELATED WORK

Maintaining focus while switching between numerous tasks is not a new challenge for professionals. In fact, the problem was addressed by Bannon and colleagues as early as in 1983: "*Current human - computer interfaces provide little support for the kinds of problems users encounter when attempting to accomplish several different tasks in a single session*" [2]. Many companies and organizations depend on the self-managed productivity of computer-based *knowledge workers* [21, 54]. The activities which characterize knowledge work include innovation, cooperation and a high amount of context switching [35, 43]. It requires individual empowerment and self-managed working pace [36], making great demands on human cognition in terms of attention management. Indeed, recent research has shown that use of, for instance, social media can lead to increased anxiety and other adverse psychological outcomes, but *only* when social media is used in place of productive activities [41]. Research has shown that self-management practices have a much larger impact on productivity and output than the external design and organization of workplaces [33], so improving and facilitating self-management of attention management therefore seems

key to enhance productivity, self-satisfaction, and well-being for professional knowledge workers.

2.1 Blocking Distractions

One popular approach to supporting knowledge workers in self-managing their attention are software solutions for blocking the distraction themselves. One approach is to make users aware of their computer usage by blocking and filtering notifications [31, 34, 51], while the usefulness of blocking the distraction sites themselves seems to be suggested by the existence a flurry of applications and browser extensions designed for this purpose. From the ironically named *SelfControl* [38] and *Freedom* [18], to the more obvious *StayFocusd* [40] and *WasteNoTime* [50], internet users have many options for blocking themselves from reaching the websites that have been aptly called *the weapons of mass distraction* of our time. Other applications offer more creative approaches, such as *Forest* [17] in which the user plants a tree at the beginning of a working session – a tree that will die if the user brings another application in the foreground.

Distraction blocking has also been investigated by researchers. Mark et al. [30] discovered that with blocking software, participants assessed their productivity significantly higher and could focus significantly longer. Resultant changes in work behaviors included switching from online distractions to physical breaks of leaving the office. However, an unexpected consequence of cutting off distractions for people with less self-control was that they were more focused and worked longer without taking breaks and therefore, experienced higher stress. In a different study, the authors showed that those who reported the greatest increase in focus with distractions blocked were those who were more susceptible to social media distractions [29]. Tseng et al. introduce *UpTime* – a system that aims to support workers' transitions from breaks back to work – moments susceptible to digital distractions [47]. By sensing transitions from inactivity, their system aims to help workers avoid distractions by automatically blocking distracting websites temporarily. Moreover, the chatbot part of the system interacts with the worker through a set of proactive and reactive chat prompts, providing friction, and offering encouragement. As the result of a three-week study with fifteen workers, the authors conclude that automatic blocking of time-wasting websites at transition points can significantly decrease distractions.

In contrast with these works (applications, extensions and research studies), the approach we present in this paper does not try to block the distractions, but rather, to temporarily redirect the user – who is likely in need of a break – towards something useful; in our case, a web application that supports microlearning for improving one's vocabulary.

2.2 Microlearning for Vocabulary Improvement

Microlearning is a study technique in which a complex learning task is broken into a series of short study interactions, distributed over time [19]. Learning sessions which are temporally-spaced have been shown to yield higher learning rates than massed presentation (i.e., "cramming") [7, 11]. Given the memory advantage of spacing

repetitions and the accessible nature of short study sessions, many researchers have investigated ways of using technology towards consolidating L2[2] vocabulary with the help of microlearning techniques.

In one of the first mobile approaches, before the time of ubiquitous smartphones, Cavus and Ibrahim [6] used the SMS system to send vocabulary reminders to learners of English. As mobile technology became widespread, a vast amount of mobile applications for this purpose appeared. Some were context aware, using the location based service Foursquare to automatically provide location relevant content [16], others aimed specifically at being non-intrusive, such as the work of Dearman and Truong [10] who developed a mobile phone *live wallpaper* interface that is always visible and presents vocabulary reminders to the user. Trusty and Truong [46] created a browser extension that augments parts of web pages with translated nouns in the L2 of the learner. An interactive pop-up menu allows the user to select the correct translation for the translated word from a set of multiple choices. Dingler et al. [13] built an Android app for language microlearning with two kinds of exercises: multiple-choice and flashcards. They discovered that adding study reminders as notifications resulted in a significant number of "quick" learning sessions. Recently, in step with device adoption, Zhao et al. [53] proposed using a smartwatch for second language vocabulary practice. In their work, they show that people are much more receptive to vocabulary reminder notifications on the smartwatch than on the smartphone, however, the small screen of a smartwatch obviously presents some constraints to the interactivity of the learning environment.

2.3 Finding Opportune Moments and Contexts for Microlearning

Most of the presented micro-learning approaches rely on push notifications to generate learning opportunities. However, research shows that push notifications cause interruptions and can induce stress [52]. More recent studies aim to define the right opportunity for microlearning.

Cai et al. [4] suggest delivering micro-learning sessions while the user is waiting for something else. They present an Instant Message web application – *WaitChatter* – which presents vocabulary exercises while the user awaits responses in an ongoing chat. Their assumption is that, given that the user is experiencing an inactive moment, they would prefer to do a micro-learning session, rather than just wait. WaitChatter was since extended into *WaitSuite* – a suite of five different wait-learning apps that each uses a different kind of waiting as an entry point to learning tasks [5].

Multiple applications available in app stores and also a few scientific studies have shown the potential of using the moment when a user unlocks the screen of their smartphone for micro-learning and micro-tasks [44, 48].

Kovacs [24] presents *FeedLearn* – a Chrome extension that inserts vocabulary exercises as interactive quizzes within the Facebook feed of language learners. An early evaluation of the idea suggests that embedding the exercises *within* the Facebook feed is a more effective way of improving Japanese vocabulary than inserting links that bring the learners to an external page with quizzes. In a similar vein,

Hahn et al. [20] investigate introducing micro-tasks in the Facebook feed of learners. The main difference between these approaches and the one embodied in Aiki is that Aiki intercepts a user *before* they arriving at the time-wasting website. One advantage of our approach is that it is more scalable: by intercepting the time-wasting website before it is displayed, one does not need to define a website-specific way of inserting exercises in the different feeds of various time wasting websites.

While some researchers have attempted to algorithmically define opportune moments for delivering microlearning reminders (e.g. when the user is suspected to be "bored") [12, 13], our work takes advantage of a user's self-defined detour to a time-wasting website.

3 EXPERIMENT

The objectives of the study were to explore a) the microlearning potential and b) the attention management potential of a browser extension through a semi-controlled experiment. Using Aiki as a design case, we investigate the following:

- **RQ1: Can we show an effect on language learning, using regular, time-limited micro-interactions (microlearning)?**
- **RQ2: How is browser redirection experienced by knowledge workers, as a means of intercepting procrastination behavior?**

We investigated these questions by asking 10 knowledge workers to install and use the browser extension for two weeks. We gave them a brief instruction in how to install the extension, but did otherwise not interfere with their usage of the extension. In the following, we describe the details of the study and our rationale behind the experimental design.

3.1 Microlearning Environment: Zeeguu

The Aiki extension is designed so the user can choose their preferred online learning environment (e.g. Duolingo, Codecademy or any specific URL, see Fig. 3a), to which they will be redirected when trying to access one of their specified time-wasting sites. However, for the purpose of the experiment, we decided to fix the learning environment for all the participants to Zeeguu – an open-source research platform that aims to enable learners of a foreign language to practice with personalized reading and vocabulary exercises.

The Zeeguu platform is a research project that has been developed at multiple universities and has been showed to be effective in improving the reading skills of Dutch high-school students studying French [27]. One instance of the project is deployed at zeeguu.org and the researchers behind the platform agreed to provide us with user interaction data from within the learning environment. This gave us insight into user behavior which would not otherwise be available on randomly specified external websites. Moreover, by using Zeeguu, we could also control the curriculum of the learning environment, allowing us to design a learning outcome test that corresponded to the learning material the participants had been exposed to during their 14 days of having Aiki installed. These data are described in detail in section 3.2.2 and 3.3.2.

In Zeeguu, the learner can choose topics they are interested in (or alternatively, topics that they do not want to see) and then the internet is crawled daily for materials that match the interests of

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[2]Second Language

the learner. Figure 1a shows an example of a list of recommended articles for a learner. The list also includes a difficulty estimation for every article, represented by the colored disks on the right. While a user reads a text, context-aware translations are provided at the click of a word. (Fig. 1b illustrates how the UI inserts word and phrase translations above the original text. Translations are automated by merging suggestions from multiple machine-translation services (e.g. Google Translate, Microsoft Translate, Glosbe, etc.. The words that a user has requested translations for, together with word contexts, are automatically saved to the user's profile and are used later to generate personalized vocabulary exercises.
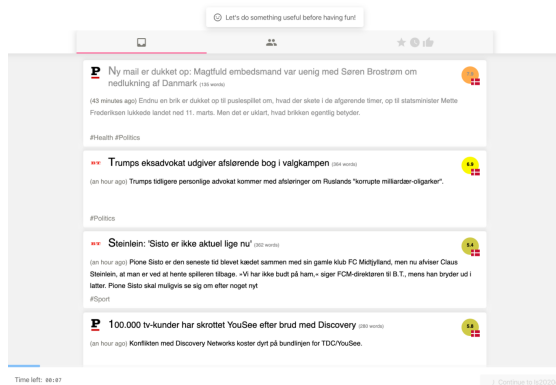
(a) Zeeguu front page and overview of available articles.


(b) Closeup of translated words in Zeeguu.

Figure 1: Screenshots from the user interface of Zeeguu – the online micro-learning platform used in the study

3.2 The Design of Aiki

Aiki is an open source browser extension. The front-end is implemented with React. The backend uses Firebase to store user preferences and the telemetry required for analyzing user interactions with the extension. The source code is available on GitHub[3]. In this section, we describe the design of Aiki in detail, so that the interaction design is comparable for similar research. We describe the entire interaction flow in the interest of prociding an informed foundation for interpreting the findings of the following experiment in terms of usability and user experience of the extension.

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[3]https://github.com/Aiki-Extension

3.2.1 Selecting Time-wasting Websites. After installing Aiki, the user is led to the settings page where they are first asked to define their time-wasting websites as seen in Fig. 2a. On the settings page, the user is reminded that adding a URL to the list of time-wasting websites does not mean the user will be unable to access the site, but rather, that the user will be asked to preface a visit to the site for time spent learning. It is explained that the user can always disable the interceptions for any site from the settings. Enabling/disabling is also possible on any website via a toolbar menu (Figure 2b). The toolbar features both a global Status of extension:-toggle, which turns the extension on and off, as well as an Enabled on this site:-toggle, which turns the extension on and off for the current URL.
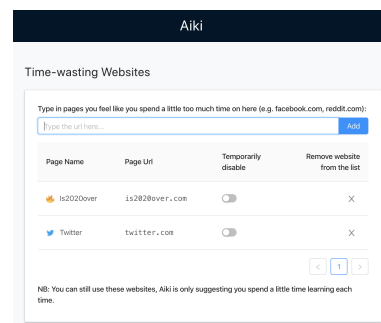
(a) Selecting time-wasting websites.
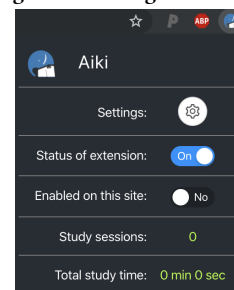
(b) Extension toolbar menu.

Figure 2: Defining and later Enabling/Disabling Time-Wasting Websites in Aiki

3.2.2 Setting Learning Environment and Timing Constraints. The next section of the Aiki settings asks the user to define their learning environment, i.e. the page they would like to be redirected to before accessing a time-wasting website (Fig. 3a). As described, the setting was locked to the learning platform Zeeguu for the purpose of this study.

The user is asked to define two time intervals

(1) The amount of time to spend in the learning environment before being able to access their time-wasting websites.
(2) The amount of time they would like to exchange the learning detour for, i.e. a time interval during which they can browse the time-wasting website before being redirected back to their learning environment.
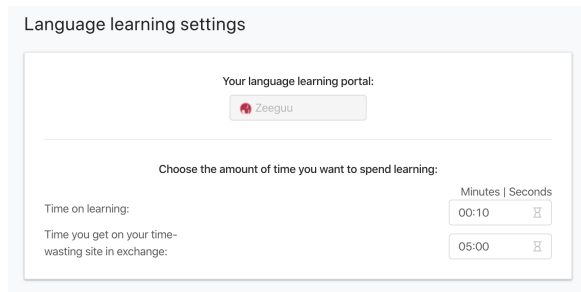
(a) Setting the learning environment and study times.
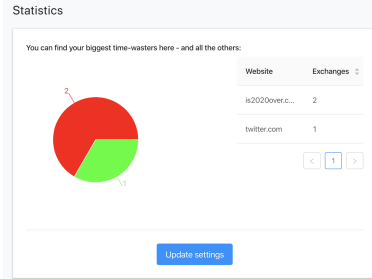
(b) Interception statistics

Figure 3: Screenshots from the Aiki extension settings: Learning environment and statistics overview.

(a) Continue button prior to pre-specified study time passing

(b) Continue button after the pre-specified study time has elapsed.

Figure 4: Screenshots of the Aiki proceed-to-page-buttons. Notice that the user can always use the Emergency skip to page-button

In the example shown in Fig. 3a, the user has chosen to exchange 10 seconds of language exercises per five minutes of browsing time on each of their chosen time-wasting websites. These settings can be changed at any time.

Finally, at the bottom of the settings page the user sees a simple statistics overview, displaying which of their time-wasting sites they have visited the most, and how many times they have been intercepted by Aiki (Fig. 3b). We chose a very simple overview for this study to explore whether the study participants were interested in the statistics overview at all.

3.2.3 Being Intercepted. While the Aiki extension is active, the user will only notice it when attempting to access any of the URLs specified in the time-wasting websites settings. When either of the URLs is entered in the address bar, Aiki will prompt a small message; "Let's do something useful before having fun!", and redirect the user to the specified learning environment. A progress bar in the bottom of the page shows how much time is left of the time span they specified in the settings. In the bottom right corner of the page, a "Continue to X site"-button is greyed out until the time has passed (Fig. 4a). After the time has passed, the button turns green and can be pressed to proceed to the site (Fig. 4b). If the green button is not pressed, the user will stay on the learning environment-site, to avoid interrupting them mid-exercise. Underneath the Continue to X site-button, a less visible "Emergency skip to site"-button is always accessible, in case the user wishes to circumvent the Aiki extension. This button was implemented in the attempt to avoid a feeling of being constrained or *blocked*. We wished to give the user the feeling of agency over their decision to exchange procrastination for learning.
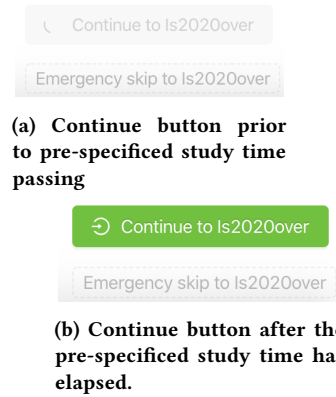
When the user spends time on any of their time-wasting sites, after having completed their time in their preferred learning environment, they are not reminded of Aiki until the pre-specified time span is up. When this happens, the user is redirected to the learning environment again.

Aiki does not control any actions on the learning environment-site. It does not know whether the user actually engages with any content on the page, or whether the user just waits for the time to pass before proceeding to their time-wasting site. This is why, for the study presented in this paper, we chose to redirect the participants to a specific learning environment (Zeeguu), to the back end of which we were given access.

3.3 Subjects

3.3.1 Participants. 10 people participated in the study. To avoid adverse effects and contrived levels of engagement with the extension, participants were not compensated for their participation. Participants were recruited through email lists, Facebook, and personal networks. Our goal was to have enough participants that a varied amount of experiences could emerge, while leaving enough time and space for individual interviews capturing *thick data* [49] about user experiences. As described in the introduction, there appear to be large individual differences in the experience of focus interventions, and our participant number allowed for such differences to be explored. We considered the study an early, controlled beta or field test [14]. Studies of usability testing in practice have shown that larger participant numbers do not equal more exhaustive findings, but rather, participant numbers "should typically be increased along with the study's complexity and the criticality of its context" [1]. We believed 10 participants was an appropriate participant number for the level of development that Aiki was on at the time of study: "going from 5 to 10 participants greatly increases the expected level of problem discovery, but going from 15 to 20 participants has far less impact" [39]. We were particularly interested in detailed feedback before deploying Aiki to a large group, as it gave us a chance to uncover usability issues and discover hypotheses for later, quantitative validation.

All participants could be classified as *knowledge workers* (as described in section 2), and they fulfilled the following three selection criteria for participating in the study: (1) Uses their computer as their primary work station; (2) Must be a Google Chrome user (as Aiki currently only works in Google Chrome); (3) Is interested in learning (more) Danish.

A note on Danish. Danish is a North Germanic language, spoken by around six million people, of which most reside in the Kingdom of Denmark. The lack of language resources available for Danish [23], as well as its lexical complexity [3], make it a relatively exotic language which most people have to actively seek exposure to. Danish was chosen as the language for the experiment because the uniqueness made it unlikely that experiment participants would encounter it outside deliberately scheduled sessions, thus, we could likely attribute advances in learning to active participation in the experiment, rather than random exposure.

Participants completed a pre-study questionnaire, a summary of which can be found in Table 1. None of the participants had ever used Zeeguu to study Danish before, but seven had experience with other online language learning platforms.

In the questionnaire, we also asked if participants ever experienced visiting websites experienced as "time-wasting" or "unproductive". Five gave scores between 6-7 on an ordinal scale from 1 (*"Almost never"*) to 7 (*"Many times a day"*). One gave a score of 5, one gave a score of 3, and three did not answer the question. Five participants described having taken different measures to try and limit themselves from visiting certain websites, because they experienced the websites as distractingc them from productive work while sat at their computer. The measures were described as, for instance, logging out of their account on the website, unsubscribing from most of their connections on a social medium-website, or unsubscribing from a service completely.

3.3.2 Learning Environment Curriculum and Language Test. As previously described, one of the advantages to choosing Zeeguu as the learning environment for the experiment was that this gave us control over the readings presented to participants. We selected 30 Danish texts as the curriculum for the 14 days; nine classified as *Beginner* level, 16 classified as *Intermediate* level, and five classified as *Expert* level. The texts were selected primarily from news sources, and covered a variety of subjects, from news about COVID-19 to gender (in)equality in Denmark. When redirected to Zeeguu by Aiki, the participants were presented with an overview of the available texts, and could choose between them.

We designed a Danish Language test with 79 multiple choice questions for the participants in the study to complete before and after their 14 days of using Aiki and Zeeguu. The test was distributed as a Google Form. The language test was designed as a mixture of general questions from similar quizzes[4] and questions tailored for the study. The language test was split in three sections; section 1 containing 19 questions of sentence construction, e.g. a question in Danish, and four options between correct or appropriate responses,

also in Danish. Section 2 contained 10 translation questions, consisting of a Danish prompt and four options of the correct translation to English. Section 3 contained 50 vocabulary questions, where a Danish word or concept was presented along with four options for the correct meaning in English. The vocabulary section was highly curriculum-specific, meaning all the words and concepts presented in that section could be found in the curriculum of texts available to the participants in Zeeguu. This gave us an opportunity to explore indications of the learning curriculum specifically influencing participants' vocabulary during the study.

3.3.3 Post-experiment Survey and Interview. After the experiment, all participants were asked to complete a short user experience-survey inspired by Shrepp et al. [37], with modifications aiming for more general and more qualitatively rich answers. The survey consisted of four ordinal-scale questions and an open-ended possibility to elaborate per question. The questions were: 1) How was your general experience with Aiki? (Very negative–Very positive), 2) Did you feel like Aiki improved your Danish skills? (Not at all–Very much so), 3) Did you feel like Aiki made you spend less time on your time-wasting sites? (Not at all–Very much so), and 4) Would you recommend Aiki to others? (Not at all–Very much so).

Following the completion of this survey, each participant was interviewed. The interview was open-ended, lasted between 8 and 20 minutes per participant, and asked the individual participant to comment on their experience with Aiki — for instance, *What changes would you have made to the setup?*, *Would different language approaches have made a difference?*, *Would different interception mechanisms?*, *Did you ever circumvent the extension?*, and *Do you feel more confident in your Danish abilities?*. If the participant had primarily provided feedback on their experience of Zeeguu, rather than Aiki (which was a recurring finding that we will describe in the Results and Findings section), the interview provided an opportunity to ask questions more specific to Aiki.

3.4 Experiment Setup and Execution

Execution of the experiment took place during spring 2020. 13 participants signed up and consented to participate in the experiment. They received the pre-experiment survey as well as the initial language test, providing a baseline of their Danish level. After the survey and language test had been completed, each participant received a login to Zeeguu (where accounts were already created on their behalf), a link, and instructions for installing Aiki. The authors were available for questions, but did otherwise not interfere with the individual participant's use of the extension during the study. We received no questions about the functionality of Aiki from either of the participants.

After 14 days of having the Aiki extension installed, we contacted participants and sked them to complete the Danish language test again, to fill out the post-experiment survey about their experience of the extension, as well as to participate in the short post-experiment interview.

3.5 Data Analysis

The data emerging from the study consists of:

(1) Pre-study information: Demographic information, level of Danish, and habits of learning language.

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[4]We used particularly the Cactus Language Courses Danish level test (https://www.languagecoursesuk.co.uk/) as inspiration.

	Age	Danish level	Usual Learning Mode	Study Time per Week
P1	26-35	Elementary (A2)	Courses in classes	0-30 min
P2	36-45	Intermediate (B1)	Online platforms; Speaking and/or writing with Danes	0-30 min
P3	26-35	Elementary (A2)	Courses in classes	1-5 hours
P4	36-45	Elementary (A2)	Courses in classes	30-60 min
P5	18-25	Intermediate (B1)	Courses in classes	0-30 min
P6	36-45	Upper intermediate (B2)	Speaking and/or writing with Danes	0-30 min
P7	26-35	Upper intermediate (B2)	Courses in classes, Online platforms	0-30 min
P8	26-35	Upper intermediate (B2)	Courses in classes; Speaking and/or writing with Danes	30-60 min
P9	26-35	Elementary (A2)	Courses in classes, Online platforms	0-30 min
P10	36-45	Beginner (A1)	Online platforms	0-30 min

Table 1: Overview over study participants.

(2) Danish language test score pre-installment of Aiki.
(3) Aiki telemetry data: websites entered as time-wasting, user settings, total amount of interceptions, etc.
(4) Zeeguu telemetry data: time spent reading, number of texts visited, amount of words translated.
(5) Danish language test score post-usage of Aiki.
(6) Post-study survey and interview: quantitative scores and qualitative elaboration user experience

This is a substantial amount of data, and with an *n* of 10 participants, we were mainly interested in preliminary user testing of the idea, allowing us to discover and share indications for further development. We thus focus on exploring indications of microlearning – achieved in part by comparing the language test scores before and after the intervention, and in part by asking participants in the post-survey whether they *experienced* learning from using the extension – and on whether a browser extension works as a catalyst of behavior change in this area. The latter is investigated by looking at usage data as well as analyzing the post-experiment surveys and interviews with affinity diagrams and subjective clustering [42].

4 RESULTS AND FINDINGS

4.1 RQ1: Can we show an effect on language learning, using regular, time-limited micro-interactions (microlearning)?

OBSERVATION 1: *Overall, we observed a slight improvement in language test scores after having Aiki installed for a 14 day period.*

Participants generally scored very high on the before-language test: the average score was 63.4 out of 79 possible correct answers, with a median of 67.5 (see Fig. 5a). We interpret this as a sign that the level of the test was less challenging than it could have been for this particular audience. The two participants with the lowest language test-score scored 47 and 48 on the first language test, while the participants with the highest scores scored 77 and 72, respectively.

On the after-language test score, the average was 67.1 correct answers (median 70.5), for an average improvement of 3.7 answers (median 4.5), or almost 6%. Two participants scored worse on their after-study language test (-2 and -4 points difference), while the participants who improved their score the most scored 9 and 7
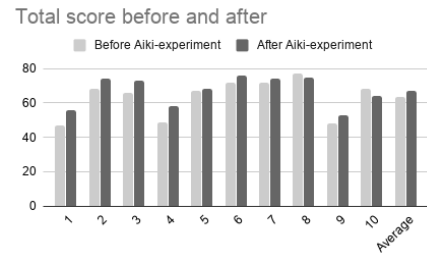
(a) Total language test scores per participant.

(b) Vocabulary test scores per participant.

Figure 5: Histograms over the language test scores before and after the study period.

points more than before the Aiki-intervention. The two participants who scored lowest on their before-test were also among the ones who improved their score the most in the after-study test, with an improvement of 9 and 5 points, respectively.

Looking at the vocabulary section, the section of the language test which was particularly tailored to the learning curriculum, that is, the average score on this was also very high on the initial test (see Fig. 5b). Participants scored on average 40.7 out of 50 possible correct answers (median 44.5). The average score of the vocabulary section was 43.1 correct answers after the study (median 45.5), an average of 2.4 points improvement, or also close to 6%.

We conducted a paired t-test for both the Total Score and the Vocabulary Score before and after the usage of Aiki. The main assumption when using the t-test is that the paired-difference

data come from a normal distribution. This normality assumption was confirmed statistically by a Shapiro-Wilk test ($\alpha = 0.05$, $p(Total) = 0.64$, $p(Vocabulary) = 0.86$). The T-test shows a statistically significant increase in the scores after the use of Aiki with respect to the initial scores. This is true for both Total Score ($t = 2.64$, $p = 0.01$, $mean\ diff = 3.7$) and Vocabulary Score ($t = 1.94$, $p = 0.04$, $mean\ diff = 2.4$). These results suggest that indeed, the usage of Aiki for two weeks had a positive effect on the language and vocabulary skills of the participants.

OBSERVATION 2: *The **experienced** improvement of language skills varied substantially based on types of exercises and interaction patterns.*

In the histograms of language test scores (Fig. 5a and 5b), we can observe that some of the participants actually scored slightly lower on their after-language test than their before-language test (while some participants improved their score so drastically that it evened out as an overall rise in score). As described in section 3.5, our goal in this experiment was not to draw statistical conclusions, but rather to uncover insights which might help us and others develop Aiki and similar tools in the future. We thus sought to uncover the factors which may contribute to increased learning, both by looking at the interaction data from Aiki and Zeeguu and the survey responses from the post-study survey.

4.1.1 Aiki interaction patterns. The most common time-wasting sites input were Facebook and Youtube. However, there was a broad

(a) Number of Aiki interceptions for the participants in the study

(b) Number of translated words vs. time spent reading. Participants 1–4 are annotated with their improvement in the language test scores before and after the study.

Figure 6: Interaction data extracted from Aiki and respectively Zeeguu telemetry

range of others, including: Reddit, Twitter, Feedly, BBC, and even Ebay. Figure 6a shows the amount of interruptions that Aiki has logged for the participants in the study distinguishing between three types of sessions:

- Skipped – a minority – where the user clicked the *"Emergency skip"* button to circumvent the language practice
- Unfinished – where the user closed the tab before completing the pre-specified learning time
- Successful – most numerous of the three – where the user completed the pre-specified time of language learning

The figure shows that three participants never used the *"Emergency skip"* button and of the seven who did, three used it very sparingly. However, three used it in approximately 20% of the cases and one participant skipped almost half of their sessions.

4.1.2 Zeeguu interaction patterns. Figure 6b shows the number of word translations (y-axis) plotted against the time spent *actively* [5] reading with Zeeguu by the participants of the study. The chart shows that there is great diversity with regards to user involvement: some participants spent a total of 120 minutes in the learning environment during the study, while others spent less than 10 minutes). Furthermore, the chart shows variation in user behavior: some users read much and translated little (e.g. P2) while others translated a lot in little time (e.g. P1, P3), and yet others did not need to translate but also did not read much. Although not visible from the charts, we observed that some people read the same text multiple times while others always chose a new text (e.g. one participant opened only four texts, while another user opened 24 texts).

The data points corresponding to P1, P2, P3, and P4 are annotated on the graph in Figure 6b since they were the ones who improved the most (with respectively +9, +6, +9, +7) between the initial and the final language test. The diagram suggests an unsurprising relationship between reading time and language improvement. A Pearson's correlation shows that that the time spent reading and the improvements in the final score are positively correlated with $r(8)=.74$ and $p=.01$. Furthermore, analyzing the data with a linear regression shows that a doubling of reading time results in roughly a 2 point increase in the improvement of the final score. The effect of reading time on improvement in the final score is significant ($p=0.0007$) and has a 95% confidence interval of 1.1-2.8.

In a way this is not surprising: the relationship between study time and learning is well known and Aiki gave the learners more time to be exposed to language. To some, it actually gave significant extra time: P1 and P2 spent three times more time studying with Aiki than they used to spend studying Danish before (cf. to their own reports); P4, P5, P6, P9 doubled their study time compared to self-reported average weekly time.[6]

4.1.3 Qualitative Experience of Learning. In the post-study survey, we asked the question: Did you feel like Aiki improved your Danish
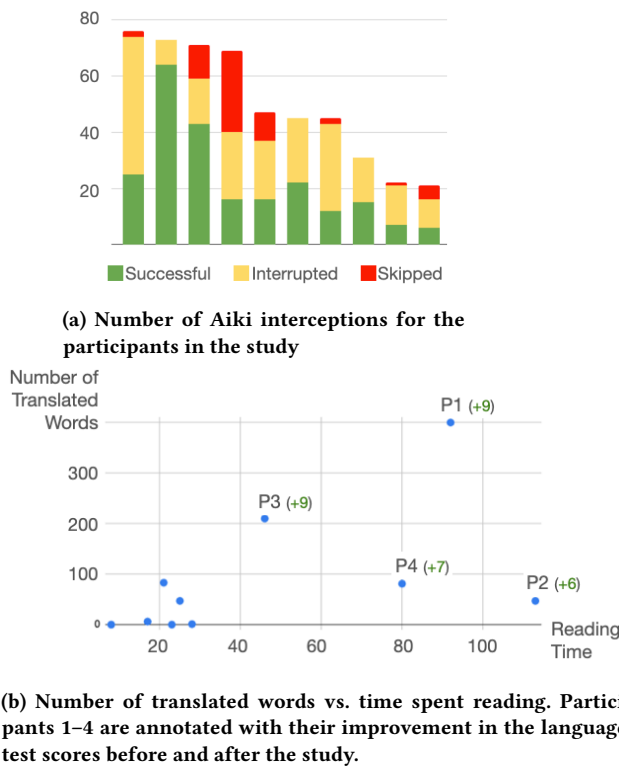
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[5] Only the time in which the users are actively involved with the platform is counted. The system infers active time based on tracking mouse movements and interactions with text as well as page activation or hiding; if a user is not active for more than two minutes the time tracking is stopped; this avoids the situation where a user leaves the browser open and goes to prepare french fries as being counted towards *study time*.
[6] The improvement is likely larger, since self-reporting is known to be unreliable. Moreover, we considered the largest value of the declared interval for comparison (e.g. if somebody declared that they study between 30-60 min we considered 60 as a reference for their study time before)

skills? (from 1 = Not at all to 5 = Very much so). The average response score for this question was 2.5, with a spread distribution (three participants responded 1, two responded 2, three responded a score of 3, and two participants responded 4 and 5, respectively). Looking at the elaborations, it is clear that participants were missing more variation in language exercises, which were limited to reading: "*The extension did not offer me any exercises that address areas in which I really have difficulties (e.g. pronouns, prepositions, endings)*" (P3), "*2 weeks is too short to judge, but i would like to think if i use it longer, then it will*" (P4), and "*it would be an overstatement that it improved my language skills in such a short time and only by reading*" (P2) (actually P2, P3, and P4 *did* improve their language test scores significantly at the end of the experiment).

Most participants mentioned, both in the survey and in the follow-up interviews that reading is not their main challenge in learning Danish, therefore the language exercise environment could have offered much more variation. From the positive responses, P1 described they felt they had improved their vocabulary, and P3 appreciated an experience of improvement in their *passive* Danish: "*I think the extension helped me to improve my passive Danish, i.e. being able to read more quickly and understand more.*" (P3).

4.2 RQ2: How is browser redirection experienced by knowledge workers, as a means of intercepting procrastination behavior?

OBSERVATION 3: *The Aiki browser extension was largely invisible to the participants, while the learning environment affected the overall experience significantly.*

The majority of qualitative feedback from study participants was focused on Zeeguu as a learning environment, rather than Aiki. In most cases, participants were not aware that these were, in fact, different tools:

In response to the survey question **How was your general experience with Aiki?**:
"*Only after 3 days of reading did I realize that I had to click on words to see translations [...]*" (P3)
"*I found the selection of articles did not match my interest [...]*"(P8)
"*I would have liked not to have to choose a text since I found myself looking for the shorter ones to read.*"(P7)

These quotes exemplify evaluations of Zeeguu, when the participants are actually asked about their general experience with Aiki. This is unsurprising, as Zeeguu was the main platform, participants interacted with - ideally, an Aiki-like extension should not be noticeable, but mostly facilitate the interaction with a different platform.

OBSERVATION 4: *When Aiki was evaluated, the evaluation was generally positive.*

The general evaluation of Aiki was positive. In the post-experiment survey, the question "How was your general experience with Aiki?" received an average score of 3.7 out of 5 from Very negative to Very positive (with a distribution of zero participants responding 1, one

responding 2, two responding 3, six responses of 4, and one score of 5 points). The survey question "Would you recommend Aiki to others?" yielded an average score of 7.9 out of 10, with only two participants scoring 3, and the rest from 6 and up. The positive traits of the application were described as, for instance:

"*It was seamless, fast, and didn't get in the way*" (P6, survey response).
"*It really helps to be more aware of the time we spend on time-waste sites*" (P10, survey response)
"*I was quite pleasantly surprised that I had the settings under my control [...], because I also adjusted it a bit as the study went on. I was a bit too ambitious in the beginning*" (P7, interview).
"*I really liked it, and I thought it was great, so when I wanted to, like, often I thought, oh, I should go to YouTube so I can just read another two minutes [...]*" (P5, interview).

Several participants described the continuous interceptions as positive reminders to devote time to learning, indicating that the exchange of time may conduce productive behavior change: "*I have now started to seek out little things to learn Danish during my day, for instance started texting people in Danish rather than texting them in English, and I've started watching more Danish television. I think the fact of using the extension has just made me more aware that I need to train Danish during the day, and not only the two times a week I have my Danish class*" (P3, interview). P1 also described that it was practical to have learning opportunities constantly available at home, rather than having to actively go to a language class.

Two participants (P5, P7) mentioned during their post-study interviews that they would have liked to continue using Aiki after the study, but that it was a nuisance for them to switch browsers for the purpose of the study (as described, the current version of Aiki works exclusively in Google Chrome). We interpret this as an indication that redirection directly in a browser has potential, but the extension should work across browsers, ideally.

OBSERVATION 5: *A redirecting browser extension has potential to improve focus and minimize distractions.*

Some of the participants mentioned that having to do language exercises before proceeding to a time-wasting site was sometimes enough of a source of inconvenience that they would rather not visit their time-wasting site at all, e.g.:

"*I knew I should be doing something productive [...], and then I decided it wasn't really worth the effort [...] I guess the value of visiting the other website wasn't offset by, kind of, the cost you have to pay in learning some language. [...] I've used a lot of these tools before, and this was the most effective tool I've ever used for stopping distraction.*" (P6, interview).

This type of behavior is, of course, not conducive for microlearning, seeing as the participant avoids interacting with the learning environment alltogether. However, the outcome, in terms of minimizing procrastination, was described as positive for the participant.

In the survey, participants were asked the question "Did you feel like Aiki made you spend less time on your time-wasting sites?" (from 1 = Not at all to 5 = Very much so). The question received very different scores, with three participants selecting 1, one selecting 2, one selecting 4, one selecting 4, and four selecting 5, an overall

average of 3.2 out of 5. Both 1 and 5 can be interpreted as a positive outcome depending on user preferences: "*I visited them more often to use Aiki*" (P5, survey response), "*I think I used my procrastination sites just as much, because actually, I was looking forward to doing a bit of Danish before checking Facebook.*" (P3, survey response).

In terms of focus, one subject which was brought up by numerous of the participants was the request of detection by Aiki of (or at least manual setting of) *focus mode*. Multiple participants experienced being in the middle of work flow, and trying to visit one of their time-wasting websites as part of their work – this could be trying to send a message via Facebook, or looking for a video on YouTube. Interrupting work flow is of course not the intention of the extension, and also the reason that Aiki was designed with the possibility to be turned temporarily off for specific URLs (Fig. 2b). However, this function did not appear to be used by participants during this study – possibly because the participants felt obliged to keep the extension active for the purpose of the study.

During the post-study interviews, we asked the participants whether they ever 'circumvented' the extension, for instance by using a different browser, by using incognito mode, or by using their phone to access specific websites. The far most popular answer was using the phone to access the sites instead, and P2, P5 and P9 mentioned specifically, that they would like the extension to work on their phone as well. Such a setup is obviously more complicated, as most people use apps to access different sources of procrastination, rather than the browser, and intercepting other apps would be a more complex challenge. It is, however, an interesting direction for further research.

As a summary of this section of results and findings, the answer to RQ2; *How is browser redirection experienced by knowledge workers, as a means of interception procrastination behavior?* appears largely positive; we could observe several reported advantages of using browser interception as a means of limiting or intercepting procrastination behavior, while the learning environment used in this case caused some negative effects to the experience. In the following section, we will report some of the specific evaluations, criticisms, and suggestions we received from the study, as design implications for a browser extension designed to intercept time-wasting and promote microlearning.

5 DISCUSSION: DESIGN IMPLICATIONS FOR A DISTRACTION INTERCEPTING BROWSER EXTENSION THAT PROMOTES MICROLEARNING

In this section, we report more detailed findings and suggestions about the design of the Aiki extension (or similar procrastination management systems), in an effort to make our results as useful as possible for other researchers. We received a large body of feedback, which we cluster mainly along the two research questions.

5.1 Effects of Aiki on language learning (RQ1)

In response to RQ1, we made two observations: *1: Overall, we observed a slight improvement in language test scores after having Aiki installed for a 14 day period*, and *2: The experienced improvement of language skills varied a lot based on types of exercises and interaction*

patterns. Although it is optimistic to attempt to improve language skills significantly over a period of only 14 days, the results are promising. Indeed, the overall language test score had improved from the pre- to post-study test mainly carried by the half the participants' improvement score being significantly higher than the participants who barely improved their score or even achieved worse scores than before. Moreover, based on our data analysis there seems to be a significant correlation between the time spent reading and improvements in the final score.

However, both the Zeeguu interaction patterns (Fig. 6b) and the qualitative reports from participants, tell us that some of the participants were not engaged by the mode of learning offered in this experiment. One participant mentioned that because the microlearning became associated with additional work, they ended up avoiding the sites altogether: "*At some point I was avoiding the Aiki-flagged sites just so I don't have to read any Danish. (I guess it's not something to be proud of)*" (P7, survey response). When inquiring about this further in this and other participants' post-study interviews, we discussed a design goal of **designing the extension / learning environment to provide positive feedback in order to create positive associations with the microlearning tasks**. We expect that in practice, in a non-experimental context, in which each learner can choose a learning environment that fits their interests and learning style, the user involvement and the learning outcomes would be superior to what we could achieve with the fixed environment in this study.

5.2 The participants' perception of procrastination interception (RQ2)

The second research question prompted three observations, of which we will focus on the implications to the design of Aiki: *Observation 4: When Aiki was evaluated, the evaluation was generally positive*, and *Observation 5: A redirecting browser extension has potential to improve focus and minimize distractions.*

5.2.1 Preventing procrastination: Carrot or stick? Reported benefits of the Aiki extension can be segregated into three types of outcomes or behavior change:

(1) **Increasing engagement with a different, productive behavior** (facilitated by the learning environment), e.g. "*I visited [the time-wasting websites] more often to use Aiki*" (P5, survey response).
    "*Once your application interrupted me and I read an article then I would not go to the [time-wasting] page.[7] *" (P5, interview)
(2) **Preventing procrastination behavior**, e.g. "*It has effectively prevented me from wasting time a couple of times.*" (P2, interview) "*I decided [visiting the procrastination site] wasn't really worth the effort [...] I guess the value of visiting the other website wasn't offset by, kind of, the cost you have to pay in learning some language. [...] I've used a lot of these tools before, and this was the most effective tool I've ever used for stopping distraction.*"(P6, interview).

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[7]This participant presents a situation which is even more than what we hoped for. We wished to "push" participants into completing a learning task *before* spending time on time-wasting websites. However, this particular participant did the learning *instead* of their originally planned leisure activity. If this effect can be achieved reliably even for a minority of users, such an approach would have a a great potential.

(3) **Promoting reflection on procrastination behavior**, e.g. "*Sometimes, typing the URL made me conscious that I was going to get redirected, and I stopped and returned to what I was doing*" (P1, interview).

The goal of Aiki was to either *minimize unwanted procrastination* or *increase experienced productive behavior*. Participants of the study seemed to have experienced the benefits of this approach in one of two general ways: as a carrot (the redirection as a desirable alternative to procrastination) or a stick (the redirection is an undesirable interruption that they would rather avoid). Interestingly, both the carrot and the stick approach are described as positive by different participants, cf. point 1 and 2 above. The carrot approach is closer to the aim of the design of Aiki, while the stick approach is similar to a conventional strategy of *blocking* distractions.

Finally, several participants also described that the redirection or interruption prompted them to reflect on their action to try to visit a different website than what was relevant to their current task, as described in point 3 above. This was also described as a benefit of the extension, irrespective of whether the following action was to continue the visit to the procrastination site or to abandon the visit.

Based on these observed benefits, future implementations of the extension may **contain different, specialized versions which cater to different types of users**. Currently, Aiki is designed as an ultra-simple one-fits-all solution, but variations maybe be customized to users who prefer the carrot approach (making the learning environment as attractive or engaging as possible), the stick approach (making circumvention of the extension extra tedious), or increased reflection on the user's actions (perhaps asking open-ended questions about procrastination to the user, which has shown promise in the research by Tseng et al. [47]). We believe more user-targeted or customizable implementations of the extension are worth exploring.

While several participants reported that it did help their focus and productivity to be intercepted by Aiki, some participants also reported negative factors of the interruptions, particularly when they experienced being blocked while attempting to use a website when the website was actually necessary for productivity. Future designs of similar extensions might **consider implementing *modes*, such as a focus-mode and a leisure-mode (either automatically detected or manually controlled), where specific websites are not intercepted.** (One way of implementing this might be to have the extension detect multiple subsequent uses of the "Emergency skip"-button, and offer the user to *snooze* the interceptions for a period of time.)

5.2.2 Integrating a learning environment into a browser extension. Finally, in *Observation 3: The Aiki browser extension was largely invisible to the participants, while the learning environment affected the overall experience significantly*, we identified some general potentials to the design of a redirection model for managing procrastination.

1: Creating interactivity between learning environment and procrastination management tool. Most participants mentioned that reading articles was not sufficiently engaging to be continuously satisfying as a main mode of language learning. Several participants requested **more interactive exercises, and a higher degree of feedback from the learning environment**. P2, P3, P5, P6, and

P10 specifically noted that "*it would be good with more interactive and engaging learning experience*", and that they would have liked "*more quizzes and feedback*" to monitor their progress. Most online learning sites are already designed around interactive exercises and feedback on progress, e.g. Duolingo[15] and Codecademy[8]. If exercises or visualizations of learning progress could be integrated into the procrastination management extension, this might be motivational for users who prefer the "carrot" mode of procrastination management (as described above).

2: Presenting the microlearning environment. Currently Aiki redirects the user to a completely different website than their original intention. This may benefit some users, such as P5 and P6 who reported sometimes not visiting the time-wasting website after the language study session anymore. Being redirected to a different website may also be a disadvantage for some users: P6 described sometimes being so distracted by being sent to a different site that they completed a reading, closed the tab, only to remember that they meant to visit this another site – and was intercepted again when opening a new tab. One way to mitigate this is to **explore a design where the microlearning opportunity appears as a window-overlay on top of the time-wasting site**, which is supported by the finding that microlearning *within* a procrastination environment appears to be more effective than directing the user to an external website [24]. In this way, the user may experience less distraction from the original intention, and it may be clearer that the microlearning task is only a short interception before the user can proceed to their desired site.

3: Interrupting with task-limited rather than time-limited tasks. Some participants reported waiting for the timer to run out to proceed to their desired time-wasting page. P7 and P9 both suggested to base the interruptions by Aiki on *tasks to complete*, rather than *time to spend* – meaning, progressing to the time-wasting site should be based on a form of conditional, rather than a set time frame. Participants 4, 5 and 7 all described picking the shortest text available in Zeeguu (i.e. "doing the minimal amount of work required"), because they considered each text one "task" that had to be completed, rather than a text they could read and abandon after a certain amount of time had run out. This suggests that **task-based interceptions may make more sense to some users**. This functionality would require a tight integration between the extension and the learning website where the external website would have to "notify" Aiki that the learner had completed a learning task. Trusting the extension to automatically analyze the activity on the external website could be fragile and makes use patterns difficult to analyze. Microlearning environments which are possible to integrate with Aiki are potentially more attractive for research purposes, in that these give control over the exercises, the user is presented with.

5.3 Summary of design implications:

In short, we present a list of the design implications we discussed in this section. These are based on preliminary research with a novel design, which means that we have attempted to make them specific enough to reflect the findings of this particular study, as well as general enough to be relevant for similar research. The design implications described in this section were:

- The learning environment should provide positive feedback about the completed tasks to avoid negative associations with the microlearning tasks.
- Consider specialized versions of the extension which cater to different users, for instance with a focus on the carrot/stick or increased reflection-approaches.
- Consider implementing *modes*, such as a focus-mode and a leisure-mode (either automatically detected or manually controlled), where specific websites are not intercepted.
- The extension could motivate by interacting with the learning environment to provide feedback about the user's progression and use statistics.
- The microlearning opportunity might appear as a window-overlay on top of the interrupted site.
- Task-based interceptions may make more sense to some users than time-based ones.

5.4 Limitations and future work

We will continue the development of Aiki to explore these design implications in further practical experiments, and we invite peers to explore the Aiki extension themselves and to share their feedback with us: https://github.com/Aiki-Extension/Aiki.

One of the most important future studies will be to investigate whether the extension provides value in a longitudinal perspective. Previous research has shown that productivity interventions tend to decline in effectiveness over time, as novelty effects wear off [25], and the results presented in this paper are limited to observations based on a short time scale. Because the redirection to any learning environment is easily changed, we hypothesize that the extension could continue to create value for a user over time.

Another study that we plan to conduct in a longer term-perspective is a comparison of time spent on "time-wasting" sites with and without the active extension. In the current study, we did not gather benchmark data about this - mainly because it is difficult to argue that data about time spent on specific websites would be natural if participants were told that their use was being monitored, and we do not have access to the data without pre-installing a form of browser tracker. A future, longitudinal study will therefore investigate the effect of toggling the extension on and off during random time periods.

As described in the methodology section, an early-stage study like this is beneficial in raising hypotheses (in the form of design implications) which will be tested in future redesigns. We hope that by sharing the results of this paper, we can encourage other researchers to conduct studies of different aspects of the extension, or to modify it to use in their own research.

6 CONCLUSION

In this paper, we presented Aiki – a Chrome browser extension designed to assist a user in exchanging procrastination for language microlearning. We tested the extension in a semi-controlled experiment with 10 knowledge workers and summarized our findings into five observations, which were translated into practical design implications for Aiki and similar applications. Based on a two-week study, we conclude that redirection is an important alternative to *blocking* specific websites, in terms of procrastination management.

This type of extension, even in its preliminary version, has potential to both limit procrastination and increase engagement with productive sites in a lightweight manner.

The design implications will hopefully provide a good foundation for better integration of learning environments with this type of intercepting extension. While the results are preliminary and the participant cohort is limited, our detailed investigation found positive indications that an intervention of this kind provides opportunities for successful microlearning and procrastination management.

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