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RESEARCH ARTICLE



Digital frugality as a pedagogical component for regulating personal learning environments. An exploratory study in an end-of-school internship

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ABSTRACT

Digital devices have been conceptualised as extensions of the self, particularly within personal learning environments (PLEs). The capabilities of technological solutions may incentivise their extensive utilisation. Digital frugality can serve as an educational instrument in this regard. The present study employed a single-case experimental design with alternating treatment, in which students and instructors ($N = 14$) engaged in digital frugality, to collect variables related to engagement and learning. Focus groups and PLE modelling were then collected to describe the subjective experience. Despite the absence of a systematic functional relationship between digital frugality and the dependent variables, the participants characterised their frugal experience as a catalyst for learning and comprehension of informed choices in the regulation of their PLE. Consequently, technological solutions for expanding cognition should be accompanied by educational measures that enable learners to regulate their PLE. Digital frugality as a means for learning should be the focus of further study.

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Digital frugality; digital artefact; self-regulation; engagement; learning

Introduction

Digital devices such as laptops, tablets and smartphones have become ubiquitous in learning environments, facilitating access to information and resources within the institutional learning context. This technology-enhanced environment has clearly transferred a significant amount of responsibility to students (Marín et al., 2020), who are expected to maintain concentration on the learning activity (Citton, 2014), avoid distractions such as games, movies or other potential distractions triggered by nudges (Decuyper & Hartong, 2023) and take advantage of the opportunities offered by the internet, resources such as Wikipedia, generative artificial intelligence programs and the myriad of media that could potentially facilitate understanding and learning. In addition, they should not be distracted by features such as autoplay and algorithms that suggest divergent content, and they should know when to engage in metacognitive processes to identify the learning engagement needed, rather than continuing to focus only on instant feedback and gratification, as digital technologies often invite

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us to do, possibly because of gamification strategies (Li et al., 2024). Digital artefacts, as extensions of the self, require many skills, far beyond knowing how to use them. A user must assess availability, fluency and trust in every technology (Carter et al., 2018), as well as how technology use might be irresponsible (Popa, 2022), especially when the technologies are complex and opaque (Clark, 2003). So, how can the learning environment support individuals in this relationship built around the specific uses of technology for learning? Or what can teachers do to support learners' self-regulation in building and managing their personal learning environment (PLE)? It raises questions about how a digitally enhanced learning environment relates to personal competencies such as self-regulation, and how these variables can be strengthened in modern classrooms. These questions become even more complex when the educational domain itself mobilises digital technologies as both professional and learning tools, as is the case in training programmes for multimedia professions.

In the context of an end-of-school internship for a multimedia degree programme (students are around 20 years old), this study explores the concept of digital frugality as a pedagogical component in developing self-regulation skills and building a PLE. The internship setting provides a unique opportunity for the investigation, as students are expected to make autonomous decisions as they transition from the school setting to a professional environment. This is particularly relevant because compulsory education programmes generally do not allow students to choose their digital artefacts (Tadlaoui-Brahmi et al., 2022), in contrast to (post-)secondary education with its bring-your-own-device practice and its less structured learning environment (Jézégou, 2009). By examining the relationship between digital frugality, self-regulation and PLE, we aim to shed light on strategies that promote self-regulated learning in a technology-enhanced educational environment. Scientifically, the aim is to document the impact of a teaching strategy (digital frugality) on the regulation of PLEs. In practical terms (as we will see in the methodology and context of the study), the aim will be to encourage thoughtful use of the technologies available to young adults in learning situations.

Digital frugality

'Frugality is the new sexy', said Drolet et al. (2025). Indeed, digital frugality is an approach that has gained attention in recent years, partly due to calls for digital degrowth (Selwyn, 2024, 2025). Sometimes associated with the idea of 'less is more' (Westacott, 2016), it can be defined as an '*art de vivre*, which implies low material consumption' or 'voluntary simplicity' (Bouckaert et al., 2011, p. 269). We define it as the process of rethinking our use of digital solutions, particularly through the development of new skills or a new understanding of digital tools as extensions of the self, with the aim of reducing practical dependence on technology. In a positive sense, frugality is seen as a way of overcoming, or at least coping with, external constraints (Asakawa et al., 2019). Moreover, the practice is sometimes linked to innovation and sustainability (De Marchi et al., 2022): by limiting access to available resources, creative solutions that focus on essentials can emerge. Indeed, frugality can be driven by personal, economic or social factors and shaped by institutional or material constraints (Hossain et al., 2022). The frugality paradigm has also been framed as a reduction in complexity and an increase in responsibility (Tiwari & Herstatt, 2019).

In education, frugality is sometimes articulated as an educational goal, sometimes referred to as ‘sobriety’ (Descamps et al., 2022), and defined as a virtue that ‘increases future adults’ chances of living well with scarce resources’ or that ‘facilitates the exercise of autonomy’ thanks to the reduction of complexity-induced constraints (Zwarthoed, 2015, p. 287). The practice of restraint is also presented to address justice, climate change and a sense of well-being in education (White, 2021). And when the spiritual and religious dimensions of frugality are set aside for secular schools, these conceptual implications are consistent with the missions of public schools. Indeed, digital frugality as an educational outcome seems legitimate, as evidenced by calls to limit educational technology in the classroom (Selwyn, 2021, p. 503).

However, few studies have been conducted on digital frugality as a pedagogical component (Hossain, 2016), even though the topic was theorised already 25 years ago (Hopper & Hendricks, 2008). For teachers, the concept has sometimes been presented as designing learning experiences with open source in mind, using available resources, or building at the speed of need (Arnab et al., 2021). In their literature review, Hossain et al. (2022) discuss the economic consequences of frugality (e.g. new jobs or more efficient markets), social impacts (e.g. improved access to services or social justice) and environmental impacts (e.g. reduced waste and increased recycling), but they do not present variables directly related to education. In a school context, it would be necessary to explore how digital frugality could function as an invitation to develop skills and knowledge – but also creativity in the sense of finding ways to learn differently or complete learning tasks without technological extensions of the self (McLuhan, 1994). Opening up the possibility of choosing digital tools requires that each student create his or her own personal learning environment.

Personal learning environment

Defined as ‘a group of Web technologies, with various degrees of integration and interaction, which help users and learners manage the flow of information that relates to the learning process, the creation of knowledge, and the development of skills’ (Torres Kompen et al., 2019, p. 195), PLEs promise greater personal freedom and flexibility, thus helping students to develop their own capabilities (Whalley et al., 2021). As such, it can be framed as a socio-technical issue that invites holistic reflection on how to learn in the context of contemporary digital opportunities and risks. It certainly provides a certain self-directed learning in formal contexts, but also enables students to connect skills and knowledge acquired in informal contexts (Cisel, 2022).

PLE have been conceptualised set of learning instruments that foster self-regulation (Yen et al., 2019). This conceptualisation encompasses three separate yet complementary approaches: subjective, technological and pedagogical meta-design (Henri, 2014). The subjective approach conceptualises PLEs as an individual’s comprehensive array of learning instruments (Väljataga & Laanpere, 2010), which can be strategically employed within the context of a specific learning initiative. Artefacts, in this context, are defined as technical in nature, yet they concurrently embody pedagogical, didactic and social dimensions (Felder, 2019b). These artefacts are meticulously arranged into a systematic framework, wherein the processes of instrumentation and instrumentalisation (Rabardel, 1995) are orchestrated. Moreover, a pedagogical approach must also be considered when

analysing PLEs in educational and professional training programmes (Henri, 2014). In this regard, the digital devices are conceived as instruments that individuals can employ to design their learning projects, define their objectives and select the set of tools and resources they need to achieve their goals (see Figure 1, for a representation). In this approach, teachers can support learners in various ways, sometimes by intervening in the digital environment itself and sometimes by demonstrating how a digital tool can become an instrument. In essence, to harness the comprehensive potential of this multi-faceted learning environment, where technical, pedagogical, didactic and social dimensions are intricately interwoven, and where freedom and obligation are inextricably juxtaposed, learners must construct and self-regulate their own PLE (Felder, 2019a).

The impact of PLE on student learning and engagement has been previously documented in academic literature. If the autonomy to design an individualised PLE can be deemed sufficient in the undergraduate student population, aspects such as time management, reading all materials and conducting additional research are considered insufficient and call into question the hetero-regulation needed (Chaves-Barboza et al., 2015). Other findings indicate that self-regulation skills such as goal setting or self-monitoring should be strengthened when the PLE approach is introduced (Alserhan et al., 2023), with the aim of guaranteeing a fruitful use of the autonomy given to the students. In alignment with this, a range of strategies have been devised to promote self-regulation skills. These include the explicit instruction of learning strategies, the provision of feedback and monitoring based on students' logs and the encouragement of self-regulation on the part of students (Wandler & Imbriale, 2017) through the formulation of questions regarding the instruments in place. This inherent complexity of the PLE may explain why

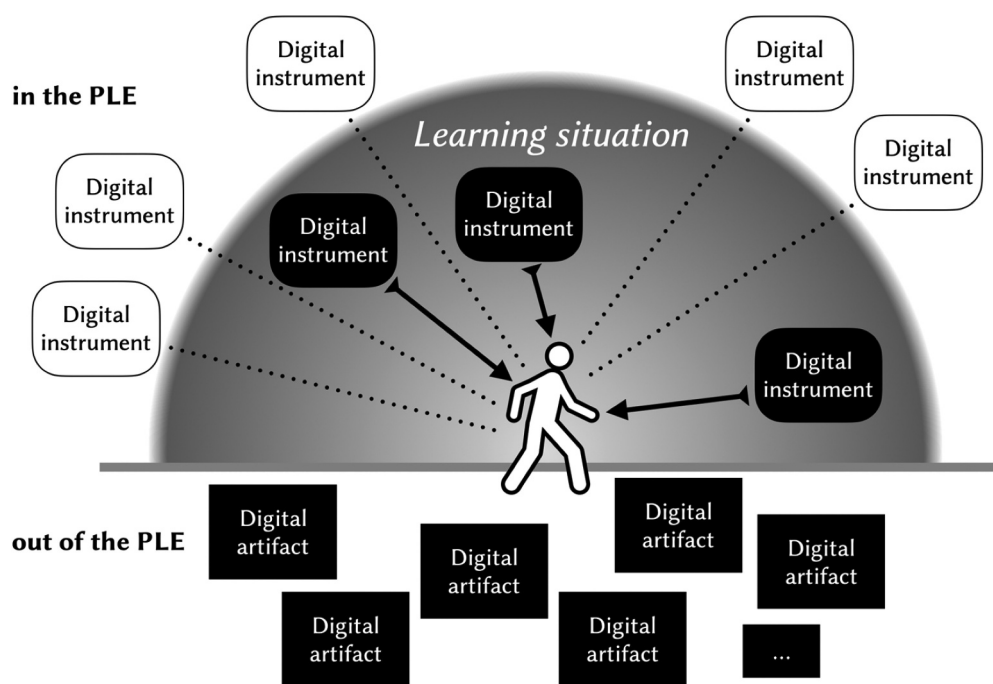


Figure 1. Representation of the PLE in a digital environment with instruments and artefacts.

younger learners generally have no input in the construction and management of the digital tools available to them in their learning practices (Mercier et al., 2025).

Accordingly, the PLE approach fosters a comprehensive reflection on the manner in which students can learn in contemporary technology-enhanced environments characterised by the perpetual availability of digital tools. Furthermore, with the responsibility for learning being reallocated to the student, inquiries emerge concerning teachers or institutional roles in supporting self-regulation skills. Specifically, it is imperative to address the methods through which students can be assisted in constructing and regulating their PLEs. While current research explores the use of AI for the creation of PLEs (Jijeesh & Smita, 2025; Ronksley-Pavia et al., 2025), this present study explores digital frugality.

Self-regulation

An individual's learning autonomy – comprised of competencies such as self-regulation, self-direction, metacognition and agency – plays a crucial role in academic success and lifelong learning (Bembenutty, 2023). For students, learning autonomy is related to time management, focus and efficiency in learning (de Bruin & van Gog, 2012). For instance, cognitive strategies such as note-taking or self-monitoring prompts are components of self-direction in Web-based learning environments (Kauffman, 2004). Indeed, a sense of personal autonomy is considered essential for students to thrive in an increasingly complex and rapidly changing world.

A recent literature review (Berger & Cartier, 2023) proposes retaining the definition that self-regulated learning is an individual's personal learning process. This process involves 'efforts to initiate, direct, and strategically manage goal pursuit in situ via metacognitively planning, monitoring, evaluating and adapting one's cognition, behaviour, motivation, and affect' (Greene et al., 2023, § 1). Zimmermann (2008) posits that the self-regulated learner can proactively select, structure and even create a fruitful learning environment. Integration of technology, self-regulated learning, intrinsic motivation and learning engagement appear to be interconnected (An et al., 2024). Consequently, with the requisite digital competencies, self-regulated learners can undoubtedly engage in the design of their own PLE.

Several strategies for promoting self-regulated learning have been identified in the extant literature. Of these, 14 – including prompting self-evaluation, seeking information and seeking assistance – were proposed as early as in 1986 (Zimmerman & Pons, 1986). Self-regulated learning has been theorised as involving cognitive and metacognitive skills (Friedrich & Ballstaedt, 1997), such as setting goals, organising and streamlining information and assessing learning immediately. With the incorporation of digital technology into the process, the concept of self-regulated digital learning has been developed, related to domain-general and domain-specific strategies (Yen et al., 2018), including time management, reflection on the learning process and concept mapping. Furthermore, the efficacy of self-regulatory procedures appears to be contingent on the context, with divergent practices emerging between personal and professional usage (McNaughton et al., 2022). However, a systematic literature review has demonstrated that environmental structuring and seeking social assistance are not yet well documented when e-learning strategies are implemented (Garcia et al., 2018). As such, it can be questioned whether the institutional

environment can promote self-regulated use of digital technologies and, consequently, whether it is receptive to building PLEs.

This study explores the concept of digital frugality as a form of temporary intervention, designed to motivate students to engage in novel learning experiences. Although frugality has been proposed as a lever for educational innovation (Masters, 2024), to our knowledge it has not been tested in a real learning context. The integration of digital frugality into specific moments throughout the weeks is theorised to function as invitations for self-regulation in the design of PLEs. In the context of 'reconfiguring ed-tech practices' (Selwyn, 2021, p. 504), frugality is conceptualised as an opportunity for students to identify the instruments they need, when they need them and for what purpose, and to reflect on their role within their PLE. However, beyond this innovative conceptualisation of digital frugality for education, further experimentation and data are necessary to explore the value of such an approach. The objective of this study is to confront the theoretical perspective of digital frugality as a pedagogical component within an education and training context, to empirically document the relationship that this educational component displays with self-regulation skills and PLE design.

Methodology

This section presents the three methods employed to ascertain whether if and how digital frugality represents an opportunity to develop self-regulation skills and support PLE design and regulation. Firstly, a single-case design ($N = 12$) with alternating treatment was utilised to assess whether self-reported measures of variables related to learning and productivity show a functional relationship with digital frugality. Secondly, a focus group comprising nine participants was recruited, and their perceptions of the digital frugality condition were subsequently analysed through content analysis. Finally, the evolution of two volunteer participants' PLEs during the course of this experience was documented through PLE modelling and reflection. This multifaceted approach, integrating qualitative and quantitative data, was employed to comprehensively describe the relationship between the introduction of frugality, self-regulation and PLE design.

Participants

The two-month digital frugality intervention was conducted during an end-of-school internship in a multimedia design training programme in the French-speaking part of Switzerland. The internship is open to students at the end of their vocational school of applied arts, who are tasked with creating content at school with the instructors' support, but based on a private mandate, during a period of about three months. The mandates could be creations of illustrations, videos, websites or any other demanding multimedia productions.

The digital frugality project was initiated by the instructor overseeing the internship programme, who noted that students were allocating learning and production time to streaming videos and sending text messages with no relevance to their assigned tasks. His concern for the development of his students' skills was so great that he contacted the teacher training faculty at his local university to ask for help. He also expressed concerns about students engaging in activities such as checking notifications and unrelated emails

during creative processes. Students should pay more attention to their tasks and be less distracted by external factors, according to the instructor, because their future employers will not tolerate a lack of productivity. In other words, students would lack self-regulation, and a change in the learning environment would be necessary. Through deliberations and negotiations, an experimental design was formulated that aligns with the desired outcome while adhering to established research standards.

Following a presentation of the project's implications and intention to provide an opportunity for learning about digital utilisation, the entire team of eight students ($M_{\text{age}} = 22.25 [1.98]$) and four instructors ($M_{\text{age}} = 45.25 [5.12]$) agreed to participate in the study. The instructor in charge obtained permission from the school authorities to carry out this project. No applications were submitted to ethics committees, as the project does not fall under the purview of the Swiss Federal Act on Research Involving Human Beings (2011). In order to guarantee the students' voluntary participation, three commitments were made by the principal investigator. Firstly, free and informed consent was obtained during a session in which the 'digital frugality' project was presented to them in detail and their opinions regarding any necessary modifications to the experimental conditions were discussed and taken into account. It was at this time that each student was able to give their consent individually. Secondly, the data they reported were only accessible to the principal investigator and not at all to the internship supervisor. The paper forms completed by participants were stored in a locked mailbox, the key to which was only available to the principal investigator. Finally, the commitment to digital frugality did not contribute to validation of their training. It is to be noted that all students concerned successfully completed their internships.

Tuesdays (intervention phase) were designated as 'no distraction days', during which digital frugality was practised. The explicit instructions were as follows:

At 8:30 a.m., every Tuesday morning, students and instructors were required to switch their mobile phones to airplane mode upon entering the classroom. They were instructed to abstain from using digital communication channels (e.g. instant messaging, email, social networks) and streaming platforms on their computers until 5:15 p.m., the end of the working day. Breaks (including lunch breaks) were included into the intervention.

Given that the work of students and teachers entails the creation of multimedia supports, the primary concern was not the removal of computers and tablets, but rather the evaluation of the software and applications utilised during the designated frame. The intervention was conducted on a total of eight Tuesdays during the spring semester.

Single-case design with alternating treatment

The single-case experimental design (SCED) was selected due to its capacity to meticulously document the functional relationships between an independent variable – here, an intervention phase every Tuesday and a baseline phase every Friday – and multiple dependent variables (Kourea & Lo, 2016). This research methodology has the benefit of high-quality standards in terms of design (Kratochwill et al., 2023), standards that this study upheld. The alternating treatment design (ATD) variation of SCED (Manolov & Onghena, 2017), defined as 'a class of [single-case experimental] designs that emphasises a rapid alternation between two or more conditions' (Kratochwill et al., 2015, p. 6), was

preferred in this study. Utilising this research design allowed us to address the assignment as commissioned and to ensure that students and instructors would not be overwhelmed by extended periods of digital frugality, as would have been the case with a SCED with multiple baselines, for example. In addition to that, this methodological approach does not require a baseline, since it compares two conditions in alternating time frames.

The dependent variables were collected via a self-report questionnaire completed at the conclusion of the working day on Tuesdays and Fridays. The questionnaire was based on studies concerning job environments (Galanti et al., 2021; Lee & Brand, 2005; Morgeson & Humphrey, 2006; Peiró et al., 2019) and was discussed with two instructors, including the person who commissioned the research project. In addition to administrative data, which included date, name and time spent in the laboratory, the participants were presented with 19 items on a Likert scale ranging from ‘-3’ (totally disagree) to ‘3’ (totally agree). Four items addressed perceived productivity (e.g. I’m satisfied with my work today), three were about self-reported professional engagement (e.g. I felt a sense of dedication today), five about distractions (e.g. I found it difficult to focus today), six about a personal sense of well-being (e.g. I felt relaxed today) and one about social unity in the workplace (e.g. There was a sense of social cohesion at work today). In addition to these items, participants were invited to add words or short sentences every Tuesday to describe how they experienced the digital frugality setting (intervention phase).¹

Although studies have shown that self-reported statements are not optimal for SCED (Alvarez, 2017), as the same individual completing the same questionnaire on multiple occasions can potentially yield less authentic, more automatic responses, the decision was made to maintain the original approach, considering the constraints imposed by the internship. The data collected must be interpreted within the context of these constraints and to acknowledge that this study constitutes an exploratory research project.

Focus group

In addition to the SCED-ATD method, qualitative data were viewed as a necessary component for understanding how the participants experienced the digital frugality setting. The form of a focus group was selected for this study, as it allows researchers to identify ‘a range of perspectives on a research topic and to gain an understanding of the issues from the perspective of the participants’ (Hennink, 2014, p. 2). In this study, the focus group was specifically utilised as a tool to assess perceptions of the frugality experience.

Nine participants (seven students and two instructors) consented to partake in a 90-minute focus group discussion, during which the following inquiries were posted: ‘How did you cope with the digital frugality constraints?’ ‘How have you had to modify your habits to cope with the constraints?’ ‘What links do you perceive between digital instruments and satisfaction, engagement, distraction, productivity, and learning?’ The responses were systematically relayed to the other participants, who were then asked: ‘What do you think of this statement? What would you like to change or add?’ The oral exchanges that took place during the focus group were recorded on audio for the principal investigator to listen to again. For the purposes of this article, the comments reporting a particular experience relating to the ‘digital frugality’ condition were transcribed and anonymised. The audio recording was then destroyed, in accordance with the

announcement made to the participants. The qualitative data collected were then analysed with conceptualising categories (Paillé & Muchielli, 2011) to record the perceptions.

PLE modelling

A modelling method was employed to document the reported PLEs and to map the participants' reflections on their potentially evolving PLEs before, during and after the digital frugality intervention. PLE modelling is a methodological contribution to the study of PLE and related phenomena that relies on explanatory interviews (Tur et al., 2016), a PLE ontology and a modelling language to create a graphic representation of a learner's PLE, relative to a given learning experience. The models produced this way support learner reflection and form an object of analysis for researchers (Felder, 2019c). A recent application of this method involved the study of transformations in learning practices during the Covid-19 pandemic. In this case, the method facilitated the identification of the relationships between self-regulation processes and learning design as educational practices shifted from traditional classroom environments to distance learning settings (Charlier et al., 2022).

Two volunteers carried out the PLE modelling, for which a high-quality audio recording was made of a one-hour session with each participant. The most informative data were determined to be the different PLE models for the participants (before, during and after the intervention phase), as well as the students' comments on these models and their evolving perceptions over the course of the digital frugality intervention. Participants were asked to reflect on the following: 'Please think back on your internship before the "no distractions" intervention. Think about what you were doing, what you were learning, how you were going about it, what tools you were using'. Subsequent to the presentation and storage of the graphic depiction of the PLE, the participants were prompted to reflect on the following: 'Now consider the "no distractions" days. What has changed in your learning environment, in the way you learn and work?' The model was then adapted in accordance with the participants' responses. Subsequent to the presentation and discussion of the second graphic representation of the PLE, the participants were prompted to consider their future PLE: 'Now think about what's next for you, how you will work today. What has changed in your learning environment, in the way you learn and work?' The third model was then created using the final version of the process.

The data stemming from the documentation of how the digital frugality intervention impacted the students' PLEs and learning experiences as well as the documentation of the participants' perceptions served as the basis for the next step of the study: quantitative and qualitative analyses.

Quantitative data – SCED

Data from the SCED-ATD phase were analysed visually (Kratochwill et al., 2014) using graphs generated via <https://tamalkd.shinyapps.io/scda/> to document the existence of a functional relationship between digital frugality and the dependent variables measured. The graphs generally reveal a wide variability in the data that rules out hypothesising a functional relationship (Manolov et al., 2014). This was observed in most variables and participants, with the following exceptions: (a) one student's self-reported productivity,

(b) one instructor's self-reported engagement, (c) the differences between every instructor's and every student's self-reported engagement, and (d) the self-reported impact of digital frugality on the entire group's sense of well-being (Figure 2).²

As proposed, the analysis of the visual rendering of the SCED-ATD data encompasses consistency assessment and magnitude difference identification (Kratochwill et al., 2023). As illustrated in Figure 2(a), consistency is not guaranteed, but the magnitude difference is effective. In Figure 2(b), both factors can be seen explicitly, with the exception of the eighth measurement point, which shows a specific reported engagement in the baseline phase. Participants reported that the day was unusual, with a prolonged out-of-office period. As indicated in Figure 2(c), consistency is certainly not observed, so it is plausible to hypothesise that the magnitude difference is greater for instructors than for students. Figure 2(d) shows a discernible difference between the conditions, despite the consistency issues identified in measurement points seven and eight.

The SCED-ATD analysis does not lend itself to statistical tests and effect size calculations, due to the absence of a discernible functional relation between the dependent and independent variables. Indeed, the data reveal that the experience

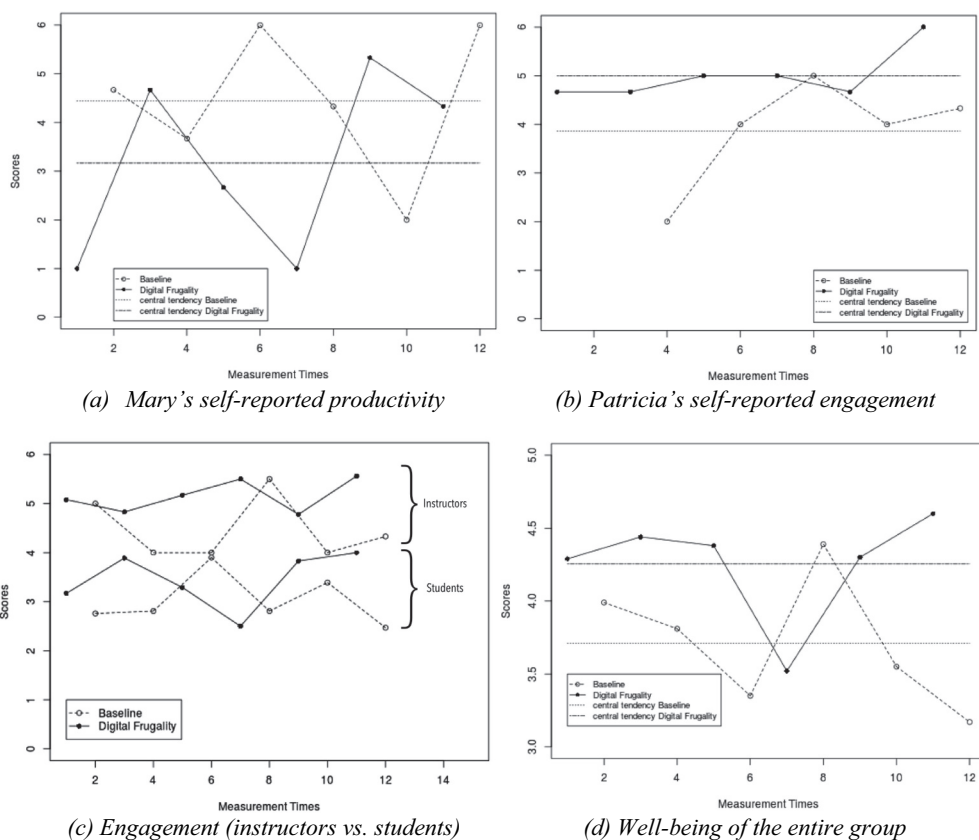


Figure 2. Self-reported impact of digital frugality on (a) Mary's productivity (student), (b) Patricia's engagement (instructor), (c) instructor vs. student engagement, and (d) sense of well-being of the entire group. Digital Frugality scores range from 3.5 to 4.6, while Baseline scores range from 3.2 to 4.0. 'Central tendency' depicts the mean of every data point of the intervention.

of digital frugality may have various self-reported effects on the participants, depending on personal perception. The volatility of most of the collected variables precludes the identification of a clear functional relationship, so further data are necessary to achieve a more complete understanding. In light of the potential impact of personal factors on the studied functional relationships, qualitative data were collected to elucidate the nature of frugality as experienced by the participants.

Qualitative data – focus group

The data collected in the focus group can be categorised into the three main classifications, as outlined below, with the verbatim dialogue serving as authentic illustrations of the experience (see Verbatims 1, 2 and 3).³ In this qualitative analysis, the decision was made to maintain the integrity of the data by not separating the contributions of students and instructors. This approach was adopted as all participants engaged with the digital frugality experience in a comparable manner. Furthermore, within the focus groups, individuals drew upon the words of others to articulate their own perceptions, exhibiting no discernible distinction between the contribution of students and instructors. It is noteworthy that, given the experiment's context in a French-speaking environment, the statements were translated into English by two bilingual scientists for the purpose of this publication.

Firstly, the participants regarded the digital frugality intervention as *a positive experience for exploring how they use digital technologies*. The entire experience was perceived as an opportunity, with the exception of the inability to access emails, which instructors felt was a barrier to professional work.

Verbatim 1. Statements showing a positive perception of digital frugality

I'm taking something positive out of it. (John, student)

I thought it was really cool to do. (Mary, student)

We noticed that when we weren't concentrating on the task, we didn't use our phones, we laughed together, our breaks were almost longer! (Linda, student)

Secondly, the experience of digital frugality has been associated with *divergent subjective consequences*. Some participants have reported a conscious awareness shift due to the intervention, while others have reported unconscious changes. Furthermore, while some participants have discussed the acquisition of new learning strategies, others have reported positive somatic impacts.

Verbatim 2. Statements showing a perception that digital frugality has various consequences

I now have an automatic reflex to put my phone away and close the [messaging app] on my computer when I need to concentrate. (Patricia, instructor)

At first, I'll think about it [the phone, in general], I'll always want to check it, but I tell myself that I'm concentrating now and that I'll get back to it later. (John, student)

At the end of the day, I had fewer headaches . . . , so I felt better, my eyes were better, so my head was better too. (Sarah, student)

Finally, digital frugality has been documented as a factor that contributes to the *emergence of a sense of liberation*. Some participants reported experiencing a sense of freedom that enabled them to refrain from providing direct answers or from constantly checking their phones. This phenomenon may be associated with the concept of FOMO (fear of missing out) as previously theorised (Alt & Boniel-Nissim, 2018).

Verbatim 3. Statements showing digital frugality as the emergence of a sense of liberation

It was nice to be aware of the impact, sometimes it was an automatic reflex, I realised how many times I started putting my hands in my pocket. (Linda, student)

I didn't need to answer people's calls during the day. With the phone, you're always hooked on people. (Sarah, student)

We're more in the moment, and at the end of the day we look at what happened [notifications]. (Sarah, student)

We used to use our phones to be productive, and we end up being counterproductive. (Patricia, instructor)

Upon the conclusion of the focus group, the students revealed that they had documented their experience independently. Photographic documentation, captured on a weekly basis, meticulously edited and disseminated via social media at the day's conclusion, substantiates the student's assumption of responsibility for the endeavour. This ownership is evident in their adherence to the 'no distractions' assignment and the adoption of the 'every Tuesday no phones' slogan (Figure 3).

Qualitative data – PLE modelling

The third type of data collected was used to document the participants' perceptions of changes in their PLE. The evolution of their PLE models represented an opportunity for the participants to comment on their PLE, their relation to digital artefacts and the digital frugality experience. Figure 4 illustrates two PLE models generated using Mary's reported experience. Figure 4 depicts her PLE prior to the digital frugality experience. Figure 5 illustrates her PLE during and after the frugality experience. The verbatim excerpts indicate that the changes in her PLE persisted after the frugality experience concluded.

A comprehensive examination and discussion of the PLEs with the participants have led to the emergence of novel perceptions regarding the digital experience, including the following: (i) distraction management, (ii) individual/group negotiation, (iii) professional/leisure blending, (iv) personal qualities, and (v) new PLEs.



Figure 3. Social network posts showing how the participants took ownership of the digital frugality intervention. (permission granted by the participants.) 'Tous les mardis sans téléphones' translates as 'every Tuesday no phones'.

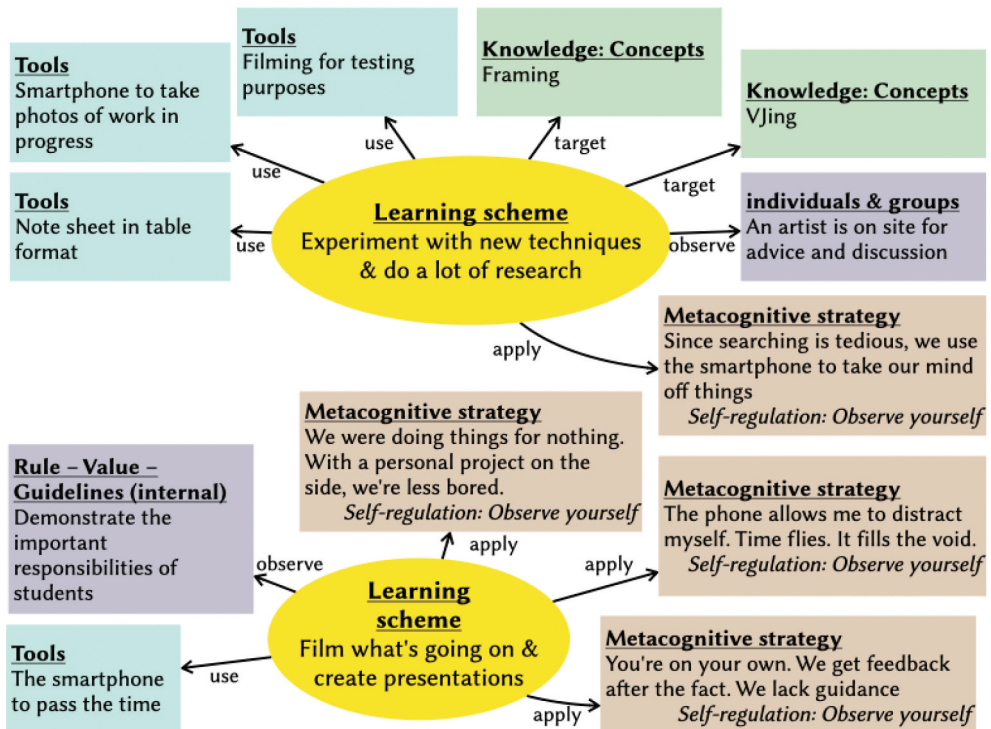


Figure 4. Mary's PLE model prior to the digital frugality experience, based on self-reporting.

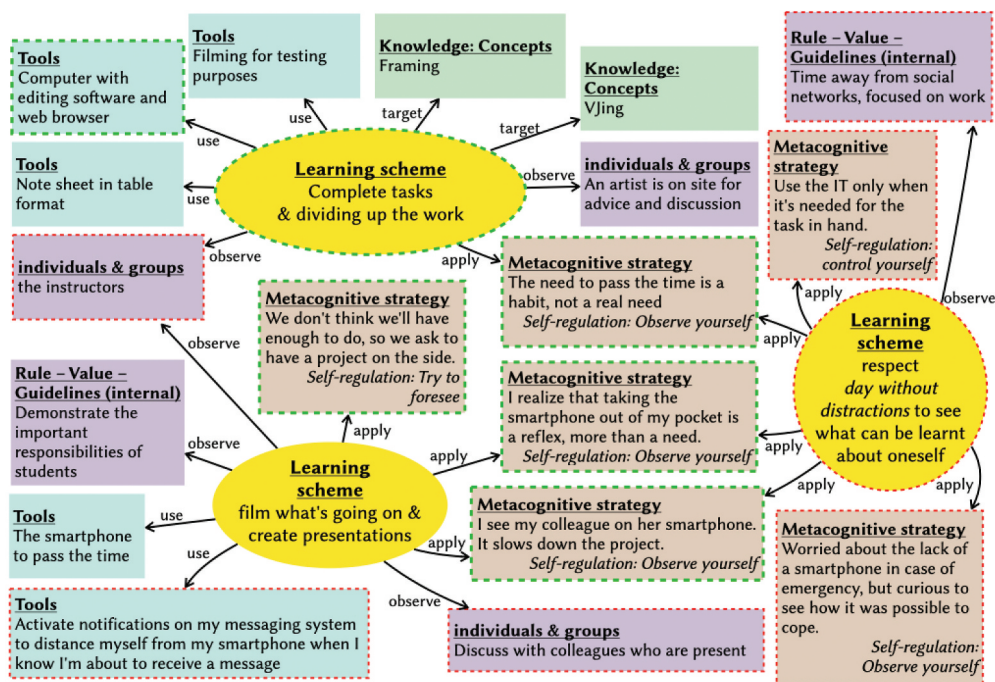


Figure 5. Mary's PLE model during the digital frugality experience, based on self-reporting. The elements of the PLE that have evolved are outlined in green. The elements of the ELP that have been added are outlined in red.

Distraction management

These two modelled PLEs and the discourse surrounding the experience suggest that the phenomenon of distraction by smartphones, social networks and streaming services is part of a more complex system. It is important to note that this issue goes beyond the mere question of the use of digital artefacts. Distraction is perceived as both a need and a pressure to connect with one's social circle. However, it is also perceived as a strategy for managing a task when it is experienced as boring, repetitive, useless, automated, or even too difficult.

Verbatim 4. Statement illustrating the complexity of distraction phenomena in educational settings that allow personal digital artefacts

The telephone wasn't much used except as a way to pass the time, because there were quite a few moments when we had been doing the same thing all day. ... But it's a bit long, actually, because after a while, as I was saying, we often ended up on our phones doing other things, because after three days of doing the same thing, we started to get a bit bored.

In the course of the digital frugality intervention, when phones were removed from students' possession, they frequently sought out alternative means of diversion. These included engaging in discourse within the group, taking extended breaks, engaging in non-professional discussions or reading a book. Consequently, in this context, a diversion of some kind is perceived as necessary.

Verbatim 5. Statements illustrating the perceived necessity for distraction strategies within the PLE

What replaced my phone was talking to my colleagues. We talked about anything and everything. It's even more dangerous for us not to have a phone, because even if we're talking about something trivial, it takes an hour. Sometimes the instructors, some of them, would join in the discussion.

And then they wanted us to transfer the video recordings on the computer. It took two hours to load them, so it already took half the day. Then, you see that you've got your little five-hour uploading bar. So, you pull out your phone, right?

One student asserts that she is able to concentrate more effectively by refraining from using her smartphone, while another contends that she is more productive when she has access to additional sources of distraction. Consequently, the necessity for distraction may pertain to issues such as learning design (how to create a more engaging training environment?), educational support (how to more effectively cultivate self-regulation in learners?) or self-direction in learning and professional tasks (how to engage in activities independently?).

Individuals group negotiation

The necessity for distraction is regarded as being personally motivated in multiple respects. Digital devices merely serve as an enabling function in this regard. If other colleagues distract and slow the project's progress, whether through face-to-face interactions or smartphone notifications, the issue causing the distraction is positioned as an external parameter.

Verbatim 6. Statements describing the way the distraction of another individual is mediated by a digital artefact

The person I was working with, I know it was a bit of a complicated life phase for her. She was often late and often absent. And she was always on her phone. So, I could really see that we weren't making any progress, and it was a bit painful because every time we had a meeting with the manager, ... I'd be told, 'no, that's not right, you've got to do this'. Then she'd arrive and we'd talk about it, demotivated, and as I said before, very quickly, I'd see her back on her phone, spending a lot of time.

When an individual perceives a use of an artefact as a source of distraction, this phenomenon is characterised as a personal challenge, which engenders feelings of culpability and the need for self-regulation.

Verbatim 7. Statements describing personal use of an artefact, revealing a form of self-regulation

Because YouTube is something that plays a very, very big role in my procrastination. I mean, there were days when, if I wasn't feeling well, I'd spend the whole day on YouTube. It's horrible because, at the end of the day, you just feel so bad for not having done anything.

However, as previously reported in the PLE model prior to the digital frugality intervention (see [Figure 4\(a\)](#)), it is regarded as an interpersonal concern when a peer's smartphone usage disturbs another individual.

Verbatim 8. Statements showing the role of interpersonal relationships when the use of digital artefacts is perceived as a distraction.

It bothers me that we're on our smartphones rather than moving forward on the project. But how do I tell my friend? I'm not the boss.

Furthermore, the two students reported that they experienced distraction through discussions with others as a means to achieving group cohesion, but not directly related to their work or learning. The distraction refers to the values and principles desirable to a community but is not perceived as being directly related to the digital artefact.

Verbatim 9. Statements showing the sense of community that fosters non-professional interactions.

Breaks created cohesion, but not on a professional level. Cohesion only happens during the break.

Professional/leisure blending

Smartphones, streaming services and social networks are equally professional, leisure and relationship-building tools. YouTube, for instance, can serve as a valuable resource for professional documentation and artistic research. However, its potential to hinder learning when it diverts attention from the task can be detrimental. Furthermore, YouTube can function as a means of emotional regulation, particularly in moments of discomfort, withdrawal or disengagement during tasks, projects, or even during the internship itself. This understanding suggests the potential for distraction to serve as an indicator of the need to modify one's PLE.

Verbatim 10. Statements showing the blending of professional and leisure activities in the context of digital artefacts

Sometimes, for projects, I'd have to search for commercials, I'd go on YouTube to see what's out there, but I had to hold myself back from watching another video.

Personal qualities

Digital frugality can serve as a pedagogical component for learners to understand their personal characteristics and to self-regulate their PLE. Once learners adopt this approach, they engage in metacognitive self-regulatory actions and procedures. For instance, one student noted that she became aware of the time and mental space her use of the messaging system consumes, or the discomfort she felt after not engaging in productive activities.

Verbatim 11. Statements showing the discomfort triggered by the time and mental space consumed by a digital artefact

Reflecting on this experience, I realised that my use of WhatsApp and other apps wasted my time, especially when I expected a notification, I became aware of the mental space it was taking up.

Another student was able to leverage the digital frugality constraints to justify her decision to refrain from responding to messages during the day. This transition occurred from technical opportunities to personal autonomy through institutional constraints with the digital frugality temporary intervention. Subsequently, new self-control skills were cultivated.

Verbatim 12. Statements showing reported new skills in the domain of PLE regulation

I learned to put my cell phone further away from me, to turn everything off, or to use notifications to stay more concentrated in my work.

New PLE

Self-regulation during digital frugality appears to have precipitated a shift in the PLE. In Mary's case, when she discusses her current project, there is a notable absence of her smartphone and instant messaging app. Concurrently, she implements two rules: first, she maintains her smartphone in a location that is distant from her desk to mitigate distractions and enhance focus. Second, she does not initiate the instant messaging app on her computer, thereby avoiding the temptation to incessantly check notifications.

Verbatim 13. Statements showing the evolution of PLE towards regulating distractions

I've noticed that it's something I reused later in my own projects or even on the days when I was allowed to have my phone. My phone, I put it either in my bag or in a drawer, don't put it on my desk . . . I try not to engage in WhatsApp conversations so that I don't go and see the messages.

Discussing these exploratory data to establish a theoretical perspective

In the present study, the less is more perspective (Westacott, 2016) frequently appears to be accurate in the qualitative data, indicating that a reduction in certain uses of technology leads to an increase in creative practices for learning. Therefore, the regulation of PLEs can be supported through the practice of digital frugality, as technology use must be discussed by the affected persons. This approach holds promise in affecting PLE due to external constraints (Asakawa et al., 2019) experienced subjectively (Henri, 2014). Contemporary technological opportunities, characterised by their vastness and unrestricted nature, call for some well-designed pedagogical limitations, thereby facilitating student contemplation on the extensions of the self (McLuhan, 1994). The temporary reduction in technological consumption appears to exert a sustainable effect on PLE for several individuals. In consideration of the benefits reported by interviewees, the hetero-

regulation imposed by the frugality experience engendered novel knowledge and skills. Other tools were instrumentalised, and some instrumentation underwent a change (Rabardel, 1995). They engaged in 'planning, monitoring, evaluating and adapting one's cognition, behaviour, motivation, and affect' (Greene et al., 2023, § 1) with modified uses of technologies.

Two predominant perceptions emerged in this context. First, technical artefacts can be regarded as self- or peer-imposed constraints to be managed. As technology allows for a blending between personal and professional life, some students experienced the pedagogical constraints of digital frugality as an opportunity to abstain from using their digital devices or from sending peers a quick response. In this case, the participants appreciated the ability to explicitly state that they were not constantly available. Consequently, digital frugality can be conceptualised as a teaching and learning strategy.

Secondly, technical artefacts have the potential to serve as a means of evading boredom or other challenges, particularly when a learning experience is initially perceived as devoid of meaning, uninspiring or undemanding. In such instances, digital frugality can be regarded by students as an opportunity to allocate time for introspection regarding the significance of a learning experience. For teachers, it can be seen as an invitation to question the learning experience proposed. Furthermore, participants have identified it as a strategy to re-establish genuine connections with colleagues.

Digital frugality has the potential to cultivate a sense of agency through temporary self-imposed or pedagogical boundaries, thereby functioning as an invitation for students to question their own PLE. In the context of constant peer solicitations or the merging of personal and professional life with a unique device, digital frugality is certainly a learning opportunity. Indeed, since technologies have become widely available, easy to access and integrated into learning situations, it is up to pedagogy to guide the student's reflection on the role they should play. Without this, students with fewer self-regulation skills may allow distracting technologies to enter their PLE. Consequently, digital frugality holds the potential to contribute to the student's empowerment, as illustrated in [Figure 6](#), based on the data and analysis conducted.

Conclusion

In this study, digital frugality is posited as a potential driver for promoting the right conditions for learning when using digital artefacts. Specifically, the restricted use of digital technologies is intended to facilitate the ownership taking of PLE design and the improvement of self-regulation skills on the part of learners or teachers. Indeed, digital frugality requires awareness of how we use digital devices to solve various social and technical problems, or to add constraints that modern technology has largely done away with. The objective of this study is to examine how digital frugality is experienced and how it is associated with self-regulation and PLE design. To this end, SCED-ATD, focus groups and PLE modelling were used to document the experience of digital frugality in an end-of-school internship that spanning two months. Every Tuesday, the entire team (consisting of students and instructors) was required to remove digital distractions (e.g. instant messaging, video streaming, email) to enhance their focus on their learning and creative work. While the quantitative data reveal a variety of implications that are undoubtedly indicative of personal factors influencing how digital frugality is

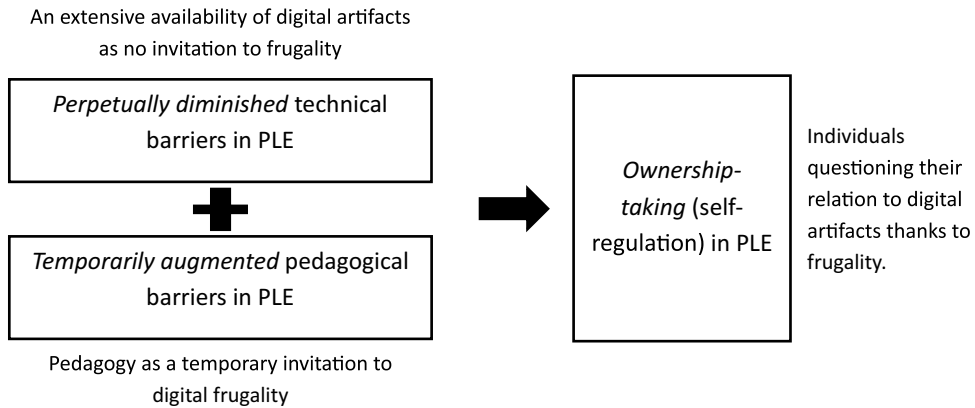


Figure 6. Depiction of a plausible relationship between digital frugality and self-regulation in a learning setting.

experienced, the addition of qualitative data allows for a more profound comprehension. The pedagogical constraint of digital frugality has generally been interpreted as an opportunity by learners in the experiment. Thus, it seems that pedagogy must, in certain situations, regulate the penetration of technologies in order to develop a critical and regulated relationship with the technical artefacts that make up the PLE.

The results discussed above must be interpreted with caution for several reasons. Firstly, if SCED-ATD analysis does not allow for a clear functional relationship between frugality and the collected variables related to learning and professional engagement. It must be remembered that the data were self-reported, which is not optimal in this context because the participants knew the condition they were in (classic vs. frugality). Secondly, the voluntary participation of all participants in the focus group and the PLE modelling might have introduced a selection bias, potentially influencing the comments made regarding the digital frugality experience. Finally, the data were collected in a highly specific context – an end-of-school internship in digital media design, in a culturally and geographically specific context (French-speaking Switzerland) – which necessitates a considerable degree of caution when generalising the results to other contexts. Furthermore, additional research is necessary to elucidate the potential influence of digital frugality on students and instructors/educators, particularly in light of the intricate relationship between digital utilisation and well-being (Bruggeman et al., 2019) or learning (Timotheou et al., 2023).

Despite these concerns, the notion of digital frugality as a pedagogical component could serve as an innovative approach within education and training programmes, particularly concerning the design and regulation of PLEs. Less hardware, lower digital consumption, free/open-source software only, moments with no internet access or periodic smartphone avoidance have the capacity to catalyse novel – or renewed – learning environments that nurture personal agency. As Bidar and Meirieu (2022, p. 213, authors' translations) articulated, it is 'a teacher's fundamental responsibility to introduce beneficial constraints that will enable

students to put aside their first reaction and commit themselves to the task at hand’.

Future studies might about digital frugality in education might concentrate on other categories of participants, record students’ decisions or examine how digital frugality could redirect the emphasis from performance assessment to learning assessment. There is also an urgent need for research into digital frugality today, as phenomena of cognitive off-loading have been documented with AI technologies (Shum, 2024). Longitudinal studies should also be conducted to investigate the extent to which the use of digital frugality has a sustainable and positive impact on learners’ PLEs in other learning contexts.

Notes

1. The survey was in French. It is accessible via: <https://doi.org/10.5281/zenodo.8108604>
2. Pseudonyms have been used for all participants.
3. Pseudonyms have been used for all participants.

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