

## **Smartwatches as Tools for Emotion Regulation in Higher Education: Evidence from an Action Research Project**

Fay Giæver (corresponding author)

Department of Psychology

Norwegian University of Science and Technology (NTNU), Norway

Email: [fay.giaver@ntnu.no](mailto:fay.giaver@ntnu.no)

Jostein Engesmo

Department of Computer Science

Norwegian University of Science and Technology (NTNU), Norway

Email: [jostein.engesmo@ntnu.no](mailto:jostein.engesmo@ntnu.no)

Niki Panteli

Department of Management Science

Lancaster University

Email: [n.panteli1@lancaster.ac.uk](mailto:n.panteli1@lancaster.ac.uk)

## **Abstract**

Digital technologies are increasingly integrated into higher education, yet the role of wearable devices in supporting learning remains underexplored. This study investigates how students in higher education use smartwatches as tools for emotion regulation in their study practices. Drawing on Gross's model of emotion regulation, we conducted an action research study with a group of nine university students combining smartwatch biofeedback with reflective diaries to examine how they interpreted and applied physiological data in their study practices. We found that smartwatch feedback acted as a real-time cue for reflection enabling students to implement both proactive and reactive strategies. Three themes emerged: (1) using smartwatches to promote general well-being, (2) organizing study sessions, and (3) maintaining focus during study sessions. While the students found that strategies aimed at promoting wellbeing and organizing study sessions were relatively straightforward, and yielded immediate benefits, focus-oriented strategies such as distraction management and mindfulness proved more challenging and elicited complex emotions. The study contributes to higher education research by highlighting the potential of smartwatches as scaffolds for emotion regulation and self-regulated learning, while also addressing the limitations of purely data-driven approaches in understanding students' behaviour.

Keywords: Smartwatches, emotion regulation, self-regulated learning, bio-feedback

## Introduction

In the current educational system, digital tools play a pivotal role in enhancing learning experiences (Haleem et al., 2022). Among these tools, wearable technologies, such as smartwatches, have garnered significant attention in higher education (Almusawi et al., 2021; Havard & Podsiad, 2020). Wearables are small electronic devices integrated into everyday gadgets (Ometov et al., 2021). These devices have for instance been shown to support student mental health by promoting engagement, mindfulness, stress management, and emotion regulation (Ensman, 2020; Greiner et al., 2024). There is also evidence that students are open to innovative uses of technology, and particularly smartwatches, to support their studies (Al-Emran et al., 2020). However, wearables also pose challenges (Engesmo et al., 2026). They may for instance be a source of disruption in the academic setting (Dontre, 2021) and concerns about privacy and security due to the collection of sensitive personal information have been raised (Plester et al., 2022; Maltseva, 2020). Additionally, there are concerns that wearables may inflict psychological distress and an overdependence on these devices for emotion regulation (Bettis et al., 2021). However, the field of research on wearables in education is still in its infancy, and more studies are needed to explore how students can effectively use these technologies to tailor personalized learning strategies (Chu et al., 2023). Given the ubiquitous nature of technology in contemporary education and the widespread use of wearables among students, it is crucial to understand how these devices can enhance learning outcomes.

This study adopts an emotion regulation framework (Gross, 1999) to explore how smartwatches can be utilized for emotion regulation among students in the higher education context. We understand emotions to emerge as the result of a sensemaking process, where individuals use past knowledge and present bodily sensations to predict and respond to their environment (Barrett, 2016). Thus, there is an important bodily component to emotions and we assume that smartwatches can provide crucial bio-feedback information to support individuals' emotion regulation. Emotion regulation involves influencing the types of emotions experienced, their timing, and their expression (Gross, 1999). Emotions and emotion regulation play a vital, yet often overlooked, role in learning and academic performance (Ben-Eliyahu, 2019; Jacobs & Gross, 2014; Camacho-Morles et al., 2021). Emotion regulation is a core component of self-regulated learning, the process in which learners plan, monitor, and regulate their, cognitive, motivational, and emotional states to achieve academic goals.

(Zimmerman, 2000; Pintrich, 2004). Managing affective states enables learners to make strategic decisions, adapt their behaviour in response to challenges and sustain engagement. We argue that smartwatches, with their ability to provide real-time and historical feedback on physiological states, can aid emotion regulation and self-regulated learning.

We conducted an action research project with a selected group of university students. This implied that we explored how these students, individually as well as in collaboration with fellow students in the project, found ways to utilize smartwatches to facilitate learning situations in tandem with feedback from the smartwatches indicating emotional arousal. The project was guided by the following research question:

*How do higher education students use smartwatches as tools for emotion regulation in their study practices?*

In the following sections, we will firstly provide a literature review where we situate wearable technology, including smartwatches, in the student context and expand on the role of emotions and emotion regulation for learning and the ways in which smartwatches may support emotion regulation within this context. Next, we will detail our study's methodology and data collection methods. Finally, we will present and discuss our findings.

## **Literature review**

### *Wearable technologies*

Wearable technologies are often seen as small electronic and mobile computing devices that are easily integrated into gadgets, accessories, or clothing (Ometov et al. (2021). A wide range of devices fall within this category, from smartwatches and fitness trackers to more invasive options such as microchips or smart tattoos. They can function passively as well as actively, attached or removed from the body, and they are frequently connected to the internet. Due to their invasive and ubiquitous characteristics, wearables have attracted the interest of researcher across several disciplines. In healthcare for instance wearable devices have been utilized to continuously monitor patients and disease prevention through promoting healthier lifestyles (Quadrie et al., 2025). Wearables have also been utilized to optimize performance in sports (Chidambaram et al., 2022). Similarly, studies from the work setting

have pointed to the promising role of wearables to regulate stress (Tarafdar et al. 2019). Smartwatches are wrist-worn devices and typically provide 24-hour tracking of environmental data (e.g., GPS), body movements (e.g., steps), body temperature, blood oxygen saturation/blood pressure, heart-rate variability/blood volume pulse, and electrodermal activity (Maltseva, 2020). Smartwatches can easily be adopted in an educational setting as they are non-intrusive, widely adopted in the general public and compatible with smartphones.

### *Smartwatches for learning*

According to Gao et al. (2022), there are six primary applications of wearable technology in education: student's behaviour tracking; health and physical activity monitoring; learning personalisation; collaborative learning facilitation; real-time assessment and feedback; and interactive learning encouragement. For instance Al-Emran et al. (2020) found that perceived use, usefulness and security significantly influence smartwatch adoption in education, while Al-Emran (2021) report that individual and task-related factors shape students' willingness to use smartwatches for learning. Rodling et al. (2020) demonstrated that smartwatch vibration is more effective for faster learning and knowledge retention compared to visual methods. Garcia et al. (2018) showed that smartwatch-based apps like ScienceStories enhance students sense of self-efficacy. Shaddeviv et al., (2018) similarly found that smartwatches improved English learning outcomes, and Herrera-Alcántara et al. (2019) linked the use of smartwatches to better self-regulation and more active lifestyles, which correlate with academic achievement.

Research on the role of smartwatches in education is however still relatively sparse. In a scoping review it was reported that existing studies were incredibly heterogenous in terms of themes and topics, the majority focusing on primary and secondary education, before college or university, and adopting quantitative methods. (Schroeder et al., 2023). A notable strength to existing research in this domain is the trend towards ecologically-valid research settings as many studies took place in authentic learning environments (the classroom) and not in the laboratory. On the other hand, the authors of the review raised concerns about privacy, data security, and ethical use of wrist-worn wearables for the purpose of research within these research settings, particularly when participants are minors.

Overall it is difficult to determine how smartwatches can improve learning outcomes. Existing research has to a large extent explored user data derived directly from devices. Thus, students' attitudes and reflections around the role of smartwatches and the data that they provide- a crucial component to the learning process and learning outcomes- has gone missing. In other words, smartwatches and the objective data that they provide is not necessarily the most important or interesting component to the learning process. What is important is how data from the smartwatch is interpreted by students and how they use this data to engage in a real life educational context. In educational contexts, it is not merely the data itself that matters, but how students engage with it—how they make sense of it, apply it to their routines, and use it to regulate emotions and behaviors in real-life learning situations. Thus, the meaningful use of smartwatch data lies in its integration into students' personal strategies for learning and wellbeing, rather than in the data's objective qualities alone.

### *Emotions, emotion regulation and smartwatches*

Emotion and emotion regulation play a crucial role for learning. Emotions are for instance an important antecedent to learning (e.g. motivation), a byproduct of learning (e.g. sense of achievement) and are evoked during the learning process (e.g. in the experience of flow during learning) (Ben-Eliyahu, 2019). As Boekaerts and Pekrun (2015) emphasize, emotions are deeply embedded in academic settings and influence both cognitive engagement and self-regulation. We also know from the psychology literature that both positive and negative emotions are important for optimal functioning in general, creativity and performance. Positive emotions, such as happiness, have for instance been found to lead to improved productivity, but do not necessarily support optimal decision-making (Staw and Barsade, 1993). Negative emotional experiences on the other hand are helpful in that they make individuals less susceptible to bias and less likely to be swayed by persuasion (Forgas and George, 2001). There is also evidence that negative emotional experiences can provide motivational and cognitive resources helpful for solving problems (To et al., 2015). Thus, both positive and negative emotions can be functional in a learning situation, but emotions need to be regulated to be appropriate for the learning situation at hand. Smartwatches can detect emotions through the tracking of electrodermal activity and heart rate (Ba & Hu, 2023). Several studies have also demonstrated how biological metrics, collected by smartwatch sensors, can allow individuals to identify links between mood changes and behaviours such as

physical activity and sleep (Hirono et al., 2022; Kershaw, 2022; Quiroz et al., 2018). A study by Arono et al. (2020) also linked emotion detection to environmental factors such as sound, temperature and humidity. Thus, smartwatches allow individuals raise their awareness of the links between bodily sensations and external events and behaviors.

In this study, we assume that individuals regulate their emotions in ways they find helpful, depending on their bodily sensations, subjective experiences, and the situations they encounter. Emotion regulation involves controlling the physiology and expression of both positive and negative emotions, serving as a means for individuals to relate to themselves and their emotions for improved well-being and functioning (Gross, 1999). There is also a temporal element to emotion regulation, suggesting that individuals can intervene at different stages of the emotion generation process (Gross, 2015; 2014). Early in this process, individuals may actively choose environments and situations based on the emotions they anticipate experiencing- a strategy known as *situation selection*. In the context of smartwatch use, this may involve utilizing heart-rate and sleep tracking to suggest optimal times for studying, taking breaks, or engaging in calming activities before or during study sessions when experiencing stress in the present moment. Alternatively, individuals may attempt to alter their current environment- a strategy referred to as *situation modification*. For example a smartwatch could prompt a user to move from a noisy café to a quieter space when they detect elevated stress levels during a study session, thereby helping to reduce emotional strain. Later in the emotion generation process, when changing the situation is not feasible, individuals may shift their focus- known as *attentional deployment*- or reinterpret the situation through cognitive change. Smartwatches can support attentional deployment by guiding users through mindfulness exercises in response to stress alerts, such as those triggered by anxiety before an exam or presentation. For cognitive change, smartwatches may encourage reflective practices, like journaling, when multiple stress alerts are detected over time, helping users reframe their experiences and bodily sensations. Finally, individuals may engage in *response modulation*, which involves directly influencing emotional responses. Smartwatches can assist by for instance monitoring the effectiveness of relaxation techniques, physical activity and sleep on physiological indicators of emotional arousal such as heart rate variability. Thus, smartwatches may not only increase awareness around bodily sensations and stressors surrounding the study context, but also inform emotion regulation strategies more directly in the situation the students find themselves. Thus, emotion regulation is a dynamic phenomenon that can be cultivated as part of self-regulated learning as students set goals, plan learning

activities, monitor their progress, and adapt strategies in response to feedback (Zimmerman, 2000). Smartwatches can play a supportive role, and serve as an external cue, in self-regulated learning by providing real-time information about internal states that are otherwise difficult to monitor. In turn this may enable learners to align physiological awareness with goal setting, environmental structuring and learning strategies. Thus, smartwatches may support students' broader self-regulatory learning cycles.

When it comes to research on emotion regulation in an educational context many studies have focused on related, but non-dynamic, constructs such as emotional intelligence and its role for academic performance (see e.g. Quílez-Robres, 2023 for a review). However emotional intelligence and emotion regulation are not the same as the former refers to a set of dispositions and abilities, while the latter is a set of behaviors. Emotion regulation has for instance been found to promote engagement and play an important role for motivation (Wolters, 2003), enhance academic wellbeing (Iuga and David, 2024) and promote academic performance (DeNeve et al., 2023). However, the existing research on emotion regulation has typically been conducted on the school level not capturing the unique features of the context of higher education (Menzheritskaya and Hansen, 2019). Thus, more research is needed to explore the role of emotion regulation among adult students in higher education. Jacobs and Gross (2014) particularly emphasized the need for targeted interventions to help students navigate stress, temptations, distractions and performance anxiety. Furthermore, they point to the importance of fostering social connection to decrease feelings in social threat in student groups and to facilitate reflection through expressive writing, something in which might ultimately help students develop malleable mindset that is particularly helpful to support learning. Ba & Hu (2023) similarly advocate for more intervention-based studies in authentic learning environments. Furthermore, as many existing studies focus on identifying negative emotions, we argue that we need more studies future studies investigating how wearables can support emotional well-being in an educational context. We therefore argue that smartwatches can have a wide range of beneficial outcomes for supporting well-being through their provision of valuable bio-feedback to facilitate improved self-awareness and the tailoring of emotion regulation strategies appropriate for unique and authentic learning contexts.

## **Methods**

## *Research Design and data collection*

We conducted an action research project (Gibbs et al., 2016) involving nine undergraduate university students (20-25 years old). The project was carried out over a six week period towards the end of the academic term, coinciding with students' exam preparations, a particularly stressful time for students. The participants were not instructed in what to do, but actively participated in shaping a bottom-up intervention. This was achieved through the four core elements of action research: Co-design, reflection, action, and problem-solving.

Following the framework by Jacobs and Gross (2014) the intervention was designed to foster:

1. A sense of community within the group resembling that of a support group,
2. Reflective practice among participants, and
3. Intra-individual development over time.

The students were recruited through a pitch of the project for approximately 60 students participating in a course hosted by one of the authors and selected on a first-come, first-serve basis. Nine students were accepted to participate in the project. The response to the project exceeded the number of available spots. However, due to our aim to recruit participants who were motivated to commit fully to the project and to prevent dropout, there were substantial costs involved in hosting the project that prevented us from increasing the sample size. For instance, the students received a complimentary book on stress management, smartwatches that they were allowed to keep once the project had ended, a complimentary lunch at every workshop they attended, and a giftcard upon completing the project. We also invested a lot of our research time in following up with the students and anticipated a large volume of research data, despite the small sample size. Finally, we considered the fact that a larger sample size would have limited our capacity to create the sense of community that we aimed for in the project (Jacobs and Gross, 2014).

In line with the framework proposed by Jacobs and Gross (2014), it was important to establish frequent points of contact with the students and to enable them to meet both in person and online throughout the project for fostering a sense of community and sustaining motivation. Data was therefore collected from workshops with participants, group interviews and semi-structured qualitative research diaries (Symon, 2006). Thus, participants logged their experiences multiple times throughout the intervention. A Teams site was also set up to enable interaction with, and between, the participants throughout the project period. Regular meet-ups and consistent logging of experiences were essential for stimulating reflection, both

individually and collectively, and for supporting and capturing their development of appropriate emotion regulation strategies over time.

Initially the participants attended a kick-off workshop. Here, they were informed about the project, their tasks and responsibilities, and were given a popular science book on the role of wearables to measure physiological data in the regulation of stress and emotions. They were equipped with Garmin smartwatches that utilized physiological data to calculate a “sleep score” in the morning and a continuous “body battery” score for the monitoring of personal energy resources and stress levels around the clock. Importantly, no data from the smartwatches was collected by the researchers; all physiological feedback from the watches remained private and accessible only to the individual students via the Garmin app. Thus, the primary aim of the study was not to collect physiological data, but to explore how participants reflected around their own physiological in the context of their studies.

In the first part of the intervention (the first two weeks), participants were asked to calibrate their smartwatches, to read the book provided, and to reflect around their experiences in structured diaries twice a week. During and after these two weeks, we read through the diaries several times in order to monitor diary completion and nudge the participants to elaborate on their experiences. We also utilized information from the diaries to address relevant issues in the planning workshop that was organized in the third week of the intervention. Here, the participants were allowed to share their experiences with fellow students in the project and with the team of researchers, and to foster a sense of community, in line with the Jacobs and Gross (2014) framework. During this workshop they were also given a two-hour lecture on the topic of emotion regulation in the study setting and the ways in which smartwatches can be utilized to support emotion regulation for enhanced well-being and increased performance.

During the workshop the participants agreed on two emotion regulation strategies they they would test in conjunction with a study session: A mindfulness- and a body scan exercise. They were also encouraged to test two additional strategies of their own choice during study sessions in the project moving forward. Most of the participants decided to implement the Hold app (Hold AS, 2025) to stop distractions and the Pomodoro technique (Biwer et. al., 2023) for increased focus during study sessions. Hold is an app where your time off the phone is tracked, and distractions are blocked. For every 20-minute session participants collect points on a marketplace to redeem products or services from Hold’s commercial partners. The

app also allows students to compete with friends, schools and other students. The Pomodoro technique is a time management method, aided by an app, in which you do focused work during 25-minute intervals- known as Pomodoros- and then take a five-minute break. Every 4 Pomodoros, students will take a longer 15–20-minute break.

In the second part of the intervention (the last four weeks after the planning workshop) the participants were asked to implement the emotion regulation strategies and continue to report their experiences in structured diaries twice a week. The diaries had the same structure for the entire duration of the project. In each diary the participants were probed to report from a study session of their choice. Each study sessions typically lasted around two hours. The diaries were organized in two parts. Part one of the diary was to be filled out prior to the study session, while part two were to be filled out after the study session had ended. In part one, the students were firstly encouraged to describe the study session that they were planning, such as specific tasks and the organization of their work. Secondly, they were asked to describe their physical surroundings (such as whether they were situated in a library or café and the level of noise) and digital surroundings (e.g. using a computer and the number of windows they had decided to keep open during the study session). Thirdly, in the last four weeks of the intervention (not relevant in the first two weeks of the intervention) they were to describe the strategies they had implemented (e.g. using the Hold app and doing a body scan). Finally, they were asked to describe their current emotional experiences (e.g. feeling anxious about an upcoming exam), and reflections around the link between their emotional experiences and physiological data from their smartwatch (e.g. a low sleep score). In part two of the diary the participants were firstly asked to describe how they had experienced the study session (e.g. whether they felt focused or if/how they were interrupted). Secondly, they were probed to describe their physical and digital surroundings during the session. Finally, they were asked to reflect around potential links between their experiences and data from their smartwatch (e.g. whether a poor nights sleep or interruptions and unfocused work had led to an increased stress score). In line with Jacobs and Gross (2014) framework, repeated exposure to these questions was intended to encourage regular reflective practice in the present, while also supporting participants in developing their emotion regulation over time by looking both backwards and forwards across the four-week period.

After the diary study had ended we collected 108 diaries. Towards the end of the project the participants attended an evaluation workshop and participated in focus group interviews. We

chose to hold four focus group interviews, rather than a single group with all nine participants, in order to encourage greater participation from each individual, reduce conformity pressures, and enable a deeper exploration of participants' experiences (Krueger & Casey, 2015). All nine participants took part in one focus group interview, and the distribution of participants across the four groups was 2, 2, 3, and 2. We used a semi-structured focus group interview guide to explore participants' experiences with the project. The guide comprised four sections: (1) daily life and study practices, (2) use and perceived usefulness of the smartwatch for emotion regulation, (3) overall evaluation and perceived learning outcomes, and (4) closing reflections. In line with the Jacobs and Gross (2014) framework the questions aimed to promote and explore individual and communal reflection and development. Between their focus group sessions participants wrote reflection reports where they were asked to include a suggestion of five study habits they would like to share with other students. The interviews were recorded and transcribed. We also recorded and transcribed parts of the discussion in the planning workshop and took detailed observation notes after all three workshops. Figure 1 presents an outline of the data collection, including the various activities, and when they took place throughout the six-week project period.

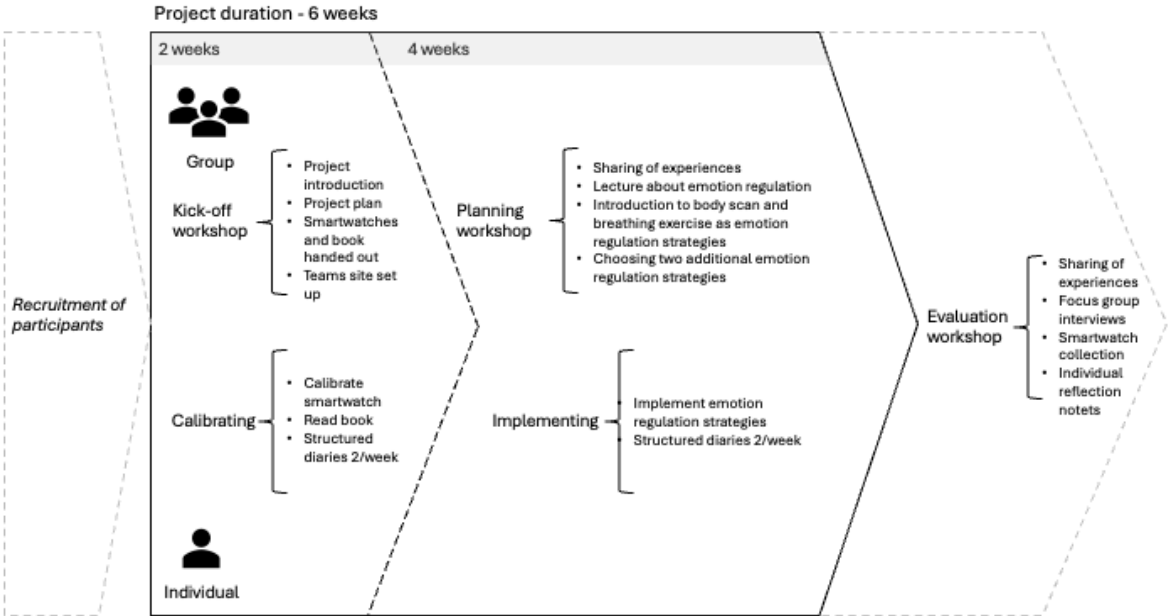


Figure 1. Data collection over the 6-week project duration.

Alt-text:

A flow diagram showing a six-week project divided into a two-week kickoff phase and a four-week implementation and evaluation phase. The left side shows participant recruitment leading into a group kickoff workshop and individual calibration tasks. The central section shows a planning workshop followed by implementation activities, including body awareness exercises and structured diaries. The right side shows an evaluation workshop with focus group interviews, individual interviews, and reflection notes.

### *Data analysis*

Data analysis was mainly carried out by the first and second author, while the third author contributed in team meetings where interpretations were discussed, refined and reviewed and the final themes were agreed upon. In the first step of data analysis all the diaries were transferred to Excel as a time-ordered data matrix (Nadine and Cassell, 2006) with one sheet for each of the nine participants. Each of these sheets were structured so that responses to the core themes/questions of the diary were inserted horizontally in columns (description/evaluation of tasks, physical and digital surroundings, strategies implemented, emotional experiences and reflections around data from the Smartwatch), while each of the diaries were inserted chronologically (weeks 1-6, two per week, 12 diaries per person in total) vertically in rows. In the next step, the first and second author collaborated in the process of extracting information from each of the diaries that pertained to emotion regulation strategies pre- and post-sessions and how the informants experienced engaging in these strategies. Here we tried to include the most important information, while also attempting to reduce the total amount of text, to prepare for the next step of the analysis where we coded the extracted text through a thematic analysis approach (Braun & Clarke, 2021). This implied that we initially did not use a fixed codebook as coding remained flexible, organic, and developed through immersion in the data in line analytical approach. However, our reading of the literature informed coding and interpretation of the data, and following from initial coding we organized our codes across individuals in two categories: 1. emotional experiences and how the students made sense of these experiences with the help of their smartwatches, and 2. how they regulated these experiences. We also summarized the emotional experiences and emotion regulation strategies for all the nine participants individually in nine separate documents to explore development over time on the intra-individual level. During team meetings we discussed the codes and summaries and how they could be merged into themes that responded

to the research question: *How do higher education students use smartwatches as tools for emotion regulation in their study practices?* Interviews and observational data were utilized as contextual background to aid analysis of the diary data. We identified three broad themes in response to the research question: Using smartwatches to promote general wellbeing, using smartwatches to organize study sessions, and using smartwatches to remain focused during study sessions.

### *Ethical considerations*

The study was approved by the National Agency for Shared Services in Education and Research. Participation in the study was voluntary, and all participants provided signed informed consent prior to participation in the study, with the option of withdrawing from the project at any time. Interviews were tape-recorded, transcribed and anonymized according to the ethics protocol approved by the National Agency for Shared Services in Education and Research. Diary entries were anonymized prior to analysis. Tape-recordings and original diary data were stored securely and deleted at the end of the project.

### **Findings**

Participants exhibited varying response styles. Some provided brief entries, particularly at the beginning of the project, while others were more expansive. These differences may reflect the participants' level of engagement with the project, but could also indicate how they experienced the intervention. For example, several participants had prior experience using smartwatches, primarily for sports and exercise—such as monitoring heart rate during interval training—but not for tracking sleep or stress in their everyday lives. Initially, many reported limited awareness of their physiological states on a daily basis and how these related to their experiences of student activities. The biofeedback provided by the smartwatches was often surprising and unexpected to participants. For instance, they observed elevated stress levels and reduced body battery following alcohol consumption, early detection of illness before symptoms appeared, and the ways in which sleep, diet, and exercise impacted stress scores.

At first, participants struggled to connect the smartwatch data with their subjective experiences and the organisation of their study sessions. This was evident both in the content and length of their diary entries:

*“I struggled reflecting about myself and my environment.”*

Consequently, during the initial phase of the intervention, it was essential to stimulate awareness by encouraging participants to experiment with self-initiated strategies. This helped them establish connections between the physiological data and their lived experiences, ultimately informing the design of study sessions tailored to their individual needs. One participant did for instance report that they felt calm, and expected stress levels to remain low during a study session, yet their watch reported medium stress leading to insights that challenge personal perception.

*“The stress measurement fluctuates between low and medium levels. I think I should probably be more in the low range based on how I feel, but maybe the watch has deeper insight into my body than I do?”*

Over time, through ongoing reflection, students began to identify patterns linking their smartwatch data, personal experiences, and perceived productivity. This enabled them to intervene proactively. Participants became more intentional and strategic in preparing for effective study periods and experimented with various strategies to structure and maintain focus during study sessions informed by data from their smartwatches as well as subjective experiences.

While participants’ diary entries and interviews provide rich descriptive insights, the themes presented below reflect our interpretive analysis of how participants used smartwatches as tools for emotion regulation in their study practices. The participants regulated their emotional experiences with the help of smartwatches through: (1) using smartwatches to promote general wellbeing, (2) using smartwatches to organise study sessions, and (3) using smartwatches to remain focused during study sessions. Across all themes, smartwatch data (e.g., stress, body battery, heart rate, sleep) acted as a real-time cue for participants to reflect on and regulate their emotions. They used this feedback to make both proactive (situation selection/modification) and reactive (attentional deployment, response modulation) adjustments. Not all strategies worked equally well for everyone. However, overall, participants found it easier to implement proactive strategies aimed at enhancing general wellbeing and organising their study sessions. These approaches often yielded immediate and

observable effects on smartwatch metrics, such as heart rate and stress scores. In contrast, strategies intended to support sustained focus during study sessions—such as using the Hold app and engaging in body scan exercises—were perceived as more complex to adopt. These techniques did not consistently produce measurable changes on the smartwatches and, in some cases, even led to short-term increases in stress levels. As a result, focus-related strategies were experienced as requiring greater commitment, discipline, and sustained effort over time to produce meaningful physiological changes.

### *Using smartwatches to promote general wellbeing*

One of the ways in which participants actively used smartwatches was as tools to monitor their physiological and emotional states as they provided real-time feedback on metrics such as sleep quality, stress levels, and body battery. These metrics were in turn used to make informed and proactive lifestyle adjustments. From an emotion regulation perspective, students engaged in both situation selection and situation modification strategies. Situation selection involved choosing environments and routines that were conducive to emotional stability—for example, one participant reported lower stress levels and a higher body battery after moving home to their parents to study before exams. This change in environment led to improved sleep, a healthier diet, and more consistent exercise, all of which contributed to a calmer and more productive study period. Situation modification was evident in students' responses to smartwatch feedback. Upon noticing low body battery or elevated stress levels following poor sleep or alcohol consumption, many chose to avoid alcohol.

*«I've tried to drink less alcohol as I've noticed it shows up on my watch. I find it easier to say no to alcohol when I can see how much just two glasses affect the watch (...) I rarely say no to alcohol. However, I really enjoyed myself even without drinking, so I'm definitely going to stop drinking "unnecessarily" at least. Even though I enjoy having a glass here and there, I can see that it stresses my body much more than I thought. I woke up with 100 in body battery today, something that hasn't happened for quite a while.»*

Here, the participant is demonstrating how physiological feedback facilitated a reframing of their bodily sensations, enabling them to link patterns across days and make intentional adjustments. This indicates a shift from reactive to strategic self-regulation.

Many participants also reported that they deliberately prioritise rest during the day to lay the foundation for better sleep and improved concentration the following day, particularly when preparing for important study sessions.

*«Another interesting factor I've noticed is how a stressful day also affects sleep quality, which in turn leads to a lower body battery the following day. The watch, together with the accompanying app, also provides explanations of what caused poor sleep. This is something I want to explore further.»*

Overall, students reported that these wellbeing-oriented strategies were relatively straightforward to implement and often resulted in immediate, visible improvements in their smartwatch data. Across participants, these proactive lifestyle adjustments formed the foundation upon which study-related strategies were built, suggesting that wellbeing-focused regulation served as an entry point to broader regulatory competence.

#### *Using smartwatches to organise study sessions*

Participants also used smartwatches to become more strategic in planning and managing their study sessions. By monitoring physiological indicators such as stress levels and body battery, participants adjusted their routines to optimise performance. For instance, some postponed study sessions when their body battery was low. Others took more frequent breaks during high-concentration activities when they felt fatigued or unwell, or even just to make sure that they remained focused for longer. Many also found that noisy environments increased stress levels, prompting them to seek quieter spaces or adjust their surroundings accordingly. From an emotion regulation perspective, students engaged in both situation modification and attentional deployment strategies. Situation modification included changing study environments—such as working from home with fresh air or using noise-cancelling headphones—to optimize study sessions based on data from their smartwatches.

*«I try to avoid distractions. I will move if my study space is not working for me. I take short breaks even if I am in a state of flow, because I know it will most likely allow me to work for longer.»*

In this quote it is evident that the participant engage in situation modification, adjusting environmental conditions to preserve long-term cognitive focus. Thus, the smartwatch functions as a monitoring tool in the present moment, but in the regulatory action past and anticipated experiences are also taken into account.

Attentional deployment was evident in how students structured their study sessions. They used techniques like the Pomodoro method to time breaks strategically, even interrupting a state of flow to take a break to maintain long-term focus. Participants also found that smartwatch data revealed that multitasking—such as switching between multiple windows on their laptop or using mobile phones during study sessions—led to increased heart rate (stress) and a decreased body battery. In response, participants engaged in strategies to minimise distractions, such as placing phones out of reach and reducing digital clutter. Some even experimented with analogue methods, such as reading in a physical book rather than on the laptop and taking notes by hand on paper, which they found correlated with lower stress levels on their smartwatches.

*«Reading a physical book feels so much better than reading on a screen. [...] After completing the session, I checked the three key metrics as usual: heart rate, stress, and body battery. [...] My heartrate remained completely steady in the 60s throughout the session, with no notable fluctuations. [...] As expected, the stress level dropped to a resting state, which came as no surprise.»*

Thus, it was evident that participants over time were able to use smartwatch data to engage in behaviours to align internal states, such as fatigue and stress, with external demands, such as the complexity of a task in mature self-regulatory ways. Overall, this theme demonstrates a progression from personal wellbeing management to deliberate orchestration of study habits. and that the smartwath enhances self-regulation on the emotional as well as behavioural level.

#### *Using smartwatches to remain focused during study session*

Participants also used their smartwatches to remain focused during study sessions. For instance they engaged in cognitive change as they reflected on smartwatch data (e.g., stress levels, body battery) to reframe their experiences around study sessions. Participants also used their smartwatches to inform the ways in which strategies and tools, such as Pomodoro and

Hold, were utilized to maintain focus during study sessions. From an emotion regulation perspective these apps contributed to attentional deployment through helping participants structure their time, limit access to distractions. These strategies did to some extent reduce stress and improve concentration. However, the emotional experience surrounding distractions was complex. While removing distractions helped students focus on one task at a time, it also introduced stress and anxiety. Many students reported persistent thoughts about their phones even when they were physically out of reach, indicating a deeper emotional dependency and difficulty sustaining attention.

*«I probably have a kind of phone addiction, so I either have to give my phone to someone or physically put it away in another room to resist the urge to check it. It feels pretty 'extreme...»*

This quote illustrates a moment of metacognitive insight, where the students are recognizing the emotional undercurrents of their distraction. Furthermore, the persistent cognitive pull toward the phone, despite efforts to reduce access, demonstrates the emotional labour involved in adopting new self-regulatory strategies.

One of the students even described that their urge to access their phone was so strong that they found a workaround to unlock the Hold app during study sessions.

*“You have about 10 seconds from the moment you leave Hold to return to Hold or turn off the phone, so you don't lose the points you've earned.”*

Thus, while students employed various tools to sustain focus, their experiences reveal the complex and sometimes paradoxical nature of focus-related regulation. The very tools meant to reduce stress could also trigger it, at least in the short-term. These tools can increase concentration, but also contribute to heightened awareness of internal tension, demonstrating that focus regulation is affectively demanding.

Similarly, the students engaged in response modulation whereby they utilized breathing exercises prior to, and during work sessions, to remain focused. Here they reported that these exercises often led to short-term reductions in stress, as measured by smartwatch feedback. Body scan exercises on the other hand were reported to be more challenging as they made

participants feel self-conscious and sometimes even increased stress. These findings reveal that some strategies of the strategies introduced in the project, aimed to modulate emotional responses, produced mixed results because they require students to confront, rather than avoid, internal discomfort.

Overall, this theme illustrates how smartwatch-supported focus strategies make participants more aware of how interruptions and multitasking affected their emotional state. Smartwatch feedback prompted reflection and adaptation, helping participants develop more intentional strategies for focus and emotional regulation. Yet, the data also underscores the emotional complexity of engaging in strategies to remain focused.

## **Discussion**

This study explored how smartwatches can support emotion regulation in a higher education learning context. Our findings demonstrate that smartwatches can serve as valuable tools for fostering self-awareness and enabling students to implement emotion regulation strategies that support learning. However, the effectiveness of these strategies vary between students and depends on the complexity and depth required to achieve lasting behavioural changes.

Consistent with Gross's emotion regulation framework (1999), students in our study engaged in both proactive strategies (situation selection and modification) and reactive strategies (attentional deployment, cognitive change, and response modulation). Our findings also show how smartwatch-supported emotion regulation aligns with established models of self-regulated learning (Zimmerman, 2000). Students used physiological feedback from their smartwatches to plan study sessions, monitor their affective and physical states during work, and reflect on the effectiveness of these strategies in iterative feedback loops over time, where behavioural changes also influenced subsequent smartwatch data and fine tuning of self-regulation efforts. Thus, smartwatches functioned not only as a wellbeing tool, but also as a scaffold for taking action in the study setting.

These findings extend prior research on wearable technologies in education (Gao et al., 2022; Schroeder et al., 2023) by demonstrating that smartwatches can move beyond passive data collection to actively scaffold self-regulation processes in higher education. A key contribution of this study lies in its emphasis on student interpretation of biofeedback, an area

often overlooked in previous research that has focused primarily on the objective qualities of data from wearables. This aligns with calls for more student-centred interventions in education whereby reflective practices are recognized as essential (Jacobs & Gross, 2014).

This study also highlights the complex and paradoxical nature, of distraction management. On the one hand, students reported that strategies such as mindfulness exercises, digital decluttering and engaging in more tactile learning experiences (e.g. reading in a book and taking notes by hand rather than using a laptop) enhanced their learning experiences. On the other hand, these strategies were sometimes experienced as challenging, and even counterproductive, in the short term. For students with strong mobile phone dependencies, efforts to reduce distractions occasionally led to increased anxiety and frustration.

This paradox may be explained by the dual role of smartphones as both sources of distraction and tools for emotion regulation- used to manage boredom, stress, loneliness, and other unpleasant emotional states. While smartphones can help users attain desired emotional states, their benefits are often short-lived and require repeated use to maintain their effects (Shi et al., 2022). As students adopt new techniques to manage their learning, a degree of self-control and discipline is necessary for emotion regulation strategies to manage distractions to be effective. However, it is often accompanied by emotional costs, and students tend to have low awareness of this experience and overestimate their ability to self-regulate digital multitasking (Dontre, 2021).

Our findings also suggest that increased self-awareness, combined with proactive strategies- such as making intentional lifestyle and study-related changes- may better equip students to manage distractions over time. As Wood (2019) argues, modifying the surrounding environment and context is often more effective in creating lasting behavior change than relying solely on conscious effort. This underlines the potential of smartwatches to support habit formation by helping students recognize patterns and make informed adjustments in their everyday lives that align with their academic and emotional goals.

### **Conclusions and Implications**

In this study, we sought to examine with the use of action research, the use of smartwatches among students in a higher education context and in particular how these types of wearable devices can enhance learning through facilitating emotion regulation. It was found that these

devices can make positive impact on students' learning by enabling them to regulate any negative emotions especially during stressful periods of their study, and make appropriate behavioural adjustments to this end. The findings from this study have several implications for the context of higher education as well as for further research. Firstly, our study indicates that higher education institutions could benefit from introducing wearable-based bottom-up interventions targeted at improving student well-being and productivity, or introducing wearable technology in already existing study skills programs. Secondly, educators should recognize that technology, or objective data from devices, alone provide insufficient information. Interventions should allow for reflection and peer discussion as they are critical for helping students interpret biofeedback and translate it into meaningful behavioural change. Finally, future research should examine the long-term impact of smartwatch-supported emotion regulation on academic performance and explore scalable models for implementation across diverse student populations and investigate how smartwatch based interventions can support holistic approaches to learning and well-being.

#### *Discosure statement*

Fay Giæver (author 1) declares that he/she has no conflict of interest.

Jostein Engesmo (author 2) declares that he/she has no conflict of interest.

Niki Panteli (author 3) declares that he/she has no conflict of interest.

#### *Ethics approval*

All procedures were in accordance with the ethical standars of the institutional and/or national research committee and with the 1994 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Norwegian Agency for Shared Services in Education and Research (Sikt) (reference number: 991526). Informed consent was obtained from all participants involved in the study.

#### *Declaration of funding*

The project received funding (50 000,- NOK) from Excited Centre for Excellent IT Education at the Norwegian University of Science and Technology (NTNU) to provide Smartwatches to students.

#### *About the authors and contribution statement*

Fay Giæver (first author) is professor of psychology at the Norwegian University of Science and Technology (NTNU). Her research interests lie in the area of emotions and emotion regulation in the work context.

Jostein Engesmo (second author) is associate professor at the Norwegian University of Science and Technology (NTNU). His research interests is within the topics of digital transformation and adoption of digital solutions.

Niki Panteli (third author) is professor of digital business at Lancaster University Management School (UK). Her main research interests lie in the are of digital transformation, virtual teams and virtual collaborations and online groups and communities.

The first author contributed to data collection, analysis and undertook the majority of the manuscript writing. The second author did the majority of data collection, participated in data analysis, and played a key role in generating ideas for the paper. The third author contributed to the conceptual development of the paper and provided detailed feedback on multiple drafts prior to submission.

#### *Data availability statement*

In accordance with the guarantees of anonymity and confidentiality outlined in the informed consent sheet signed by the participants, the data can not be made available.

## References

Al-Emran, M. (2021) Evaluating the use of smartwatches for learning purposes through the integration of the technology acceptance model and task-technology fit, *International Journal of Human–Computer Interaction*,37(19),1874–1882.

<https://doi.org/10.1080/10447318.2021.1921481>

Al-Emran, M., Granić, A., Al-Sharafi, M. A., Ameen, N., & Sarrab, M. (2020). Examining the roles of students' beliefs and security concerns for using smartwatches in higher education. *Journal of Enterprise Information Management*, 34(4), 1229-1251.

<https://doi.org/10.1108/JEIM-02-2020-0052>

Almusawi, H. A.; Durugbo, C. M. and Bugawa, A. M. (2021). Wearable Technology in Education: A Systematic Review. *IEEE Transactions on Learning Technologies*, 14 (4), 540-554. <https://doi.org/10.1109/TLT.2021.3107459>

Arano, K. A., Gloor, P., Orsenigo, C., & Vercellis, C. (2022) Emotions are the Great Captains of our lives: Measuring moods through the power of physiological and Environmental Sensing. *IEEE Transactions on Affective Computing*, 13(3), 1378–1389. Available at: <https://doi.org/10.1109/taffc.2020.3003736>

Asareh, A., Davis, H., & Levine, S. (2022). Emotion Regulation and Academic Burnout Among Youth: A Quantitative Study. *Educational Psychology Review*.

Ba, S., & Hu, X. (2023). Measuring emotions in education using wearable devices: A systematic review. *Computers & Education*, 200, 104797.

<https://doi.org/10.1016/j.compedu.2023.104797>

Barrett, L. F. (2016) The theory of constructed emotion: an active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, 12 (1): 1-23.

- Ben-Eliyahu, A. (2019) Academic Emotional Learning: A Critical Component of Self-Regulated Learning in the Emotional Learning Cycle, *Educational Psychologist*, 54 (2), 84-105, <https://doi.org/10.1080/00461520.2019.1582345>
- Bettis A.H., Burke T.A., Nesi J., Liu R.T. (2022). Digital Technologies for Emotion-Regulation Assessment and Intervention: A Conceptual Review. *Clinical Psychological Science*, 10 (1), 3-26. <https://doi.org/10.1177/21677026211011982>
- Biwer, F., Wiradhany, W., oude Egbrink, M. G. A., & de Bruin, A. B. H. (2023). Understanding effort regulation: Comparing ‘Pomodoro’ breaks and self-regulated breaks. *British Journal of Educational Psychology*, 93, 353–367. DOI: 10.1111/bjep.12593
- Boekaerts, M., & Pekrun, R. (2015). Emotions and emotion regulation in academic settings. In L. Corno & E. M. Anderman (Eds.), *Handbook of educational psychology* (3rd ed., pp. 76–90). Routledge.
- Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. London: Sage.
- Camacho-Morles, J., Slemp, G. R., Pekrun, R., Loderer, K., Hou, H., & Oades, L. G. (2021). Activity achievement emotions and academic performance: A meta-analysis. *Educational Psychology Review*, 33(3), 1051-1095. <https://doi.org/10.1007/s10648-020-09585-3>
- Chidambaram, S., Maheswaran, Y., Patel, K., Sounderajah, V., Hashimoto, D. A., Seastedt, K. P., McGregor, A. H., Markar, S. R., & Darzi, A. (2022). Using Artificial Intelligence-Enhanced Sensing and Wearable Technology in Sports Medicine and Performance Optimisation. *Sensors*, 22(18), 6920. <https://doi.org/10.3390/s22186920>
- Chu, S. L., Garcia, B. M., & Rani, N. (2023). Research on wearable technologies for learning: A systematic review. *Frontiers in Education*. <https://doi.org/10.3389/feduc.2023.1270389>
- De Neve, D., Bronstein, M.V., Leroy, A., Truyts, A. And Everaert, J. (2023). Emotion Regulation in the Classroom: A Network Approach to Model Relations among Emotion Regulation Difficulties, Engagement to Learn, and Relationships with Peers and Teachers. *Journal of Youth and Adolescence*, 52, 273-286. <https://doi.org/10.1007/s10964-022-01678-2>

Dontre, A. J. (2021). The influence of technology on academic distraction: A review. *Human Behavior & Emerging Technologies*, 379-390.

Engesmo, J., Panteli, N., & Giaver, F. (2026, April 9–10). Wearables and smart technologies in the workplace [Conference track description]. In UKAIS Conference, Sheffield University. <https://www.ukais.org/>.

Ensmann, S. (2020). The Effects of Wearables on Performance in Education: Serving the Whole Student with Directed Attention on Health and Wellness. *Educational Technology Beyond Content*.

Forgas, J. P. and George J. M. (2001). Affective influences on judgments and behavior in organizations: an information processing perspective. *Organizational Behaviour and Human Decision Processes*, 86, 3–34.

Garcia, B., Chu, S. L., Nam, B., & Banigan, C. (2018) Wearables for learning: Examining the Smartwatch as a Tool for Situated Science Reflection. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*.  
<https://doi.org/10.1145/3173574.3173830>

Gao, Wei, T., Huang, H., Chen, X., & Li, Q. (2022) Toward a Systematic Survey on Wearable Computing for Education Applications. *IEEE Internet of Things Journal*, 9(15), 12901–12915. <https://doi.org/10.1109/JIOT.2022.3168324>

Gibbs, P., Cartney, P., Wilkinson, K., Parkinson, J., Cunningham, S., James-Reynolds, C., and Pitt, A. (2016). Literature review on the use of action research in higher education. *Educational Action Research*, 25(1), 3–22. <https://doi.org/10.1080/09650792.2015.1124046>

Greiner, K.; Müller, E. and Mädche, A. (2024). Designing a Smartwatch-based Micro-Intervention to Support Students Emotion Regulation. *ACM International Conference Proceeding Series*, pp. 432 – 436. <https://doi.org/10.1145/3670653.3677520>

Gross, J. J. (1999). Emotion regulation: past, present, future, *Cognition and Emotion*, 13 (5): 551-573.

Gross, J. J. (2014). Handbook of emotion regulation. Guilford Publications.

Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry*, 26(1), 1-

Haleem, A., Javaid, M., Qadri, M. A. & Suman, R. (2022). Understanding the role of digital technologies in education: A review, *Sustainable Operations and Computers*, 3, 275-285, <https://doi.org/10.1016/j.susoc.2022.05.004>

Havard, B. and Podsiad, M. (2020). A meta-analysis of wearables research in educational settings published 2016–2019. *Educational Technology Research and Development*, 68, 4, 1829-1854.

Herrera-Alcántara, O., Barrera-Animas, A., González-Mendoza, M., & Castro-Espinoza, F. (2019) Monitoring student activities with smartwatches: On the Academic Performance Enhancement. *Sensors*, 19(7), 1605. <https://doi.org/10.3390/s19071605>

Hirono, T., Maruyama, H., Musashi, E., & Hosoda, T. (2022) Method of emotion estimation based on the heart rate data of a smartwatch. 12th International Congress on Advanced Applied Informatics (IIAI-AAI). Available at: <https://doi.org/10.1109/iiiaiai55812.2022.00125>

Hold AS. (2025). Hold – Focus and rewards (Version 3.5.1) [Mobile app]. Hold AS. <https://www.hold.app>

Hökkä, P., Vähäsantanen, K. & Paloniemi, S. (2020). Emotions in Learning at Work: a Literature Review. *Vocations and Learning* 13, 1–25.

Kaynakçı, F. Z. U. and Güneri, O. (2023). Psychological distress among university students: the role of mindfulness, decentering, reappraisal and emotion regulation. *Current Psychology*, 42, 14823–14833

Kershaw, B. (2022) Biosensor measures of human emotion. Proceedings of DRS.

Available at: <https://doi.org/10.21606/drs.2022.401>

Iuga, I.A. and David, O.A. (2024). Emotion Regulation and Academic Burnout Among Youth: a Quantitative Meta-analysis. *Educational Psychology Review*, 36, 106,

<https://doi.org/10.1007/s10648-024-09930-w>

Jacobs, S. E., & Gross, J. J. (2014). Emotion regulation in education. *International handbook of emotions in education*, 183-217.

Krueger, R. A., & Casey, M. A. (2015). *Focus groups: A practical guide for applied research* (5th ed.). Sage.

Maltseva, K. (2020). Wearables in the workplace: The brave new world of employee engagement, *Business Horizons*, 63 (4), 493-505.

Mouatsou, C. and Koutra, K. (2023) Emotion regulation in relation with resilience in emerging adults: The mediating role of self-esteem. *Current Psychology*, 42, 734–747

<https://doi.org/10.1007/s12144-021-01427-x>

Menzheritskaya, J., & Hansen, M. (2019). The role of emotions in higher education teaching and learning processes. *Studies in Higher Education*, 44(10), 1709-1711.

Nadin, S. and Cassell, C. (2006). Using Data Matrices. In Cassell, C. and Symon G. (eds) *Essential Guide to Qualitative Methods in Organizational Research*, pp. 271-287.

Ometov, A., Shubina, V., Klus, L.; Skibińska, J., Saafi, S., Pascacio, P., Fluatoru, L.; Gaibor, Q., Chukhno, N.; Chukhno, O.; Ali, A.; Channa, A.; Svertoka, E.; Bin Qaim, W.; Casanova-Marqués, R.; Holcer, S.; Torres-Sospedra, J.; Casteleyn, S.; Ruggeri, G.; Araniti, G.; Burget, R.; Hosek, J. and Lohan, E. S. (2021). A Survey on Wearable Technology: History, State-of-the-Art and Current Challenges, *Computer Networks*, 193, 1389-1286. <https://doi.org/10.1016/j.comnet.2021.108074>.

Pintrich, P. R. (2004). A Conceptual Framework for Assessing Motivation and Self-Regulated Learning in College Students. *Educational Psychology Review*, 16(4), 385–407. <https://doi.org/10.1007/s10648-004-0006-x>

Plester, B., Sayers, J., & Keen, C. (2022). Health and wellness but at what cost? Technology media justifications for wearable technology use in organizations. *Organization*. <https://doi.org/10.1177/13505084221115841>

Rodling, S., Biedermann, D., Schneider, J., & Drachsler, H. (2020) Associative media learning with smartwatches. IEEE Global Engineering Education Conference (EDUCON). <https://doi.org/10.1109/educon45650.2020.9125157>

Shadiev, R., Hwang, W.-Y., & Liu, T.-Y. (2018). A study of the use of wearable devices for healthy and enjoyable English as a foreign language learning in authentic contexts. *Journal of Educational Technology & Society*, 21(4), 217–231. <https://psycnet.apa.org/record/2018-56404-018>

Shi, Y., Koval, P., Kostakos, V., Goncalves, J., & Wadley, G. (2022). “Instant happiness”: Smartphones as tools for everyday emotion regulation. *International Journal of Human-Computer Studies*, 165, 102958. <https://doi.org/10.1016/j.ijhcs.2022.102958>

Qadrie, Z., Ashraf, H., Maqbool, M., & Farooq, S. (2025). Wearable Technology in Healthcare: Opportunities, Challenges, and Future Directions. *Smart Wearable Technology*. <https://doi.org/10.47852/bonviewSWT52025578>

Quílez-Robres, A., Usán, P., Lozano-Blasco, R., & Salavera, C. (2023). Emotional intelligence and academic performance: A systematic review and meta-analysis, *Thinking Skills and Creativity*, 49, <https://doi.org/10.1016/j.tsc.2023.101355>.

Quiroz, J. C., Geangu, E., & Yong, M. H. (2018) Emotion recognition using Smart Watch Sensor Data: Mixed-design study. *JMIR Mental Health*, 5(3). Available at: <https://doi.org/10.2196/10153>

Schroeder, N. L., Romine, W. L., & Kemp, S. E. (2023). A scoping review of wrist-worn wearables in education. *Computers and Education Open*, 5, 1829-1854.

<https://doi.org/10.1016/j.caeo.2023.100154>

Staw B. M. and Barsade S. G. (1993). Affect and managerial performance: a test of the sadder-but-wiser versus happier-and-smarter hypotheses. *Administrative Science Quarterly*, 38, 304–28.

Symon, G. (2006). Qualitative Research Diaries. In Cassell, C. and Symon G. (eds) *Essential Guide to Qualitative Methods in Organizational Research*, pp. 98-113.

Tarafdar, M., Cooper, C. L. & Stich, J. (2019). The technostress trifecta - techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Information Systems Journal*, 29(1), 6–42. <https://doi.org/10.1111/isj.12169>

To, M. L., Tse, H. M., Ashkanasy N. M. (2015). A multilevel model of transformational leadership, affect, and creative process behavior in teams. *The Leadership Quarterly*, 26, 543–56.

Wolters, C. (2003). Regulation of Motivation: Evaluating an Underemphasized Aspect of Self-Regulated Learning. *Educational Psychologist*, 38 (4), 189-205.

[doi:10.1207/S15326985EP3804](https://doi.org/10.1207/S15326985EP3804)(open in a new window)

Wood, W. (2019). Good habits, bad habits: The science of making positive changes that stick. Farrar, Straus and Giroux.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press. <https://doi.org/10.1016/B978-012109890-2/50031-7>