"Schlusslicht": An Ambient Display to Keep Kids and Parents in the Loop When Managing Playing Time and Disengaging From Games

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ABSTRACT

Ending a gaming session can be challenging for children and parents/guardians. Although many tools exist to monitor and restrict playtime, many do not adequately communicate session progress to children, and do not effectively involve guardians in the process. This is a missed opportunity for families to develop media literacy, and can also lead to conflicts and fights about playtime. To open up conversation about playtime management as a shared responsibility between children and guardians, we present "Schlusslicht" – an ambient display that seeks to facilitate a shared awareness of progression of a gaming session and remaining time between guardians and children, and can be leveraged to further explore how we can best support children when disengaging from play sessions.

Video link: https://www.youtube.com/watch?v=khEdN9C9Sgw

CCS CONCEPTS

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

KEYWORDS

Tangible User Interfaces; Ambient Display; Children; Disengagement; Play Time Monitoring

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1 INTRODUCTION AND BACKGROUND

Playing video games has become a popular leisure activity for many children [22, 36]. While playing games has been acknowledged as an essential part of the child's development of communication, discovery, and problem-solving skills [3, 4, 36], and gaming, in general, facilitates enjoyment [31] and well-being [13], the engaging and immersive nature of games often facilitates the loss for the sense of time [24] and captivating the players, challenges them to end a play session [1, 6]. Especially for children, disengagement from game sessions is difficult due to their still-developing abilities to self-regulate [3, 4, 15, 37]. With this, the parents/guardians are frequently responsible for moderating the children's paying time [2, 3]. Consequently, the moderation of playtime mostly resolves in interfaces for time-restriction that display messages to disengage [25] or block out players after the time contingent runs out [14]. Such abrupt endings often yield frustration [6] and have been identified as sources of regular conflicts between guardians and children [26, 30]. Furthermore, the literature reports that guardians are continually overwhelmed with consequently monitoring the children's playtime while managing day-to-day duties [34], and a shared awareness of the playtime is lacking. In contrast, supporting the child's agency has been shown as more effective than time-restricting methods [38] and planning out screen time together with the guardians in advance can help children to disengage [9, 10]. The goal of this work is to relieve the disengagement process and mitigate the negative experiences of ending play sessions by easily allowing children and guardians to remain aware of playing time. To achieve this, we draw our design from a body of work on calm interaction [5].

Tangible User Interfaces (TUIs) embed digital technology into a physical form and have been vastly adapted to support the understanding of abstract phenomena through graspable experiences [7, 12] with "objects-to-think" [27]. Tangible objects encourage users to act, and in social settings, TUIs can act as a mediator for communication [33] and provide affordances for collaboration [11]. However, while playing, the player's attention is focused on the game, and presenting encouraging disengagement on-screen may be insufficient, as it conflicts with what is happening in-game and negatively affects the player experience [32]. Instead, one can aim for an unobtrusive and tangible representation in the environment

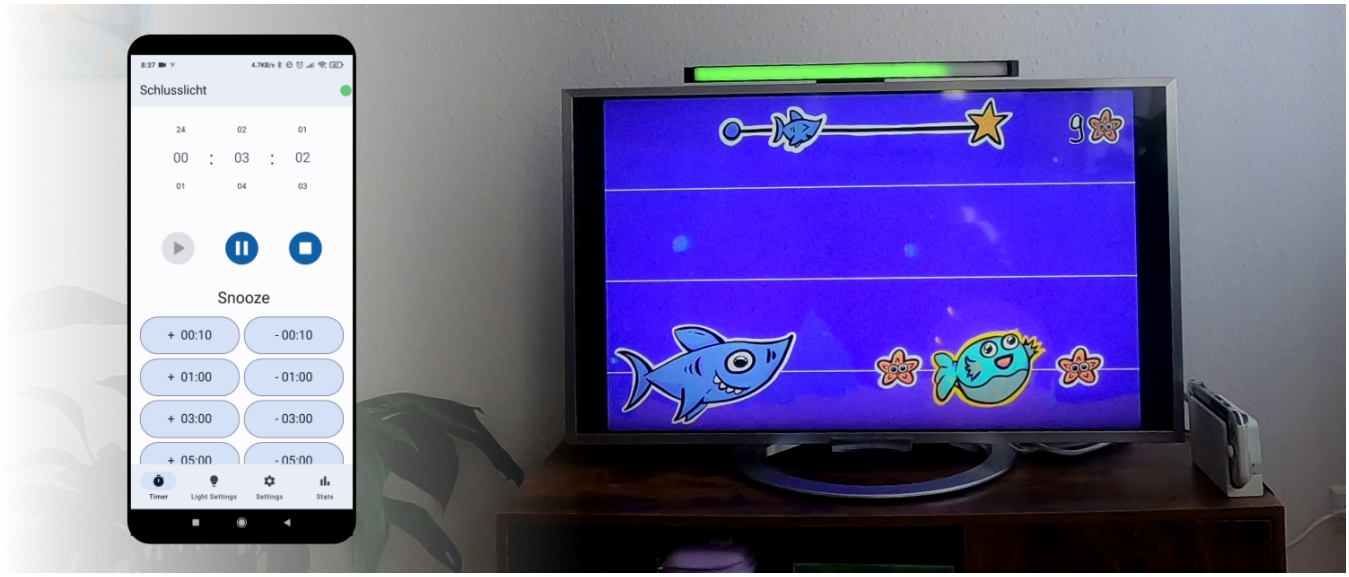


Figure 1: The tangible device Schlusslicht. Playing time can be managed via the app; progress is visualized through ambient light.

through ambient displays [28]. Sitting at the periphery of the users' attention, they are generally designed to communicate non-critical information [28] "a person is aware of, but not focused on" [19] and act as a viable complement for the on-screen information of the main activity [8]. Generally, ambient displays are equipped with low-cost hardware and limited output capabilities, communicating information through changes in color, brightness, or Light-emitting diode (LED) position [20]. Ambient displays have been implemented in a variety of contexts, such as monitoring well-being [18, 35], displaying notifications [29], or visualizing the progression of time [23] and appeared effective in reducing interruptions of the main activity (in this case playing) [21] and support calming aesthetics [5]. Considering design for children, Macklin [17] emphasizes the importance of age-appropriate and familiar communication language and shows visual cues, such as colors, to significantly support children's attention, positive mood, and memory.

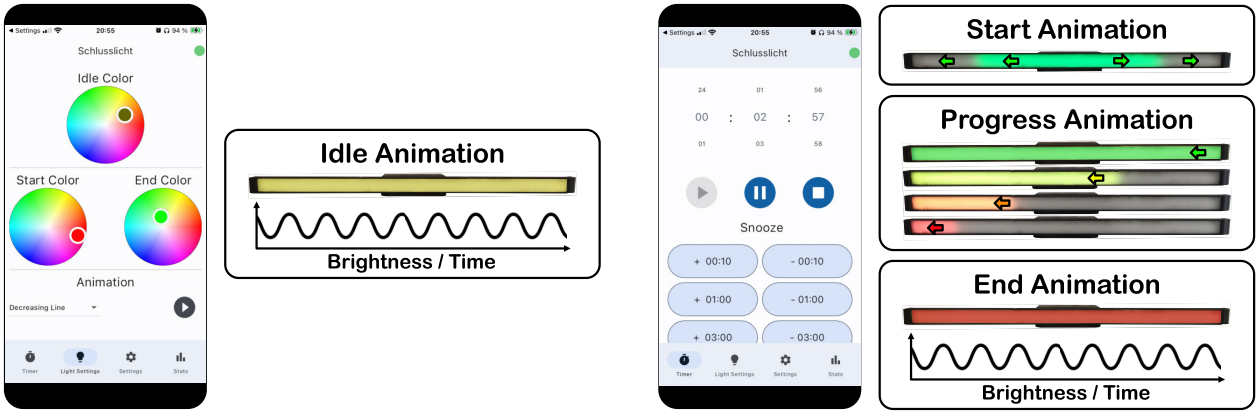
In this demo, we present "Schlusslicht" (Fig. 1), an ambient display to communicate progression through a play session, remaining time, and the point of disengagement to children and guardians. With this work, we seek to explore how to (1) support children understand their playtime through a more accessible representation of time, relying on age-appropriate cue design, (2) encourage the child's self-guided disengagement by allowing them to monitor their playtime, and (3) encourage participation of guardians by creating shared awareness of play session progression, offering an opportunity to guide the child through the disengagement process..

2 THE ARTIFACT SCHLUSSLICHT

The setup consists of an ambient display – a tangible device that should be positioned in the vicinity of the Television (TV) or monitor used to play (see Section 2.2), and a mobile app for Android and iOS to configure the timer and the visuals of the tangible display. The setup is meant to be used effortlessly and unobtrusively during domestic play sessions to support time management and monitoring. The tangible display acts as a communicator for the guardians and the children, displaying progress in real-time during the play session and indicating different phases of the play session. In contrast, as the app provides control over the time contingent, the app should be carried out by the guardians only. The app and the tangible operate within the local WiFi network utilizing the common Internet of Things (IoT) protocol Message Queuing Telemetry Transport (MQTT) for lightweight communication across devices and extensibility. The source code, along with the 3D models, is open source and available at https://zenodo.org/doi/10.5281/zenodo.10868728.

2.1 Using Schlusslicht

Here, we describe an archetypal usage scenario of the Schlusslicht setup (Fig 2): (1) When turned on, the tangible display idles, showing a slightly pulsing constant color, indicating it is ready to use. (2) Before a play session, the guardian sets the intended duration for the session using the app. This can happen together with the child. During the setup, the parties can decide how the session will be displayed on the tangible. They can choose between different types of animations for the progress and the color scheme (Fig. 2a). Any adjustment is mirrored in real-time on the tangible display to allow a preview of the animation. (3) To start the session, the guardian presses the play button on the app and starts the timer. This triggers an initial light animation to indicate the beginning of a play session. Next, the progress animation starts (Fig. 2b). (4) With the running timer, the animation progresses, and the app indicates that the session is running. The app provides options to pause or stop the session, which turns the light into a pause mode similar to the idle



(a) Before session (b) During session

Figure 2: Interactions before and during a session. a) Before session: Users can customize colors, animations, LEDs brightness, and timer presets while the tangible previews the current selection or the pulsating idle animation. b) During session: Users can observe the running timer in the app but can still influence it, e.g., through pausing, stopping, or snoozing. At the session start, the tangible plays a start animation. Afterward, progress is displayed through the progress animation, followed by a dedicated, pulsating end animation. Pulsation of the idle and end animations is done through a sinusoidal modulation of LED brightness.

state but with disclosed progress. Further, guardians can change the session duration by adding or removing time from the session contingent (snoozing). These changes in the remaining duration are mirrored in the progress animation accordingly. For alterations that are small fractions of the sessions' time, these changes are almost unnoticeable. Allowing guardians to alter the sessions' time to better accommodate unanticipated in-game (longer boss fight) or external circumstances (shorter cookery time). (5) At 80% of the session time, the progress animation starts to pulsate and indicates that the session is about to finish soon. This should allow all parties to prepare themselves for the end of the session. (6) When the timer runs out, the tangible plays the closing animation, after which it returns to idle. By that time, the child should exit the play session with the support of their guardian.

2.2 Tangible

Schlusslicht's tangible revolves around a Raspberry Pi 4B, an Adafruit DotStar strip of 72 individually addressable RGB LEDs, and light diffuser sheets that are embedded into a $54 \times 10 \times 3$ cm 3D-printed housing (see Fig. 3). The housing is made of two main parts: a case for the Raspberry Pi and a rail for the LED strip, which consists of three main pieces. The parts can be produced on commonly available 3D printers and assembled within 10 min. The device can be positioned below or on top of a TV and also fits a 1/4" camera mount for tripod usage to accommodate diverse living room situations. The design of the timer display follows Matviienko et al. [20]'s guidelines, which recommend distinct encodings for status, progress, and notifications for ambient light systems. The tangible sequentially deactivates the LEDs to inform the session's progress, resulting in a linear fade animation. During the sequence, the color of the LEDs changes from a start color (e.g., green) to an end color (e.g., red). Additionally, users can select if the progress should be displayed continuously or in blocks. Mode changes, e.g., from an idle into an active state or when the timer ends, are further highlighted through pulsation – a sinusoidal modulation of LED brightness. The Raspberry Pi is programmed using Python 3.10, with the primary functionality to manage the timer and control the LED display. For the main communication, it runs a Mosquitto [16] MQTT broker service, which allows for flexible subscription-based communication across multiple devices. The MQTT broker receives all published messages and distributes them only to clients that subscribe to respective topics. Additionally, a locally running Bluetooth Low Energy (BLE) service supports initial configuration from within the app by transmitting network credentials. The Raspberry Pi controls the LED display through a Serial Peripheral Interface (SPI). Messages are level-shifted from 3.3 V to 5 V due to the difference in operating voltage of the Raspberry Pi SPI pins (3.3 V) and the LED strip (5 V).

3 OUTLOOK ON-SITE DEMONSTRATION AT IDC 2024

At this stage, Schlusslicht is a research prototype with basic functionality aiming to provide a basis for further exploring how ambient displays can support positive disengagement from games, and create a shared awareness of playing time. In the future, we want to leverage the tool to understand how it can help families end play sessions in lab and field studies, examining whether ambient displays can support managing playing time in daily life. In particular, we are currently exploring children's experiences of disengagement, and we want to feed key findings into the artifact and app. Additionally, there are technical challenges that need to be addressed: Currently, the ambient display is not coordinated with the game that is played, and needs to be manually synced. In our ongoing development, we implement a game that communicates with the ambient display and allows the game content to be adjusted to match the anticipated playtime.

With this demo, we aim to spark discussion around child-inclusive playtime mediation. We especially invite visitors with children as

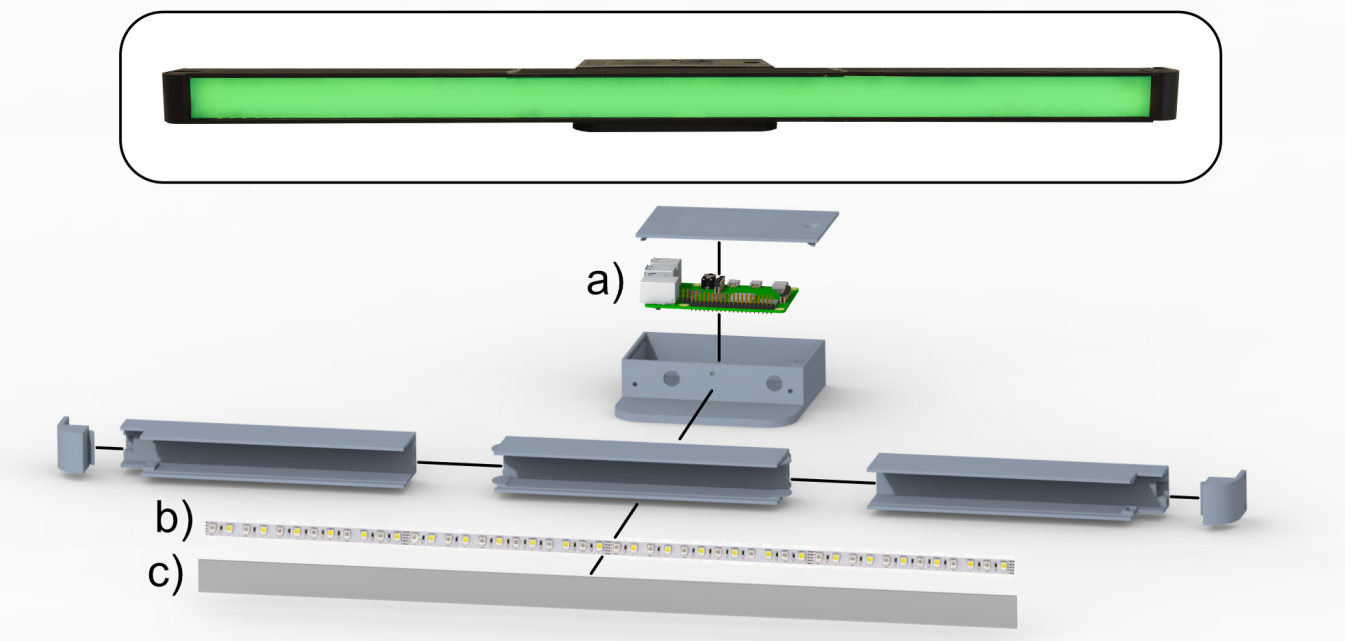


Figure 3: View of the tangible device with a rendered explosion. The device is a 54 cm long, bar-shaped ambient light emitter. Users are informed on status, progress, and notifications through changes in color, the number of active LEDs, and brightness. For the final assembly, parts are glued and screwed to each other. All cables are hidden in distinct cable channels. a) Raspberry Pi 4B as main processing unit. b) RGB LED strip, we used a 0.5 m Adafruit DotStar strip with 72 LEDs. c) Light diffusor sheets to mask individual LED output. We reused sheets of an old LCD TV.

well as Human-Computer Interaction (HCI) researchers involved in interaction design for children to explore our demo and join us in reflection how we can build playful experiences that are engaging, but also support the exit from play. At the venue, we will simulate a gaming situation with Schlusslicht in use. Visitors will be able to take both the children's and the guardians' perspective, and interact with the mobile app, as well as play different Nintendo Switch games with the ambient display monitoring the play sessions. For the installation, we will bring the tangible ambient display together with mobile devices with the app installed and a gaming console to demonstrate Schlusslicht in action. On-site, we will require a 2×3 m space with a large (35 - 50 inch) display and two tables with four chairs.

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