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Gathering requirements for IoT-assisted wellbeing in elementary school—a multi-stakeholder perspective

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Introduction: Students experiencing poor wellbeing in elementary school can suffer lifelong consequences, including low self-esteem or depression. Understanding how to increase student wellbeing through information-based approaches is therefore important. While previous research has explored wellbeing frameworks, this study uniquely investigates the intersection of elementary school wellbeing with Internet of Things (IoT) implementation potential.

Method: We present the first comprehensive requirements analysis gathered from both staff and students for improving wellbeing in an elementary school in rural Sweden, with the aim of implementing IoT solutions. We collected qualitative data through individual interviews and workshops with 25 staff members and a survey from 464 students. We analyzed the data in an inductively and deductively way, using the Konu and Rimpelä's wellbeing framework.

Results: Our novel findings reveal alignment between staff and student perspectives across the framework's categories: having, loving, being and health. One example is the importance of motivation in each learning situation and creating a foundation for good social relations among the students. The requirements related to the health category received the least attention, reflecting less focus on individual student circumstances.

Discussion: This study contributes new knowledge by detailing wellbeing needs for elementary school and relating them to data-driven innovation, such as IoT, for gathering both objective and subjective information. We also acknowledge that this creates additional demands on current solutions and raises significant privacy concerns in school environments. Future research will incorporate expert IoT knowledge and develop prototype solution based on these identified requirements.

KEYWORDS

Internet of Things (IOT), requirements, wellbeing, elementary school, stakeholders

1 Introduction

Many elementary school students do not feel well whilst at school and struggle to reach the required level of learning for graduation (Kjellgren et al., 2022; Baourda et al., 2024). Students' wellbeing is therefore crucial and can be understood as feeling healthy and content (Soutter, 2011; Hossain et al., 2023). Promoting wellbeing should be fundamental in education. Feeling unwell throughout elementary school can cause lifelong problems, such as low self-esteem and poor employment prospects (Kjellgren et al., 2022). Information about students' wellbeing is therefore important to enhance our understanding of it. One approach is to collect data from Internet of Things (IoT) solutions. IoT offers numerous advantages for information gathering. Notable among these is the updating frequency, which keeps information current using smart and intelligent infrastructure. This infrastructure makes it easy for anyone to connect their smartphones and laptops to the internet while logging in into IoT solutions. Through this, automation facilitates interactive and repetitive daily tasks such as measuring air quality, noise levels or class attendance. Another benefit is the ease of communicating and interacting with various groups, e.g., within school settings (Rodić-Trmčić et al., 2018). Introducing IoT solutions in school environments presents an interesting design challenge. IoT solutions have been successfully designed for diverse areas, such as smart cities, homes and Industry 4.0. Educational institutions are adopting IoT in various activities, for example, classroom timing, students' participation, and alertness in class. In addition, to access real-time student data in a timely way, it is vital to interconnect the school's smart-boards, interactive whiteboards, and other safety-related activities with the sensors and IoT-based devices (Wang and Yu, 2022). While many IoT solutions, like smart home security systems, shipping containers and logistics tracking, are based on advanced engineering and an understanding of the physical world, IoT solutions for school environments, such as students' wellbeing, require an additional understanding of human physiology and psychology. While some aspects of the school sector entail relatively straightforward solutions, like connected bodily state monitors, other aspects, such as subjective experiences or learning environments, are much more challenging to capture.

Furthermore, end-users with different knowledge and perspectives on the design, makes the process even more complex. Professionals with relevant medical and technical skills can readily be involved in eliciting requirements and designing physical state monitoring systems. However, school professionals and students often lack sufficient understanding of IoT systems to be involved in eliciting technical requirements. Hence, designing IoT systems for wellness begins by teasing out the end-users' relevant psychological and physiological needs, such as air quality (Abdel-Basset et al., 2019) or emotions (Hasanbasic et al., 2019; Wang et al., 2024). These needs then function as the basis for design requirements and the subsequent development of the IoT system. Given that many IoT systems for wellness are not fully automated, it is necessary to design services that transform the data collected by sensors into actionable information for system users. It is highly recommended that stakeholders consider various parameters such as connectivity, cost, adequately trained staff/faculty, privacy, security and so on while planning and adopting IoT devices in elementary schools

and classrooms. This is because IoT, on the one hand, is user-friendly with greater ease and comfort, while on the other hand is challenging for educational institutes, especially small elementary schools.

Previous research on IoT requirements for elementary schools has focused on various aspects, such as connectivity between school devices and students' and staffs' devices, and privacy (Kassab et al., 2020). There is a need for strong and stable wireless connectivity to facilitate easy communication and effective information exchange. One consequence of connectivity is the need to secure private information and exchange sensitive data, which is highly demanding (Llurba and Palau, 2024). These requirements can result in improved wellbeing when it comes to health monitoring of students, using smart watches, smart rings or smart belts (Verma et al., 2018; Llurba and Palau, 2024).

Despite growing interest in IoT applications for education, there exists a significant research gap in understanding the specific requirements for IoT-assisted wellbeing solutions in elementary schools from multiple stakeholder perspectives. While previous studies have addressed technical aspects of IoT implementation in educational settings, our work makes three novel contributions to the field: (1) we provide the a comprehensive analysis of both staff and student perspectives on wellbeing requirements in elementary education specifically aimed at informing IoT design; (2) we apply the Konu and Rimpelä wellbeing framework to systematically categorize these requirements across having, loving, being, and health dimensions; and (3) we identify challenges and opportunities for IoT implementation in rural elementary school settings, where resource constraints and privacy considerations create additional complexity.

Therefore, based on reports from various stakeholders of IoT and a school, this paper presents the requirements for collecting interesting data about school students' physical and mental wellbeing. Because the efficacy of a learning environment is deeply connected with students' ease and comfort, it is necessary to provide better health services to increase students' wellbeing in their various schools and institutions. The collected data will empower schools to protect and respond to students' needs. Integrating sensor technologies in schools and educational organizations can increase the students' and staff's motivation and interconnection to improve the social climate and overall health status. This is achievable because IoT-driven sensing technology is easy to deploy with effective results and sufficient guidelines due to the scalable, cost-effective and user-friendly features of IoT technologies.

This study was guided by the following research question:

- What are the different stakeholders' perceptions about requirements for IoT-assisted wellbeing in elementary school?

This article contributes by presenting the requirements for increasing students' wellbeing in an elementary school by adopting IoT. We accomplished this by conducting a qualitative case study with an elementary school in Sweden as the case unit, and conducting semi-structured individual interviews and workshops with school staff. Moreover, with the help of gathered qualitative empirical student data, more insight about wellbeing is revealed. The structure of the remainder of this article is as follows. Section 2

presents the Background, and section 3 proposes a detailed Method from data collection to analysis and evaluation. Results are revealed in Section 4, while the discussion is presented in section 5. Finally, section 6 concludes the article.

2 Background

2.1 Students learning based on wellbeing

As pointed out by Konu and Rimpelä (2002) health (physical and mental) and the notion related to it—wellbeing—were for a long time separated from other aspects of school life. The World Health Organization (WHO) defines wellbeing as a “positive state experienced by individuals and societies. Similar to health, it is a resource for daily life and is determined by social, economic and environmental conditions” (World Health Organization, Nutbeam and Muscat, 2021, p. 10). Wellbeing in the context of schools is frequently discussed but its definition, particularly considering student wellbeing, is often not stated (Chapman, 2015; Primdahl and Simovska, 2024). Many institutions position wellbeing as a goal or aim in their curricula, but the emphasis on young people’s physical and psychological health might be insufficient (Chapman, 2015; Durden-Myers and Evans, 2025). Nevertheless, the literature investigating young peoples’ wellbeing identifies evidence-based determinants contributing to this notion. These include positive adult-child relationships, a sense of belonging, positive self-esteem, and the possibility for pupils (in the school setting) to be involved in the decision-making processes—giving students responsibilities which enhances their perception of ownership (Anderson and Graham, 2016; Juliyabadu Gunathilake et al., 2025).

Students’ wellbeing and learning outcomes are related to habits, where habits could be seen as behavioral tendencies tied to specific contexts and environments (Fiorella, 2020). Stressful environments can have a detrimental impact on both wellbeing and learning, and students may need ‘safe spaces’ for harmony and reflection (Farrington et al., 2019). Learning, learning environments, and wellbeing are closely intertwined, and as pointed out by Stanton et al. (2016), well-designed learning experiences result in increased student wellbeing. Students’ quality of learning is based on their wellbeing in well-designed and harmonious learning environments; simultaneously, well-designed quality learning brings wellbeing to students.

The determinants of students’ wellbeing and the relationship of wellbeing with learning outcomes, are addressed in the model proposed by Konu and Rimpelä (Konu and Rimpelä, 2002; Konu et al., 2002). The model builds on the sociological concept of wellbeing, with Allardt’s theory of welfare as a fundament (Allardt, 1976, 1993). The presented School Wellbeing Model (Figure 1) is constructed around four main elements: having, loving, being, and health. Having is in this model related to school conditions such as schedules, group sizes, environments, punishment, and safety. Loving refers to social relationships like group dynamics, student-teacher relationships, bullying, and the general school climate. Being comprises the means of self-fulfillment with possibilities for guidance, encouragement, creativity, and increased self-esteem. Finally, health is an extension for the health status involving psychosomatic symptoms and

chronic physical diseases, and common colds (Konu and Rimpelä, 2002). The model is further developed by Mili and Buragohain (2020), adjusted to other contexts than the Scandinavian and including *Strenghts and Resources* and *Digital World*. *Strenghts and Resources* focuses on Personal productivity, Staff engagement, and Leadership Development, and the *Digital World* on Internet facilities, Digital Tools, and Smart Classroom. The *Strenghts and Resources* are viewed in more subjective fashions in this specific study’s context in comparison to the international arena and *Digital World* are here standardized on a national level, adding less impact to wellbeing. Still, a literature review provides a number of conclusions (Aulia and Patria, 2020). First, their findings show that only a few studies have been conducted about wellbeing within the school context. Second, previous studies focused on positive aspects to explain student wellbeing rather than the negative aspects (such as anxiety, stress, and depression). Their literature review found that the domains of student wellbeing include positive emotions, social relationships, the lack of negative emotions, engagement with school, interpersonal factors, and achievement. The conclusions of this literature review are (a) the definitions used to explain student wellbeing are based on several approaches, namely mental health, hedonistic and eudaimonic, (b) several aspects that construct the student wellbeing at school namely dominant positive emotions, school satisfaction, negative emotions, social relations and engagement to school.

As above-described, wellbeing is connected to learning and achievements, and Konu-Rimpelä’s model can be used to evaluate schools through the lens of wellbeing indicators. The evaluation based on the model can be either objective (e.g., facts about the different wellbeing indicators) or subjective (e.g., how students, school staff, and teachers perceive wellbeing indicators). The present research refers to the School Wellbeing Model, building on subjective evaluations.

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2.2 Internet of Things

IoT was initially defined as “uniquely identifiable objects/things and their virtual representations in internet-like structure” (Kassab et al., 2020), and has grown significantly over the last decade. These technologies connect the Internet with everyday objects such as sensors and devices (medical equipment, home appliances, etc.) transforming how we interact with our environment through their

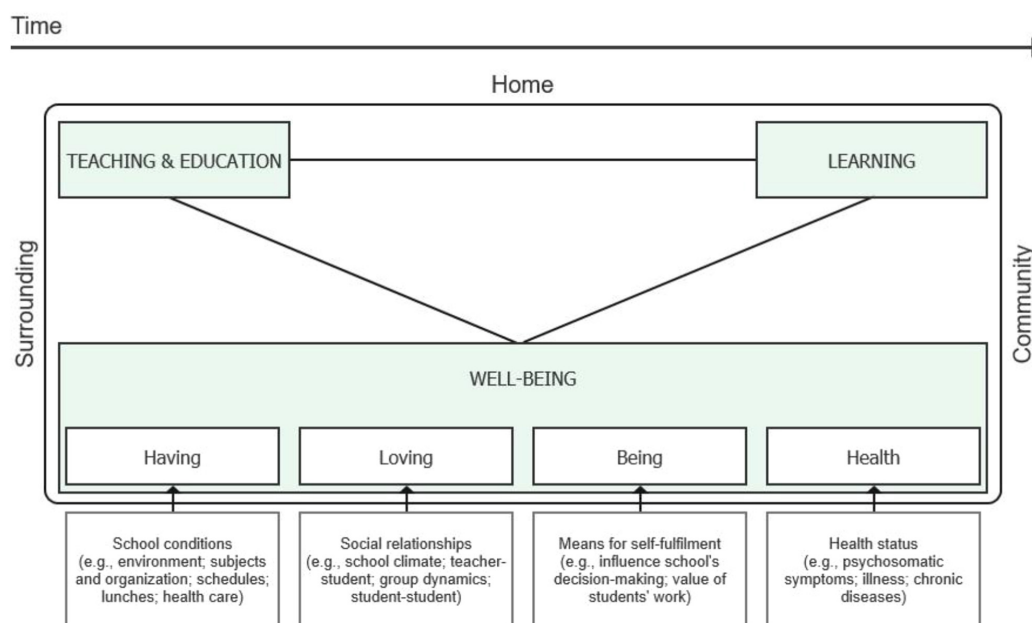


FIGURE 1

Conceptual model for school wellbeing, adapted from Konu and Rimpelä (Konu and Rimpelä, 2002; with permission of Oxford University Press).

communication and computing capabilities (Magsi et al., 2021; Quevedo Piratova et al., 2025). IoT applications now span areas such as smart cities, home monitoring and automation, healthcare, manufacturing, energy and utilities, smart grids, and intelligent transportation management (Jain et al., 2025). Experts anticipate billions of sensors and actuators will connect to the Internet through heterogeneous access networks enabled by technologies such as Radio Frequency Identification (RFID), wireless sensor networks, embedded sensing, and real-time and semantic web services (Duroc, 2022).

2.2.1 IoT in schools

IoT-based wearable devices, with their smart and ubiquitous features, are bringing together different domains including schools and educational institutions. The Internet of Things fosters a well-connected, collaborative, and efficient education system. These user-friendly, unobtrusive sensing and wearable devices give students better access to learning materials, online classes, and communication tools. For teachers, particularly in higher education, IoT provides an outstanding platform to analyze and measure learning progress, including homework completion, on-time attendance in class, and daily student outcomes (Abbasy and Quesada, 2017; Kandil et al., 2025).

IoT offers significant value to ensure wellbeing in school environments. Both physical and mental wellbeing serve as cornerstones for school-going adults and children alike. These aspects directly influence performance and responsiveness from students, teachers, and staff in all settings—school, hostel (accommodation), and home. Students' mental and physical conditions directly impact their routines and overall school performance, with extended periods of mental or physical illness potentially placing a student in a critical situation (He, 2023). Stress and anxiety can severely undermine students' health,

interrupting learning as well as increasing administrative burdens when school staff must contact families and guardians. Research indicates that IoT facilitates easier measurement of physical and potentially mental wellbeing indicators in terms of wide coverage, services, timeframe, workforce, and so on from societal and economic aspects (Muzammal et al., 2020). Hence, it is vital to design students' wellbeing strategies encompassing both physical and mental aspects with IoT-driven wearable devices helping to monitor students' daily activities across different environments (home, hostels, and schools) while providing sufficient and timely information to school staff and students' families. IoT-based wearable and sensing devices with the capability to target these wellbeing-related issues are widely available and appropriate options to be adopted for the wellbeing of schools (Sadriazadeh et al., 2022; Andrade et al., 2025).

Kassab et al. (2020) identified three key potential beneficiaries using IoT in educational settings: instructors, students, and staff. For instructors, IoT can help manage attendance and equipment availability; for students, it can enhance social aspects of education, such as peer communication and group work; for staff, it can assist with monitoring psychological health and tracking public portable equipment with RFID tags. Similarly, in their overview of IoT in education, Zeeshan and Neittaanmaki (2021) highlighted how IoT-based solutions can create smart school environments benefiting school management (through energy management, student health monitoring, and support for special needs), teachers (via automated attendance, feedback, and assessment systems), and learners (through enhanced productivity and personalized learning).

2.2.2 Challenges to IoT-based solutions

Despite explicit benefits of using IoT-based solutions for wellbeing and education, their ubiquitous nature poses significant

challenges, particularly regarding security and privacy. Obaidat et al. (2020) note that privacy concerns span multiple layers of IoT functionality. At the application level, questions arise about who has access to the data collected by IoT and how that information is used. The transport/network layer raises uncertainty about data encryption and security measures within specific infrastructures like wireless networks and cloud services. Perhaps the most concerning are the perception/sensor layers, where IoT collects personal information (e.g., names, addresses) and, at times, sensitive data or special categories of data.¹ The processing of this information often lacks transparency, with data potentially aggregated to profile individuals. For instance, it might be possible to assess individuals' preferences (e.g., hobbies, interests), political views, health habits or health-related information, and even credit card information or other financial details. The pervasive nature of IoT data collection, combined with minimal user interfaces, heightens privacy concerns because users might be unaware of nearby devices collecting their data or what data is being collected (Tawalbeh et al., 2020).

2.2.3 IoT and user requirements

Despite extensive discussion of IoT benefits and challenges in past research, to date, the proposed IoT solutions remain predominantly technology-driven, with new technical developments often proceeding without identifying users' needs. Research on IoT user requirements remains limited, though Moreno et al. (2014) suggest realizing IoT's full potential requires shifting from enterprise-centric systems to user-inclusive solutions where users become both the final decision-makers and the IoT system co-designers. Mehmood et al. (2021) discuss user requirements in the context of dynamic virtual IoT networks layer though their paper only considers users at the application layer,² without an in-depth assessment of their requirements. Smart homes represent one of the most researched IoT-related topics addressing user requirements. Georgia et al. (2021) presented an evaluation of user requirements, describing non-functional, functional, social, and financial aspects of smart homes. Their user requirements were assessed based on past research, considering users' motivations, security and privacy concerns, technology acceptance, and similar factors. They defined the following requirements: financial, social-technical, usability, reliability, and performance. Such requirements were then evaluated (pairwise comparisons) but only by technically skilled participants (IT students and IT professionals).

To the best of our knowledge, research on IoT user requirements in education is particularly scarce, with no peer-reviewed articles dedicated to school IoT user requirements. Michelsen and Johansson (2019), as part of a larger educational IoT project (IoT Hubskola), identified user needs based on observational studies in schools. They categorized primary needs

around security and monitoring (including physical safety and student monitoring to enhance wellbeing), environment (including indoor quality indicators, outdoor environment, and sound environment), and administration (including school attendance, handling of contact details, staff administration, and purchasing). Additional needs included teacher-student communication, food and waste management, technology use like difficulties in using the school equipment, pedagogics/learning analytics impacts on students' health (of daylight, diet, exercise), and logistics (transportation access). Based on that, Michelsen and Johansson (2019) listed the following areas of user needs that were highly relevant to their project: Sound and air quality in the school environment; Attendance management; Booking and unlocking of rooms/premises; Repair requests (e.g., for technological equipment); Repair requests for students' computers; Substitute teachers; Automatic assessments; Optimized cleaning; Meal logistics; Tracking of children.

3 Materials and methods

This study was designed as a qualitative case study with an elementary school in the rural part of Sweden as the case unit. We conducted semi-structured individual interviews and workshops with school staff and gathered empirical data from students using a qualitative survey approach. Through this method, we achieved data triangulation by gathering data from multi-stakeholders.

3.1 The case

The elementary school for this project is newly built. The school is located in the central part of a smaller city, with walking distance to the city library and a swimming and multisport hall. The school aims to be inclusive for everyone and is adaptable to individual student needs. One idea behind the school's design is to allow students to choose between social interaction or individual recovery in environments that are impression-reduced, or sensory friendly, e.g., leaving the walls without posters or using carpets on the floor. Other impression-reducing elements include L-shaped classrooms painted in colors that are experienced as soothing. The physical building is divided into home nests, cafeterias and group rooms. Each home nest has room for 100 students and is designed to function as a smaller school. In each residence, three classrooms are separated from the rest of the school, and only the students who belong to that residents have access. The home nests aim to contribute to increased wellbeing, while also making it easier for students by eliminating the need to navigate a large school and search for classrooms before each lesson. This design avoids unnecessary classroom movements to reduce stress. Students can buy snacks in the cafeterias and meet their friends, including those from other classes and residences. The overall strategy for this school's staff is to work with students' mental health, thereby decreasing long-term school absences, and developing inclusive and accessible learning environments. Health is of great importance for students' school performance and wellbeing, where an excellent physical environment is one of the factors that has proven to positively impact students' health. The

¹ According to the Art. 9 GDPR these data include: ethnic origin, political opinions, religious or philosophical beliefs, trade union membership, genetic data, biometric data, data concerning health or data concerning a natural person's sex life or sexual orientation (European Commission, 2016)

² Generally, the IoT system architecture can be described as four layers: (1) object sensing (sensing object and gathering data); (2) data exchange (handles data transmission); (3) information integration (data recombination, cleaning, and transformation into knowledge); and (4) application service layer (provides the content to different users) (Ma, 2011)

quality of the physical environment is controlled and monitored with the help of physical protection rounds with staff and safety walks with students. Students' health data is collected through physical meetings and conversations between staff, students and their caregivers and compiled in a regional database. This provides a basis for the school's work to reduce risk factors and strengthen student protective factors. However, the data only shows the values at specific points in time every third year, and measurements for entire groups of students are distributed over the year.

3.2 Data collection

The data collection is divided into two parts: first, data collection from the staff at the school, and then from the students. The collected empirical material was on a general level, and not referring to the model of [Konu and Rimpelä \(2002\)](#).

3.2.1 Data collection staff

One of the authors conducted seven individual interviews based on a convenience sample from various work roles identified by the school's vice chancellor within the time period of fall 2022. The respondents were five employees at the elementary school, one from the architect group and one from the school administration in the municipality. The interviews took 50–70 min to complete and had an exploratory format. The interview questions focused on what a dream scenario would look like where staff in their respective professional roles could best promote the students' wellbeing and learning. Another focus of interview questions concerned the information available about the students and what information was missing. Later in the fall of 2022, three researchers conducted two workshops with the theme: "What are the ingredients for a good school?" This was then broken down into sub-themes: health, physical environment, learning environment and others. Again, the respondents were based on a convenience sample from the school's vice chancellor. The nineteen participants responded to the dream scenario prompt, discussing what a good school looks like and what worked well or less well for them. The participants were teachers, special educators, school nurses, social educators and deputy principals, of whom four had also participated in the individual interviews. Two 2-h workshops were conducted to engage in practical work with groups limited to 10 or fewer participants. We worked via Zoom and used the digital tool Miro to capture and generate ideas in a shared digital workspace. The data from the interviews and workshops were recorded and transcribed verbatim for further data analysis.

3.2.2 Data collection students

Data was collected from the students through a qualitative survey with open-ended questions in the fall of 2022. The survey questions were related to the school's quality work and business development and aimed to investigate what students think characterizes a good school. Participants in the study were 464 students in grades 7, 8 and 9 at the elementary school. The selection was made as a convenience sample: the participants were the students who were present at the time of data collection and who consented to complete the survey ([Jakobsson, 2011](#)). The inclusion criterion for participating in the survey was that the participant

must be a student in years 7, 8 or 9 at the school where the survey was conducted. At the time of the study, there were 695 students at the school, which means that approximately 67 per cent of the students at the school answered the survey. All students present on the day the survey was conducted were offered the opportunity to participate in the study. Students could answer the survey using a computer, mobile phone or tablet. The survey was accessible by either going to [menti.com](#) via a web browser and entering a code they received from their teachers or using the camera on their phone or tablet to scan a QR code that opened the survey link. The total time required was estimated to be about 15–5 min for instructions and 10 min for answering the questions themselves. All questions could be answered in free text. Each question could be answered multiple times to provide more than one answer. Although there was no possibility to go back to a previously answered, or skipped, question, there was the possibility to answer the survey again once all questions had been answered, to add additional answers afterward. The teachers provided the deidentified collected data to the researchers in Excel format in a separate database.

3.3 Data analysis

Several researchers conducted the data analysis in three steps: initial analysis of staff material, analysis of students' material, and synthesis of the analyzed material. For the staff material, individual interviews and workshops were deductively analyzed according to the theory by [Konu and Rimpelä \(2002\)](#) in Nvivo12. Two researchers independently read the transcribed material repeatedly from both physical and mental wellbeing and learning perspectives. After the independent read-through, they individually formed sub-themes based on the themes in the theory. Those sub-themes were then discussed, and jointly agreed upon. The analyzed material from the interviews and workshops were then presented in a report.

The student material was analyzed inductively in Nvivo12, initially forming a master thesis ([Andersson, 2022](#)). One author read all collected data without preconceptions ([Braun and Clarke, 2006](#)). Eleven answers were excluded from the students' material as they consisted only of empty text boxes or contained text that could not be analyzed. The responses of the remaining 464 participants were included in the analysis. The data were then coded to highlight parts relevant to the research questions, resulting in a relatively large number of codes for the entire material. Initially, data were coded separately for each question asked of the students. However, significant overlap in answers across specific subsets of questions became apparent. Hence, answers across several questions, and thus several codes, were merged before the next step as there was no reason to continue separating these answers. The codes that emerged in previous steps were then reviewed to identify those that could be categorized into themes.

The final step was to interlink the previously analyzed material. The foundation for the synthesis was the analyzed material presented in the master thesis, the report, and the deductive analysis of the workshop material. The researchers merged all analyzed text into one dataset, viewing themes and responses altogether on equal terms. Some themes or questions included data from only staff or only students. Where student material or staff material alone addressed one topic, the theme remained. [Table 1](#) shows an overall picture of the conducted steps to gather empirical material for this study and [Supplementary Table 1](#) with the number for each code.

TABLE 1 Conducted steps to gather and analyzing empirical material.

Activity	Staff	Students
Data collection	Seven individual semi- structured interviews	Structured questions in a survey with 464 usable answers
	Two workshops with nineteen participants altogether	
Data analysis	Iterative reading transcribed material from the interviews	Iterative reading material from the survey
	Deductive analysis of interview material	Inductive analysis of survey material
	Writing and publishing report based on the interview material	Writing and publishing master thesis
Data analysis	Deductive analysis of the workshop material and combining the material from the report and the master thesis	

3.4 Ethics

Ethical considerations included informed consent and the handling and use of collected data (Sinclair, 2017). For informed consent, the researchers informed both staff and students about the project background, potential risks and benefits of participation, and their right to suspend their participation at any time without any risk of adverse consequences (Olsson and Soerensen, 2021). All respondents were informed that the study was conducted in collaboration between the school and Karlstad University and that researchers at Karlstad University would read their answers, but that the answers would not be linked to any specific individual (such as age, year group, gender identity or IP address for the student survey). For students, it was emphasized that participation was not part of the schoolwork and would in no way affect assessment or grades either positively or negatively. Furthermore, information was provided that participation was voluntary and that the data collected were intended to improve the school environment to create the best possible conditions for students. The confidentiality requirement states that collected personal data must be stored securely so no unauthorized person can access them and treated as confidentially as possible (Olsson and Soerensen, 2021). The staff material was stored in a secure database and did not contain personal information. For the students’ material, the data submitted to the researchers did not contain personal information (such as name, age, year group or IP number) that could link answers to a specific individual. The collected data were stored on encrypted servers at the university. The study was approved by the faculty’s ethics reviewer according to the guidelines set by Karlstad University (case number: HS 2022/155) and following its guidelines.

4 Results

This results section includes material from individual interviews and workshops with the staff and the survey with open answers from the students. Initially, the overall categories were physical design, wellbeing, learning, and work with data. These categories are built on the synthesized staff and student material. As the categories were well-matched with Konu and Rimpelä (2002)’s model, we decided to present them accordingly. Here we have used the overall themes of having, loving, being, and health.

4.1 Having

This theme addresses the physical design of the school and the schoolyard and includes the sub-themes: The design of the building, Limited or cramped spaces; Cleaning and maintenance; Access to physical activities and Administrative hindrances to learning and is synthesized in Table 2.

4.1.1 The design of the building

Both students and staff express themselves in favorable terms regarding the building’s design, which includes everything from the school’s floor plan to the outdoor and indoor environment. The design principles of minimizing movement and impression-reduction are experienced positively by the respondents. One note in the workshop emphasizes a downside that the teaching teams are isolated, with no cohesion in the school, while another note mentions the absence of meeting places for staff. One staff respondent describes that colleagues miss having contact with those working in other home places, resulting in limited knowledge exchange. While many students are happy with the impression-reduced classrooms, some believe that this approach has made the classrooms becoming less home-like. A few students also experience that, contrary to the intention of impression-cleaned classrooms, it has negatively affected their concentration: “What makes a good school, in my opinion, is that the classrooms have many furnishings, so there is a lot to look at. It makes it easier to focus”. As part of creating classrooms designed with the student’s best interests in mind, the rooms have been painted in colors intended to be soothing, combined with their L-shaped layout. The colors are meant to contribute to students’ wellbeing in their classrooms.

4.1.2 Limited or cramped spaces

Despite students’ and staff’s overall happiness with the school design, they regularly return to the subject of limited or cramped spaces. Although the school building is newly built, it is perceived as cramped. Students express it like this: “I think it is good overall, but it is so crowded everywhere.” There is limited access to group rooms where the students have the opportunity to sit and work on their school assignments. These group rooms are often difficult to access as they are frequently occupied. The demand for group rooms appears considerably greater than the supply, expressed by staff as: “Group rooms are good but more access to them would facilitate.” Both students and staff wish for more places where students can meet and socialize with their friends and classmates. The students propose opening up existing spaces to

TABLE 2 Having.

Category	Requirement	Expressed by:	
		staff	students
The design of the building	Less isolated staff teams	✓	
	More homely home nests		✓
Limited or cramped spaces	More group rooms	✓	✓
	More places for students to socialize at	✓	✓
	More available comfortable chairs	✓	✓
Cleaning and maintenance	Clear and fresh school building		✓
Access to physical activities	More options for physical activities	✓	✓
	More free access to the sport hall	✓	✓
Administrative hindrances in learning	New approaches to scheduling	✓	
	Labs and sport halls not restricting the schedule	✓	
	Too much information in the presentation of schedule	✓	
	Technical equipment that is working as supposed	✓	

reduce congestion in the home nest. Regarding the limited spaces, students and staff emphasize problematic issues with lack of seating and the need for multiple seating options. Students want enough seating for all students to be comfortable, especially while forming groups during breaks and free time. In the classrooms, students can choose between chairs and stools, but there are not enough chairs for those who prefer to not use stools. Staff note: “Too many pallets give us students with back pain.” Students express: “What can be a little worse at school are the stools you sit on. They are not so comfortable, and sometimes you cannot sit on a chair because everyone is busy”. Other students express that the stools in the classroom can negatively affect their ability to concentrate. What was intended as freedom of choice in seating arrangements is instead experienced by the students as a limitation.

4.1.3 Cleaning and maintenance

Another important aspect that students repeatedly mention is the importance of effective cleaning and caring of the school. Students want to be met by clean and welcoming rooms when they come to school. This is of such great importance to them that some describe it as affecting their motivation in school: “Going to a fresher and a little nicer school means that you can concentrate and make school work a little more seriously.”

4.1.4 Access to physical activities

Staff emphasize the importance of having access to activities as a major issue for increasing physical health. The schoolyard was under construction during the collection of empirical material. Therefore, staff and students describe too few activities available during breaks and free time, and a need for opportunities to be active during these periods. Students are specific in their requests, with activities such as billiards, football, basketball or table tennis recurring in their feedback. There was a wish to have access from the schoolyard to the leisure center. “More leisure activities such as sports and maybe having a basketball goal or soccer field.” One frightening result of the lack of activities is that both students and staff report increased phone usage among students. Students feel the breaks are dull due to limited activities, and they use their

phones to pass time. Staff suggest that indoor activities could be arranged in the sports hall, but note administrative issues with scheduling: “After all, the schedule is governed by the fact that the halls that are available are few, how can one get access to them for everyone if I think like music and sports and so on.” The sports hall is identified as a limited resource, and there appears to be a lack of creativity in using it for free activities.

4.1.5 Administrative hindrances to learning

Staff respondents mention several administrative obstacles to achieving a favorable school environment. One concern is that they consider the schedule to be the focus, rather than the learning. This manifests, for example, in the schedule being based on entrenched views of lesson length and school day start times. Consequently, teachers lack sufficient time to complete planned activities during lessons, and students are not ready to learn new material, particularly during the first lesson each morning. The schedule is also constrained by existing facilities, with access to sports and laboratory facilities governing timetable decisions. Several respondents also describe the schedule as containing too much information for students with special needs. These students struggle to understand the schedule as currently presented and only need to know, for example, what to do next and which room they should be in. In addition to scheduling challenges, several respondents mentioned technical equipment as an administrative burden. The newly built school has new technical equipment which, when properly installed and used, becomes an asset. However, there have been problems with the technical equipment, which has created irritation and frustration. Even when functioning properly, some staff find the technical equipment challenging to use due competence gaps, which affects motivation to utilize the technology.

4.2 Loving

This theme addresses how students experience their social relations, both positively and negatively. It includes the sub-themes:

Social relations; Safety; Stress, pressure and demands; Work peace; The role of the teacher and Variation in teaching and is synthesized in Table 3.

4.2.1 Social relations

For students, the impact of friends and classmates is paramount to their wellbeing at school. School can often be perceived as complex, and friends' support becomes vital. At the same time, school and the friends there can be experienced as a refuge for students who find it pleasant to be away from home or those with problematic home situations: "You get to meet friends, and if you do not feel so good at home, the school feels like a good place. There you can get help from teachers or classmates," "I thrive at school because I have friends who support me, and I feel good at school because of them." Although students have described home nests in favorable terms, these also create social restrictions because only those who attend a particular home nest can access it. This becomes especially apparent when students have friends who belong to other home nests: "I would thrive more if you had the opportunity always to be able to meet those who are not in the same residence. We usually have breaks at different times, and there is no place where you meet in the middle of the day." The staff deeply understand the importance of having good friends and classmates at school, and one suggests that there should be opportunities to find new friends each term. The staff are concerned about how the time spent on mobile phones impacts social relations. They describe that students communicate through happy messages, quarreling, or problem-solving: "because it has to be photographed and it has to be filmed, and it has to be everything, like that. It is tough for them." Therefore, the ongoing interaction outside school means there is no time or place to escape. Mobile phones are also used for filming, which becomes problematic when films are publicly shared to embarrass students. Staff describe one result as students avoiding sports lessons due to previously published film sequences. Another discussion among staff concerns social relations with adults besides caregivers. Staff implementing social discipline in their work roles try to interact and form many social relationships with students to enhance their wellbeing and identify problems as early as possible. One reported challenge is that staff and other adults are stressed and do not devote sufficient time to interact with students. The students also emphasize the importance of having teachers to talk to in person and note that the teachers at the school meet these requirements.

4.2.2 Safety

Both students and staff identify safety as an essential component of the school environment, with all groups seeing themselves as contributing to safety. Feeling safe at school is fundamental. Consequently, this is one of the school's focus areas regarding wellbeing. What makes a school a safe and positive environment is how secure the students feel in the space, with the staff and other students. If students do not feel safe in the area, there is a problem, as students' wellbeing should be prioritized. One staff member discussed student safety this way: "I know where I am heading, I know where I belong, and I know what is expected from me. All those aspects are important to succeed in school, to feel safe in the building, safety from the teachers and in finding knowledge."

To enhance building security, the home nests are locked to students other than those assigned there, and the number of students in each home nest is limited, contributing to perceived security. The home nests have a pass system, requiring students to use a key tag to enter the premises. Both students and staff emphasize the social dimension of safety. Staff work diligently to promote treating each other respectfully: "That you are kind to each other and respect each other". Unfortunately, responses emerge where staff and students describe instances of bullying and shortcomings in mutual respect toward others, especially concerning female students, their appearance and their clothing. One staff expressed the safety goal thus: "You can be just as you are, that you do not have to fall within any predetermined framework, and it is probably difficult to get any sense of belonging if you do not get accepted." The bullying risks negatively affect students' wellbeing at school, both regarding attendance and academic performance.

4.2.3 Stress, pressure, and demands

Many students experience considerable stress, pressure and demands. For some, the academic demands are so high that they feel their wellbeing is compromised: "(...) I generally do not feel good about school because there are too many demands on us and we have far too much to do." As a counterpoint to academically demanding subjects, there are practical subjects such as sports, music and handicrafts. For many students, these subjects have become a way to manage the stress and demands they experience in theoretical subjects. Here they can relax as these subjects typically have few or no formal assessments: "Sports and music (...) make school more fun. We get to play, play and talk to each other. The most important thing is that there are not so many tests in those subjects, so we do not get so stressed and have much more fun." The staff discuss students' stress in various contexts. One observation is that some students, mainly girls, put excessive pressure on themselves, forgoing fun activities with friends or physical activities to complete home assignments instead. The staff insist that social relationships are essential and that this group needs to be monitored and supported. Another stress-related topic concerns students' anxiety about their social relations, especially regarding social media. Students aspire to look like the prevailing ideal, which creates stress if they feel they fall short. Staff also discuss their own stress regarding lesson preparation time and daily school activities. Regarding preparation time, they describe the pressure to ensure lessons are sufficiently effective to support student's learning. During the school day, they experience varying levels of stress when unexpected issues arise. One staff member expresses interest in understanding (through data) how often interruptions disrupt their daily schedule.

4.2.4 Work peace

An important factor in students' learning, which they frequently returned to, was their ability to work and learn in an environment with access to mental peace and quiet. Two aspects were highlighted: peace in the classroom and opportunities to work outside the classroom (for example, in group rooms): "Group rooms. They help so that you are not disturbed in the classroom. But it would have been possible to improve the school by having more group rooms (...)." Some students described managing the

TABLE 3 Loving.

Category	Requirement	Expressed by:	
		staff	students
Social relations	Good social relations with other students	✓	✓
	No filming in relation to sport lessons	✓	✓
	Time to talk with the students	✓	
Safety	The students should know the expectations	✓	
	Treating each other in a respectful way	✓	✓
Stress, pressure, and demands	Reasonable workload	✓	
	Students should take time off for leisure activities besides school work	✓	
	Enough time to prepare lessons		✓
The role of the teacher in learning		✓	✓
Work peace	Peace in the classroom		✓
	Access to group rooms	✓	✓
	Less distraction from content on digital devices not related to the lesson		✓
Variation in teaching and learning	Various activities during a lesson	✓	✓
	Frequent group work		✓

lack of quiet in classrooms by listening to music on headphones when permitted “I usually listen to music in class, then I usually focus better.” Some teachers express concerns when it comes to digital teaching materials. Much material today is digital, requiring students to use their computers extensively to read digital books. While some students view this as helpful for keeping track of things, teachers and other students see it as a significant distraction from assigned tasks which reduces work peace.

4.2.5 The role of the teacher in learning

Teachers express their commitment to making lessons as enjoyable as possible to reach students and enhance their learning capabilities. At times, they feel frustrated when they do not motivate the students as intended and struggle to understand why. One teacher talks about the challenge of motivating all students simultaneously: “This should increase motivation, so it is not the case that it increases for everyone, but when some do.” Therefore, teachers describe understanding how to motivate every student in their subject as a dream goal. The school has started a course for teachers on lesson design to achieve this goal. One teacher describes that students differ considerably in their motivation and learning pace, placing high demands on lesson design. One factor mentioned is how some students may be motivated by immediate feedback or grading but future grades may seem too far away to be relevant to their motivation. Many students briefly describe a “good teacher” as essential for their learning, noting that the teacher plays a more significant role than the lesson or subject itself: “(…) a subject that I do not like can still be fun thanks to the teacher. A teacher who is good can make any lesson fun to go to.” Students also clearly articulate what they need from teachers. For example, teachers must be pedagogical, clear and employ repetition: “All teachers should explain more and more clearly what it is to do this particular lesson, what is the lesson’s goal you should do and catch up with, and make it easier to get started and know what to do”. Additionally, they

emphasize the importance of teachers showing genuine interest in their subject. Teachers should be “good at explaining and teaching” but also have “enthusiasm and know [how] to make a lesson happy and kind.” An essential aspect of learning is the opportunity for students to receive help when they need it. Here, opinions appear to diverge. Some students report good pedagogical support from teachers: “I think learning is straightforward here at school. All teachers are pedagogical and ensure that everyone gets the help they need.” Others express a need for more support, perhaps by more resource staff being made available for additional assistance: “What you could do better is to have several resources that can help”; “Something that would make it easier is to get more help from a resource.” Still other students express themselves less specifically about what is helpful for them, while clearly expressing that a good school is one where students “get the help they need” regardless of whether the help comes from teachers, friends, resource staff or the opportunity to work “in a group room with few people and (...) a good teacher who explains.”

4.2.6 Variation in teaching and learning

As described previously, both teachers and students desire variation in lesson content. A lesson lacking sufficient variation risks being perceived as monotonous and boring. Staff mention variations among tasks, such as incorporating reading, listening and visual supplementation. Students repeatedly mention appreciating lessons that begin the teacher reviewing content first and then showing a relevant video. Interactive learning is also valued by students, who express appreciation for occasions when teachers use games or competitions to reinforce learning. Group work provides another form of variation. Students frequently mention group work, focusing on the learning that occurs through interaction with peers: “I learn when I discuss and reason with my friends because then I know how they have thoughts and can compare it with how I have thought.”

TABLE 4 Being.

Category	Requirement	Expressed by:	
		staff	students
Students' attendance	That students come to school and attend the lessons		✓
Students' motivation	Understanding when the teacher motivates the students	✓	✓
	Teachers explaining the agenda for each lesson and be repetitive during the lesson		✓
	Get the needed help during a lesson	✓	✓
Students' participation in learning	Form a student council	✓	✓
	The students want to be involved in planning lessons		✓

TABLE 5 Health.

Category	Requirement	Expressed by:	
		staff	students
Food and sleep	Introducing diet diary to get student to eat proper breakfast and lunch	✓	
	No crossing paths in the dining hall	✓	
	Introducing a sleeping diary	✓	

4.3 Being

This theme concerns the students' perceptions of the elements essential for their effective learning in school. It includes the following sub-themes: Students' participation in learning and Students' attendance and is synthesized in [Table 4](#).

4.3.1 Student's participation in learning

One staff member should form and start a student council to elevate student's voices in the school. The staff describes this idea and recognizes the opportunity to get students involved in learning and in the school by creating class councils in each grade level that give their views to the student council. The students, on the other hand, are keen for their teachers to invite them to participate in designing their lessons, believing this positively affects their motivation: "When the teacher and the student decide together how the day or lesson should go then better motivation than if we just sat still and listened." Similarly, students' participation can also mean teachers asking students how they prefer to approach and work with tasks: "way with tasks within the work area you are in." It is thus vital "that the teacher takes into account the students' opinions."

4.3.2 Students' attendance

All staff respondents discuss students' attendance from different dimensions. They first consider whether students come to school at all: "...but the thing that I, when I work with the school attendance team that is the most important thing, is the attendance, it's like a and o for and quickly see to quickly see when someone is slipping away." If students do not attend school, there are built-in system actions where they are identified and offered alternative schooling. When it comes to class attendance, the majority feel there is a problem with slow attendance management and difficulty in obtaining an overview of attendance via the current

information system. One reflection from the staff respondents is to consider when absence becomes alarming—whether it occurs on a few isolated occasions or when it impedes knowledge acquisition. Another dimension of attendance is that several students play computer games during class, meaning they do not engage with lesson content. Consequently, their knowledge acquisition suffers.

4.4 Health

This theme concerns the students' health and includes food and sleep, shown in [Table 5](#).

4.4.1 Food and sleep

Staff express concern about the students' eating habits. The students are not used to eating breakfast at home, and parents are not used to serving their children breakfast at home, as expressed by one staff member: "that all of a sudden the time at home should be enough to sit down and eat breakfast, before they have gotten up, dressed and gone away, as they were." From an early age, students have had breakfast served in childcare and after-school care. When the students become teenagers, they become responsible for obtaining a good breakfast, as the parents often do not monitor this. Lunch habits are described differently for various groups of students. Several students with access to vehicles often eat lunch at a pizzeria, which risks unhealthy eating habits. Some students do not eat anything for lunch, which may be due to prevailing body ideals or logistical problems in the dining hall. To obtain food in the dining hall, one must stand and queue. For students with neurological conditions, this can create such resistance to eating that they skip it altogether. The staff respondents base their reasoning on the premise that healthy eating habits provide energy and form a foundation for learning and stress tolerance. Therefore, several suggest introducing a diet diary for a brief period. They also

TABLE 6 Work with data.

Category	Requirement	Expressed by:	
		staff	students
Work with data	Information to make better decisions	✓	
	Knowledge on how wellbeing impacts students' learning	✓	
	Knowledge on how physical activities impact students' learning	✓	
	Integrating information systems to get a full picture of each student's situation	✓	
	Avoidance of intrusion or abuse of the students' privacy	✓	

emphasize implementing a sleep diary to increase some students' sleep hours. They note that students use their phones late into the night and do not turn them off to sleep because the student is at a critical stage in a game or due to unresolved conflicts on social media.

4.5 Work with data

The use of data is mainly related to decision-making or achieving behavioral changes. Some staff also express curiosity about making better-informed decisions and look forward to accessing more data based on IoT solutions. One example given is to further understand the relationship between wellbeing and learning, e.g., based on measuring air quality in the classrooms, shown in Table 6. By improving air quality, it is assumed that wellbeing will improve and thereby enhance learning. Another example is physical activity and learning, where staff describe measuring students' physical activity and relate it to their learning progress. The discussion advances to boundary values, e.g., how much physical activity is enough or too much for a student during a week, what should happen when they are under or exceed these values, and the impact on their learning over time. The worst-case scenario is that a student with an eating disorder exceeds physical activity recommendations and continues pushing beyond established boundaries. The staff utilize various information systems concerning students. Data are gathered in various ways and over various periods. Overall, there is one database where students' health data is entered from a survey completed by the students and their caregivers every third year. The staff also mention information systems used daily, where student data such as absences and notes from meetings concerning students are recorded. A frequent topic of discussion is how to integrate these information systems to obtain a comprehensive picture of each student's health, learning and family situation. In connection with this, questions arise about who should have access to all this information to prevent intrusion or abuse of the student's privacy.

5 Discussion

The aim of this study was to gather various stakeholders' requirements for IoT-assisted wellbeing in an elementary school. When it comes to requirements there are a few studies focusing on

requirements from the staff's and students' perspectives (Michelsen and Johansson, 2019). Even though these studies show that research has been done, they exist primarily as project reports that have not undergone any peer review process. Most articles about IoT in elementary schools focus on the buildings themselves, referring to smart buildings, smart cities (Rico et al., 2022), smarter universities (Kiryakova et al., 2017). We would therefore like to emphasize our findings as a step forward; both in detailing specific requirements and in introducing users as active participants in designing IoT solutions. In this case, we build upon Zeeshan and Neittaanmaki (2021) literature review, generalizing requirements for IoT solutions in a school environment.

Our findings show, on an overall level, that there is consensus on what constitutes a requirement, though students provide more detailed input. This indicates that teachers recognize students' wellbeing as foundational for knowledge absorption and learning. It also demonstrates that staff take a holistic approach beyond their subject matter, considering what truly benefits students. Students express more detailed wishes regarding their wellbeing across all categories, suggesting they view school as an essential gathering point in their lives. The social relationships they create at school are as necessary to them as the varied lesson content. Their attention to detail can be seen in practical requests, such as wanting more chairs to sit comfortably during their breaks. When compared with our theoretical basis, the Health category appears less comprehensively defined than others. Several factors may explain this: health concerns are private and, therefore, not explicitly stated by respondents; participants expressed themselves in more general terms without elaborating; and our staff interviewees occupied professional roles other than school health practitioners who might have emphasized specific health concerns more prominently. A significant finding that emerged focuses specifically on IoT solutions and their data capabilities. The objective data collection that IoT enables can provide valuable insights into factors that support increased wellbeing. For example, IoT systems could track food consumption patterns in the school canteen, comparing amounts of food eaten each day with the number of students eating in the canteen. Such data can create a strong foundation developing evidence-based improvements to students' wellbeing. Notably, respondents showed considerable support for data collection that could inform decision-making to enhance student wellbeing. We illustrate how these findings align with and extend the framework proposed by Konu and Rimpelä (2002) in our revised model (see Figure 2).

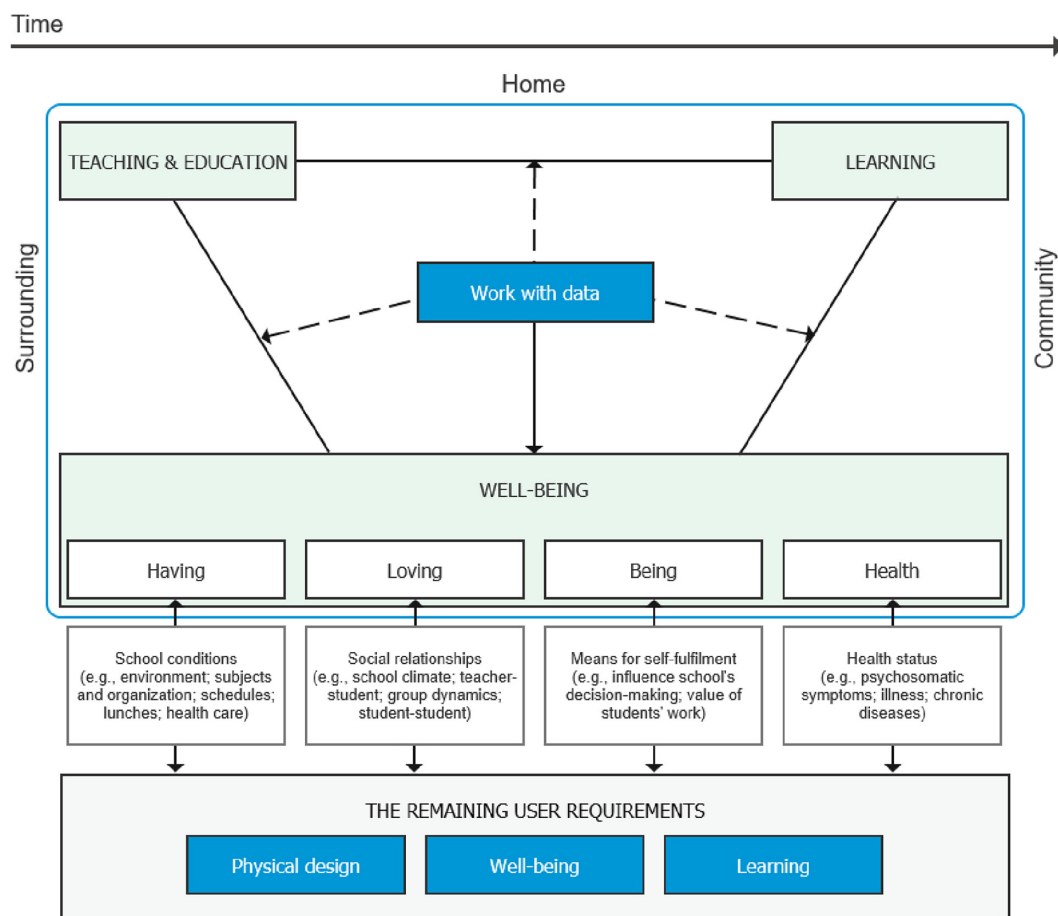


FIGURE 2
Revised model.

5.1 Challenges to satisfy user requirements

Designing IoT solutions for schools based on the user requirements identified in the present research presents challenges, primarily due to the potentially invasive nature of such solutions. For instance, facial recognition could seamlessly monitor students' school attendance, while surveillance systems could track students' physical wellbeing, eating, and sleeping habits in the school and beyond. Wearable devices could measure stress levels and emotions through physiological indicators (e.g., heart rate patterns and electrodermal activities). However, these data are often personally identifiable and sensitive, raising significant privacy and security concerns as previously discussed in section 2, particularly when collected from minors. However, if the benefits of collecting such data outweigh the associated risks, IoT developers and designers should prioritize solutions that minimize such risks. In some cases, aggregated data might be sufficient, where personally identifiable information related to physiological measurements could be removed during data collection (i.e., data minimization). Alternatively, non-invasive technologies could be employed, such as thermographic cameras that count students to assess crowding levels without identifying individuals.

A second major challenge lies in transforming the requirements into practical solutions. IoT-solutions typically consist of sensors without user interfaces, making them difficult for end-users to understand. Additionally, IoT-designers often struggle to interpret requirements from end-users, as they rarely interact directly with them. End-users typically express their requirements without a technical understanding of IoT capabilities or limitations, while designers often lack context for interpreting these user requirements. This knowledge gap can lead to requests that are either technically unfeasible or fail to address the actual problem, creating a translation challenge between user needs and technological solutions. A particular challenge arises when requirements involve subjective elements that are difficult to quantify. For example, requirements such as "less isolated staff teams" or "good social relations with other students" involve subjective experiences that resist straightforward measurement.

5.2 Contributions

With its wealth of empirical material, this study makes a contribution to both academic discourse and practical application. The updated version of the model serves as a first step toward

linking wellbeing with user requirements for innovative, data-driven solutions, such as those found using IoT solutions. This revised framework not only enhances the overarching theoretical aspects but also provides a foundation for further exploration into the relationship between wellbeing and design practices.

Moreover, the updated model introduces a set of curated sub-themes that allow for a more granular analysis of the primary themes. These sub-themes enable researchers and practitioners alike to delve deeper into specific facets of the relationship between design and wellbeing, thereby offering a richer understanding of the subject.

Practically, the implications of this study are profound, as it offers insights that can be leveraged to design and implement targeted IoT solutions aimed at augmenting wellbeing. By utilizing the identified themes and their accompanying sub-themes, practitioners are better equipped to determine the specific features and considerations necessary for creating effective solutions on a broader level.

5.3 Limitations and future work

This study has several limitations. First, it involves only one school, whose specific rules and culture inevitably influence their responses. Second, participants' limited knowledge of IoT solutions may have led them to propose requirements that are not solvable with this technology. Therefore, we must consider the requirements for effective information communication across various stakeholder groups, including students, staff, and caregivers.

6 Conclusion

IoT solutions for schools are rarely designed based on end-user requirements, such as staff or students. Our findings show that requirements gathered from staff and elementary school students regarding wellbeing are aligned, though students provide somewhat more detailed input. These requirements extend the categories in [Konu and Rimpelä \(2002\)](#) model for wellbeing: having, loving, being, and health— all of which require data collection in various forms, as reflected in our revised model. In contrast to [Mili and Buragohain \(2020\)](#) model, that is developed for another context than the Scandinavian, more answers are gathered from the students and the findings are more subjective in their characteristics. Moreover, data is added in our revised model to enhance the model for wellbeing involving IoT-applications as means for data collections. Specific requirements encompass building design, social relations, attendance monitoring, and tracking of food consumption and sleep patterns. The focus on data collections introduces additional requirements for data management, particularly using data to improve decision-making while preventing intrusion or abuse of students' privacy. The latter is one of the key challenges in implementing IoT solutions in an elementary school, alongside the difficulty of transforming user requirements into IoT solutions. End-users naturally express their needs without considering the feasibility of technical implementation, and those requirements often involve both

objective and subjective data elements, further complicating design. Therefore, this revised model should be further used and a crucial next step is to compare and develop these requirements with knowledge of current IoT solution design practices and capabilities.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contribution

KB: Writing – original draft, Writing – review & editing. JA: Investigation, Writing – original draft. AK: Formal Analysis, Writing – original draft, Writing – review & editing. AA: Writing – original draft. PM: Writing – original draft, Writing – review & editing.

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Supplementary material

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