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Anticipatory Insights: Producing AI narratives to explore future biometric applications in education within a human rights framework.

MA thesis

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Abstract

Abstract "Anticipatory Insights: Producing AI Narratives to Explore Future Biometric Applications in Education within a Human Rights Framework," we journey into the possibilities and ethical considerations of biometric technology in education by 2050. This paper imagines a future where AI helps us craft narratives to predict and critically examine the integration of biometric systems in learning environments. By focusing on a human rights framework, we aim to uncover the potential impacts on privacy, equality, and access to education. The narrative-driven approach allows us to visualize diverse scenarios, highlighting the balance between technological advancement and the protection of individual rights.

Keywords: Human Rights, Future Biometrics, Educational Technology, 2050, Speculative Fiction

Title

Anticipatory Insights: Producing AI narratives to explore future biometric applications in education within a human rights framework.

Contents

Introduction

Biometrics holds a great potential to transform education; the implementation of technological advances must be weighed by considering ethics. As outlined by the Universal Declaration of Human Rights, specifically the right to privacy and the right to education (1948) are particularly relevant to the collection and use of biometric data. The potential for misuse of biometric data becomes more pervasive in this context of education.

This thesis will identify and quantify, by AI-generated stories of education in 2050 in five different locations, the biometric measurements anticipated, and discuss the human rights concerns. Identifying the insights through this research will emphasize the importance of navigating educational futures with the appropriate use of biometrics and respecting human rights.

Literature Review

There is a growing body of research on the use of AI as well as the future of education. Most of the research involves the use of biometrics and project advancements in technology in the security of providing educational materials to students. There is no comprehensive research into specific types of projected biometrics, plausibility, and human rights implications. This is a significant gap. Most of the articles available speak to the future of technology and the integration of artificial intelligence to achieve self-directed and personalized learning (Jack, 2023). Identified were 18 research papers on the future of biometrics in education. Of the 18 papers reviewed, there was an equal divide between micro-credentialing, sustainable education, social-emotional learning, and technology use and preparation of the student and teacher.

Theoretical Overview

Fictional Design Research is a speculative approach used to explore and consider possible futures. While it shares conceptual ground with science fiction, its academic applications distinguish it from traditional speculative storytelling. Science fiction primarily aims to entertain while sparking discussion and debate about social conditions and technological developments. In contrast, fictional design research intentionally fosters structured inquiry into speculative futures, focusing on generating data for academic analysis rather than entertainment (Houlden & Veletsianos, 2022). The distinction lies in the purpose; whereas science fiction offers engaging narratives with social commentary, fictional design research constructs speculative futures to prompt critical examination of emerging technologies and socio-cultural landscapes.

Fictional design research emerges from broader traditions of design fiction, speculative design, and critical design, as articulated by Dunne and Raby. These scholars emphasize that such design approaches focus on conceptual possibilities rather than physical artifacts, enabling discussions on what futures we may desire or reject (Dunne & Raby, 2013). Houlden and Veletsianos argue that engaging with

fictional methods for research fosters radical imagination, which is essential not only for understanding possible worlds but also for enacting positive change and resisting oppressive structures (Houlden & Veletsianos, 2022). Fictional design research thus serves a dual function: it generates imagined futures and facilitates discussions about whether those futures are desirable. Furthermore, imagined futures have the capacity to shape present behaviors, thereby moving speculative scenarios closer to reality (Houlden & Veletsianos, 2022).

A crucial area where fictional design research proves valuable is in the study of educational technology. Conventional educational technology research primarily examines the relationship between existing or emerging technologies and pedagogical practices. Fictional design research, however, offers a speculative lens that allows researchers to explore potential long-term consequences of educational technologies long before they are widely adopted. It has been employed to generate scenario-based futures that assist decision-makers, administrators, and stakeholders in evaluating possible educational outcomes (Houlden & Veletsianos, 2022). These scenarios function as a type of education fiction, a concept Hrastinski defines as having four key characteristics: (1) it connects the past, present, and future; (2) it is both speculative and informed; (3) it employs atmosphere to evoke emotions; and (4) it encourages reflection (Hrastinski, 2023).

Education fiction frequently adopts a dystopian and cautionary tone, warning of potential risks posed by unchecked technological advancements, political forces, and ethical failures. These narratives commonly highlight issues such as surveillance, automation, and control in educational settings, aligning with broader critiques of educational technology. However, fictional design research differs from dystopian speculation by employing a structured, research-driven methodology aimed at fostering critical discourse and proactive decision-making.

Fictional design research diverges from science fiction in its academic and methodological intent. While science fiction has historically inspired discussions about technology and ethics, its primary function is entertainment-oriented storytelling (Dunne & Raby, 2013). In contrast, fictional design research constructs speculative narratives with explicit academic intent. One fundamental difference between the two lies in their application. Science fiction immerses audiences in fictional worlds that *may* inspire debate, whereas fictional design research *can* generate structured speculation for analytical purposes (Houlden & Veletsianos, 2022). This distinction is particularly significant when examining biometric educational technology, as traditional empirical studies often struggle to anticipate the long-term ethical implications of emerging technologies.

Biometric educational technologies are rapidly evolving and increasingly marketed to educational institutions, yet research on their human rights implications remains limited. Fictional design research provides a mechanism for anticipating potential ethical risks, enabling policymakers and educators to

assess their implications before widespread implementation. Traditional edtech research is often reactive, addressing concerns only after technology has been introduced. Fictional design research offers a proactive framework, allowing researchers to explore the social, ethical, and pedagogical dimensions of emerging technologies in advance (Houlden & Veletsianos, 2022).

Early studies on adaptive learning systems and learning analytics primarily emphasized their capacity to personalize education. However, subsequent concerns regarding student privacy, data ownership, and algorithmic bias emerged (Hrastinski, 2023). A speculative approach through fictional design research could have inspired earlier discussions of these ethical dilemmas, prompting more responsible technological development. Additionally, scenario-based speculative research in education has been employed to support decision-making by educational administrators and policymakers, helping them evaluate the long-term consequences of adopting new technologies (Houlden & Veletsianos, 2022). Such scenarios can also provide a framework for exploring legal and policy implications in future educational settings.

The intersection of biometric educational technologies and human rights remains an underexamined area in educational research. Biometric tools promise enhanced personalization and efficiency but raise significant ethical concerns regarding privacy, autonomy, and bias. Privacy concerns question whether students can be protected from pervasive biometric surveillance (United Nations, 2021). Issues of autonomy and consent arise when considering whether students will have the ability to opt out of biometric tracking without facing academic or institutional repercussions (General Data Protection Regulation [GDPR], 2018). Algorithmic bias further complicates these concerns, as biometric edtech may disproportionately impact students from marginalized backgrounds (Veale & Binns, 2017).

Traditional human rights research typically relies on legal analysis and empirical studies. However, because biometric edtech is still emerging, retrospective analysis alone is insufficient and legal precedent is lacking. Fictional design research offers a pre-emptive approach, allowing scholars to anticipate potential human rights violations before they materialize (Houlden & Veletsianos, 2022). For example, the United Nations Convention on the Rights of the Child (UNCRC, Article 16) underscores the importance of protecting children's privacy. Despite this, current biometric edtech applications, such as classroom emotion recognition systems, already blur the boundaries between surveillance, protection, and privacy infringement. By generating speculative generative AI-driven narratives, this study explores how biometric edtech might challenge and invoke human rights frameworks in future educational contexts.

A notable aspect of this study is its use of generative AI-generated speculative fiction as research data. Unlike traditional qualitative storytelling methods, generative AI-generated fiction offers distinct advantages, including scalability, diverse sociopolitical and cultural perspectives, and the ability to synthesize existing discourse (Floridi & Cowls, 2019). However, this fiction is not without limitations.

Bias in training data may result in narratives that reflect Western-centric perspectives or overemphasize dystopian themes (Bender et al., 2021). Additionally, AI-generated stories lack lived experience, meaning that human interpretation remains crucial in extracting meaningful insights from generated stories. These limitations do not diminish the value of AI as a research tool; rather, they highlight the need for critical engagement in analyzing its outputs.

In conclusion, this study positions Fictional Design Research (FDR) as an essential methodology for investigating the future of biometric educational technology and its human rights implications. FDR distinguishes itself from science fiction by producing research-driven speculative futures rather than entertainment narratives (Dunne & Raby, 2013; Houlden & Veletsianos, 2022). It has been effectively applied in education and technology research, particularly in scenario-based speculative studies (Hrastinski, 2023). Moreover, it serves as a critical lens for human rights research, allowing scholars to anticipate ethical dilemmas in biometric edtech before they manifest in real-world contexts (United Nations, 2021). AI-generated fiction further enhances this research approach by enabling large-scale data production for pattern analysis and theoretical exploration (Floridi & Cowls, 2019). As biometric edtech continues to evolve, speculative research will be essential for ensuring that emerging technologies align with human rights frameworks.

The objective of this research is to use AI to help us understand the projected use of biometric technologies in education in 2050, while identifying the human rights implications. The specific questions follow.

Research Questions:

What biometric technologies are prefigured into education in the generated narratives?
What potential human rights issues are highlighted in the narratives of the identified biometric technologies?

Method

A profound transformation is expected to occur with the rapid evolution of technology and the increase in digital tools in use in education. Some of the promises include the use of biometrics, digital tools, and innovations that promise personalized learning and optimization of learning outcomes. However, the use of biometrics in education might evolutionize education and delivery, but it gives rise to many human rights issues. Some Human Rights include autonomy, security, privacy, and protection. The collection and storage of sensitive biometric data raises significant concerns about the potential for misuse.

This research aims to consider the future use of biometrics in education to help inform policy decisions as related to potential Human Rights issues. The five stories in five locations were generated three times

with a progressive refinement of the prompts. The final set of five stories over five locations were coded for this research.

AI-generated narratives are being utilized in various cultural contexts to identify the suggested biometric technologies. The importance of biometric ethical use, storage, and protection of human rights must not be overlooked.

This is a qualitative, fictional research design based on an anticipatory narrative approach to project biometric integration in 2050. Five distinct stories were generated over five locations. A quantitative, iterative, thematic analysis and coding process of the stories was utilized to uncover patterns and insights arising from the narratives.

AI-generated stories: Seventy-five AI-generated stories were collected to explore biometric integration in 2050. Each set of five stories for five different locations was produced three times. In each case the story prompts were adjusted in response to the versions generated and the quality and reliability of the data produced. The stories were generated with prompts such as:" Write a 1,000-word speculative fiction story about education in 2050 set in South Korea. The narrative should focus on one central character (for example, a public-school student, a university student, a teacher, or a professor etc.), and describe their personal experiences within this futuristic educational system. Ensure the story includes the biometric tech in use. Consult news sources for the current events overview to contrast the story in 2050."

See Appendix 1 for the consultation websites for references for social and cultural background information.

Each prompt was used for five stories per location. The goal of the prompt refining was to clearly ground the fiction within real-world cultural and policy frameworks. The data from each set of stories was reviewed to refine the prompts. The third set of stories is being utilized for the data collection for the purpose of this research paper. (See appendix for an example of the prompt refinement)

To ensure a broad cross-section of results, the stories were generated with three AI storytelling platforms: AskAI, DeepSeek, ChatGPT. The location of the stories and the randomization of the storytelling platforms were aimed at a deeper, more comprehensive approach.

The decision to look 25 years into the future is to consider the next educational generation. The choice of five locations was selected for their geographical and cultural variety. The authors' insights and awareness of the specific locations' educational systems also informed the choice. The goal was to measure the future in the present.

The stories were all reviewed, and further iterations for refinement of the prompts to elicit more comprehensive data was conducted.

Analytic framework for the analysis of the AI-generated stories

Items for biometric measurement

Through an iterative process, the individual items for biometric measurement were categorized into thematic groups for quantification.

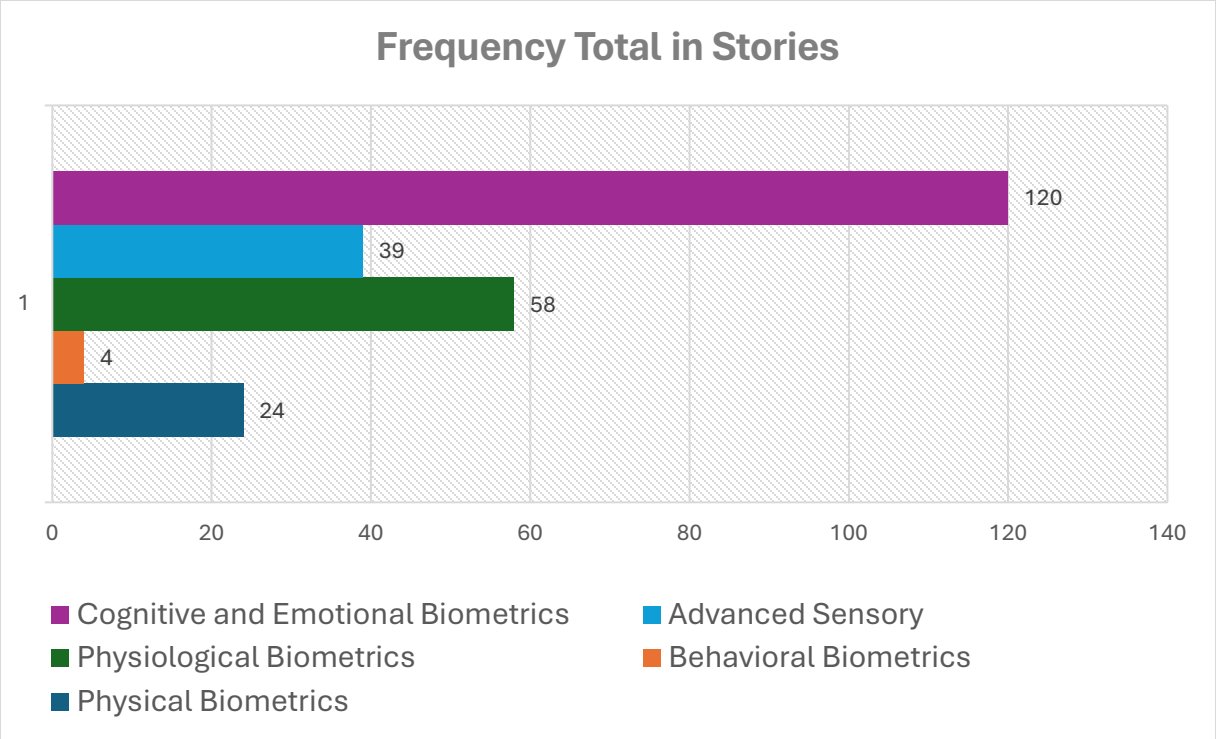
To code the data from the stories, a breakdown for coding was conducted.

Physical Biometrics: facial recognition, fingerprint scanning, iris/retinal scanning, and hand geometry.
Behavioral Biometrics: gait analysis, voice patterns, keystroke dynamics
Physiological Biometrics: pulse, blood pressure, brainwave patterns, blood vessel patterns, chemical monitoring, and DNA profiling
Cognitive and Emotional Biometrics: emotional state detection, cognitive load monitoring, stress and fatigue levels, and empathy detection
Advanced Sensory Biometrics: thermal imaging, eye movement, skin texture analysis, dietary needs, and neural network connections

Many of the specific measurements could be coded in different categories depending on the use of the data. I.E., security applications or emotional and physiological use.

Biometric Code Results for 25 Stories Iteration 3

Cognitive and Emotional Biometrics	120
Physiological Biometrics	58
Advanced Sensory	39
Physical Biometrics	24
Behavioral Biometrics	4



Biometrics

The term biometrics means "the measurement and analysis of unique physical or behavioral characteristics, especially as a means of verifying personal identity" (2025). Most definitions agree on the physical and physiological measurements for biometrics; however, there is no consensus on the definition of emotions and emotional state. Researchers have been investigating the use of biometrics to determine emotional state. Most have considered the use of skin conductivity, electromyography, respiration, blood pressure, pulse rate, and facial expressions as an indication of emotional state (Chandler & Cornes, 2011).

Facial recognition is being widely used for security access to many systems. It is one of the most commonly used recognition software programs for security access. It has advantages over other recognition systems, such as iris, fingerprints, and voice (Kortli et al., 2020, p. 342). Facial recognition is an emerging technology for use in schools and across society (Andrejevic & Selwyn, 2019). Currently, the technology is less accurate as it relies on measurements of human body characteristics. Andrejevic & Selwyn state it is being increasingly utilized for security, attendance, with a growing interest in monitoring student engagement. There is still a significant

gap for the use to gauge emotions, and currently it has reduced learning to “a passive process of knowledge consumption”(Andrejevic & Selwyn, 2019).

Behavioral biometrics such as gait analysis and keystroke patterns are being used to provide a multimodal biometric profile for enhanced security for smartphone users (Lamiche et al., 2018). Voice pattern recognition is being widely used for authenticating individuals for automated phone systems such as banking, healthcare and government.

Physiological biometrics are in common use. Medical applications of pulse, blood pressure, respirations, electroencephalogram (EEG), and blood chemistry are used to assess health status. There is current research using neuroimaging and deep learning to examine emotion detection. The study outlines “ EEG and MEG (magnetoencephalography) provide superior temporal resolution, making them suitable for real-time emotion tracking. Deep learning models … show promise in extracting meaningful patterns” (Halkiopoulos et al., 2025). The progression of non-invasive electroencephalography is being researched to identify pain in cats at the University of Montreal (2024). This is a development in the acquisition of EEG without interference from the subject. The anticipated developments with this research it likely that we will be able to track cognitive and emotional biometrics effectively by the year 2050.

In the book Impacts of *AI on Students and Teachers in Education 5.0* (Yashodharan & Vijayanand, 2025), the authors review with a predictive model the use of advanced sensory biometrics.

Some of the advanced biometrics include: eye movements to note fatigue and stress, skin conductivity, cognitive load through EEG, dermatoglyphics with correlation to cognitive abilities and intelligence.

It is identified that customizing education for the diverse learners and learning styles will be assisted by biometric integration, allowing for the personalization of education.

The most significant category of biometric technology in 2050 will measure cognitive and emotional activity. The purpose of this section is to analyze the anticipatory use of those technologies through a human rights framework. While our narrative analysis does not focus on AI automation, we may assume that AI automation will process the collected biometric data in the future, and consider much current debate which focuses on the increasing and projected use of AI in education. As put forth by Wayne Holmes, et in their 2022 *AI and Education: A Critical View Through the Lense of Human Rights, Democracy, and The Rule of Law* there is a need to

understand the key issues in the complex challenges raised by the collection of data, to ensure that future developments benefit the common good (Council of Europe, 2022). In analyzing these key issues brought forth in projected biometric data collection, this analytical framework consists of the UNESCO Future of Education Report, The Universal Declaration of Human Rights (UDHR), and the Convention on the Rights of the Child (CRC). Each story location's profile is briefly described to provide essential context in addition to the relevant human rights concerns. Selected examples from the narratives highlight those particular rights and their implications for enhancement or diminution. The patterns and themes brought out are then discussed in terms of encouraging a proactive educational policy approach.

Human Rights

This analysis will use relevant principles from the UNESCO Future of Education Report to evaluate the human rights implications. It pinpoints the year 2050 as a focal point for recommendations which address past, current, and future considerations. The report calls for a new social contract for education, the intentional and ethical use of technology, and proposals for renewing education. First, the new social contract for education can be understood as an agreement within society to work towards a shared benefit; reflecting norms, commitments, and principles. The principles include the right to quality and accessible education throughout life and strengthening education as a public common good. Second, the intentional and ethical use of technology can be wielded as disruptive forces in key areas such as climate change, populist politics and injustice, unkept promises of digital technologies, and AI automation and structural transformations. Specifically, use of technology as disruptions to key areas that affect education should prioritize just and peaceful societies, a healthy planet, and shared progress that benefits all. And third, proposals for renewing education move the teaching focus towards collaborative cooperation, move disciplines towards ecological, intercultural, and interdisciplinary structures, respect and reimagine schools as global institutional spaces, and move towards an expansive view of education to be lifelong and everywhere. These recommendations require individual and collective action through social dialogue and a commitment to equality for all. The transformation these recommendations aim towards calls for global solidarity, collaborative research, and the active involvement of universities and diverse stakeholders to reimagine

education as a lifelong right and a common good (UNESCO, 2021). By examining the stories through these three principles, the analysis will identify areas of alignment or misalignment.

The universality of the Universal Declaration of Human Rights (UDHR) applies to all five locations of the stories. The Convention on the Rights of the Child (CRC) also highlights the special legal status of adolescents who do not yet enjoy full legal adult status. As the previous section of analysis identified cognitive and emotional biometric technologies likely present in education in 2050, the use of those technologies invokes UDHR Article 12- right to privacy (United Nations, 1948), CRC Articles 2-no discrimination, 3-best interests of the child, 12-respect for children's views, 13-sharing thoughts freely, 16-right to privacy, 24-health, water, food, environment, 28-access to education, and 29-aims of education (OHCHR, 1989). It is important to note the interconnected and interdependent nature of human rights, meaning that the respect or infringement of one right may extend to other rights (Goonesekere, 2020). This holistic perspective recognizes children's rights as not only connected to each other, but also the rights of other individuals and groups of people (OHCHR, 1989). Therefore, the human rights implications should be interpreted in a broad, rather than a narrow, approach.

In addition to viewing human rights as interconnected, the human rights implications will be analyzed as potential enhancements or diminutions. This means that the examples invoke a right which can be seen as either enhancing that right through promotion and protection, or diminishing the right through a threat of infringement or an outright violation. While the stories were not produced to focus solely on dystopian views of the future of education, nor will this analysis solely focus on the potential threats to and violations of human rights. The biometric technology use can also be regarded as having the potential to promote, respect, and protect human rights. While technology itself loses its neutrality once it is applied, the anticipatory issues should inform proactive regulation.

Examining the stories through the analytical framework of UNESCO principles, UDHR, and CRC requires a brief background of the five locations to provide context. As previously mentioned, South Korea, Palestine, Estonia, the Pacific Northwest of the United States, and British Columbia of Canada were chosen to present a variety of cultural, social, and educational contexts. It is worth noting that particular regions were selected in Canada and the United States

to address the issue of scalability. While a deeper understanding of each location is required for more in-depth human rights analysis, this paper approaches their educational landscapes in terms of relevant key features of their cultural, political, and social characteristics. From these backgrounds, certain characteristics may be of interest, relevance, or significance within the analyzed examples.

Results

In this section, we present the results of our analysis, The stories included five locations, including South Korea, Palestine, Estonia, Canada, and the United States.

South Korea

Education in South Korea is set amidst a backdrop of communal and collectivist values, marked by Confucian and Buddhist philosophies which present hierarchical yet balanced social stratification. Contemporary educational issues center on high PISA (Program for International Student Assessment) performance, competitiveness, and growing concerns over student well-being. Society is heavily influenced by *hakbeol* (academic background) which creates a hierarchy and significantly impacts social and professional opportunities. The *suneung* (national college entrance exam) is a high-stakes, intensely competitive event that shapes much of the educational experience. The country has predominantly embraced Buddhism throughout its history, and roughly 30% of the country now identifies as Christian. Confucianism also continues to play a role, emphasizing respect for authority, filial piety, and a strong work ethic. These factors influence a highly competitive cultural landscape, where success is often measured by academic achievement and career advancement. Coercive parenting, with its gendered expectations, remains a concern within Korean culture, as well as suicide being a leading cause of death amongst adolescents (Park et al., 2024). Despite these concerns, the country is generally seen as having a positive human rights record with national and international commitments, but needs to address violations related to digital sex crimes against women (Human Rights Watch, 2025).

As seen in the five stories set in South Korea, the most significant human rights concerns are related to UDHR Article 12 and CRC Article 16- right to privacy and CRC 3- best interests of the child. While the stories about the future of education in South Korea appear to move

towards the aims of the UNESCO report principles, they also present future critical points. These critical points could allow us to reimagine the education system as benefitting all by promoting student mental and emotional well-being over competitive academic performance. However, the biometric data collected from monitoring students in invasive ways could exacerbate rather than improve issues surrounding pressure and academic performance by adding a cognitive and emotional "performance" element to Korean education. The constant monitoring could undermine students' well-being and healthy development.

The following examples illustrate some of the highlighted human rights implications.

Story 1-UDHR 12 AND CRC 16: "Ael, a holographic figure that danced with colors as it provided her with updates on the day's classes, assignments, and even her peers' moods based on their biometric data." **Implication:** This shows how technology is used to monitor not only academic progress but also the emotional states of students. **Diminution:** It raises concerns about the extent of data collection and its potential impact on privacy and student well-being. **Enhancement:** Regulation to protect privacy and anonymize peer data could promote socially cohesive socio-emotional development and support mental health.

Story 1-CRC 3:"The continuous monitoring of performance metrics created an atmosphere of relentless competition. Every assignment, every interaction was quantified, leading to a culture where success was measured in numbers rather than personal growth." **Implication:** This highlights the focus on quantifiable performance over well-being. **Diminution:** This quantification of cognitive and emotional data can exacerbate a stressful and competitive environment, potentially harming students' overall well-being and perpetuating circumstances related to youth suicide. **Enhancement:** Proposals for renewing the education focus away from performance metrics and towards overall well-being could optimize this technology use.

Story 2-UDHR 12 AND CRC 16: "It was a projection of her personal learning profile, a living document that adjusted in real-time based on her biometric feedback...Biometric alert: High stress detected." **Implication:** This presents how students' biometric data, including stress levels, is constantly monitored and used to adjust their learning environment. **Diminution:** It raises concerns regarding the intrusive nature of this technology. **Enhancement:** Regulation to protect privacy would optimize the ethical use of this technology.

Story 2-CRC 3: "Good isn't good enough in this era, Ji-Soo...You need to push yourself further. The world is competitive, and innovation is key." **Implication:** This illustrates the intense

pressure placed on students to constantly excel and innovate. **Diminution:** Misalignment with UNESCO principles which could be detrimental to their mental health and development. **Enhancement:** A balanced emphasis placed on contributing to the knowledge commons while focusing on collaboration rather than competition would respect the best interests of the child.

Story 3- UDHR 12 AND CRC 16: "Every student's learning profile is activated upon entry, allowing teachers and AI systems to adjust lessons based on individual strengths and weaknesses...The classroom buzzes with energy as students engage in group discussions, their biometric bracelets transmitting emotional data to the classroom AI." **Implication:** This demonstrates prolific surveillance, dependence on AI automation. **Diminution:** Potential over-surveillance and AI dependence at the expense of human-centered teaching could negatively affect students' behavior through intrusive data collection and analysis. **Enhancement:** Regulation to protect privacy could optimize this technology use to promote the aims of quality education.

Story 3- CRC 3: "At home, Ji-Hoon's parents monitor his progress through a family dashboard, which aggregates data from his school performance, biometric readings, and even his social interactions...Ji-Hoon nods, but internally he feels trapped between his aspirations and societal expectations." **Implication:** This demonstrates how technology can increase parental involvement and surveillance. **Diminution:** This could create a sense of being constantly evaluated, potentially undermining the child's autonomy and well-being. **Enhancement:** A balanced approach could encourage the new social contract where parents' are empowered with emotional insights to better support their children's developmental needs.

Story 4-UDHR 12 AND CRC 16: "As he stepped inside, Jihoon's palm was scanned by the biometric sensor embedded in the entrance...each student's learning path was curated based on their unique biometric data—heart rate, cognitive engagement, and even emotional responses gathered through wearable devices." **Implication:** This shows how biometric data is used for identification and to personalize education. **Diminution:** This data collection could be invasive if not protected. **Enhancement:** Regulation to protect privacy would optimize this technology use for quality aims of education.

Story 4- CRC 3: "The pressure to succeed in this hyper-competitive environment was palpable...The biometric feedback system often buzzed with anxiety levels during exams, a constant reminder of the expectations weighing heavily on their shoulders." **Implication**: This

illustrates how the combination of advanced technology and societal expectations creates a high-pressure environment. **Diminution:** Monitoring interruptions can negatively impact students' mental health and exacerbate a competitive environment. **Enhancement:** Regulations which balance minimal learning disruptions and interventions which support student well-being would optimize the use of this technology.

Story 5-UDHR 12 AND CRC 16: "His heart rate, blood sugar, and hydration levels were all monitored in real-time...The Pressure Index, a biometric measure that tracked stress levels in real-time...They say it'll help identify those who need support, but I don't want to be judged for my stress levels." **Implication:** This illustrates the comprehensive monitoring of students' physiological and emotional states, and the students' hyper- awareness of being constantly watched. **Diminution**: Constant monitoring could undermine privacy and emotional well-being. **Enhancement:** Regulation to protect privacy and prioritize the intentional and ethical purpose of this monitoring to assist, rather than scrutinize, students who need support.

Story 5-CRC 3 in: "They say it'll help identify those who need support, but I don't want to be judged for my stress levels...He appreciated the opportunities provided by technology but couldn't shake the feeling that the essence of education—curiosity, exploration, and human connection—was sometimes overshadowed by the algorithms and metrics that governed his daily life." **Implication:** This shows the students' concerns of being judged and the potential for technology to undermine the core values of education. **Diminution:** The best interests of the child could be undermined by an overreliance on AI automation and unkept promises of digital technology, exacerbating educational competition and mental health challenges. **Enhancement:** A balanced approach which prioritizes UNESCO principles could optimize this technology use and maintain the best interests of the child.

Palestine

Education in Palestine is set amidst a challenging backdrop of occupation and ongoing genocide which causes significant disruptions and mounting challenges. Palestinian society is marked by a predominantly Muslim belief system and characterized by resilience and activism, shaped by a history of displacement. Creative expression and the preservation of collective memory are often found in art and oral traditions. The concept of honor (sharaf) influences social interactions and community relationships. Strong community interdependence and social cohesion are vital, with a sense of collective responsibility. Social mobility can be influenced by

wasta (connections and influence). Additionally, Palestinian culture includes Bedouin and other tribal and or nomadic cultural minorities, who maintain distinct traditions and lifestyles. (Evason, 2020). The Oslo Accords have been an influential yet unmet agreement whereby control over the education system was transferred from Israel to Palestine, in part working towards a final goal of peace (U.S. Department of State, 1993). The dependence on UNRWA's (United Nations Relief and Works Agency for Palestine) historic and ongoing support highlights the systemic hardships under which Palestinian society operates (UNRWA, 2024)

As seen in the five stories set in Palestine, the most significant human rights concerns are related to UDHR Article 12 and CRC Article 16- right to privacy and CRC 29-aims of education. While the future of education for Palestine in 2050 is uncertain due to the ongoing genocide, the integration of biometric technology in schools, which are no longer controlled by occupation, could aim to personalize learning and enhance security. Whether peace presides or occupation continues, the use of this technology may lead to extensive collection and monitoring of students' personal data. This includes tracking their academic progress, emotional states, and even social interactions. The stories suggest that this could create an environment where students feel constantly watched and their privacy is compromised. We can already see how the constraints of occupation have weaponized surveillance, but these stories allow us to imagine a future under different circumstances.

The following examples illustrate some of the highlighted human rights implications.

Story 1-UDHR 12 and CRC 16: "Biometric sensors picked up on her excitement, adjusting the intensity of the experience….Biometric technology ensured that every student's learning style was catered to, adapting lessons to their emotional responses and cognitive needs."

Implications: The story describes biometric sensors monitoring emotional and cognitive engagement. **Diminution:** This raises concerns about the extent of personal data collection and potential misuse, especially if the occupation continues. **Enhancement:** Regulation to protect privacy and prevent misuse could optimize data to personalize education in line with UNESCO principles, especially under a sovereign education system.

Story 1-CRC Article 29: "Education in 2050 was intricately linked to environmental consciousness, teaching students like Amina the importance of caring for their land."

Implication: This emphasizes the integration of cultural heritage and sustainability.

Diminution: If continued under occupation, this aim could exacerbate environmental racism by

misplacing responsibility in the hands of Palestinian children to care for land which is currently being destroyed**. Enhancement:** Use which aligns with the goals of education that promote the intentional and ethical use of technology to disrupt climate change and promote peaceful society, especially under a sovereign education system.

Story 2-UDHR 12 and CRC 16 Article 12: “As Amina arrived at school, she walked through a biometric security gate that recognized her face, allowing her seamless access…Amina sometimes felt uncomfortable with how much data the system collected about her emotions and academic performance." **Implication:** The use of biometric security gates and wrist devices that monitor students' academic progress and emotional well-being. **Diminution:** Potential misuse raising concerns about the extent of data collection, privacy, and children’s ability to express their views regarding this data collection, especially under occupation. **Enhancement**: Regulation which protects privacy could ensure this technology use makes learning environments safer, and encouraging students to freely express their discomfort with technology use would ensure a balanced and ethical approach, especially under a sovereign education system.

Story 3-UDHR 12 and CRC 16: "She wore a sleek device on her wrist—an educational biometric monitor that tracked her progress, health, and emotional well-being in real time…The biometric technology not only facilitated personalized learning but also monitored social interactions." **Implication:** Monitors that measure and track virtually all dimensions of a student’s physical, social, and educational life. **Diminution:** Misaligned intentions raise concerns about the intrusiveness of such technology, especially under occupation. **Enhancement:** Regulation would protect privacy and alignment with UNESCO principles for intentional and ethical use of technology would be optimized under a sovereign education system.

Story 3- CRC Article 29: "We’re going to explore how our past informs our future...We’ll use the biometric feedback from your devices to tailor today’s lesson. If you’re feeling stressed or disengaged, let’s adjust our approach." **Implication:** The importance of collaboration, teacher-led and peer support regarding emotional data. **Diminution:** Lack of anonymization may be too intrusive and undermine the aims of education, especially under occupation. **Enhancement:** Regulation to protect privacy, balanced with UNESCO principles towards intentional and ethical use, and renewing education focus, especially under a sovereign education system.

Story 4-UDHR 12 and CRC 16: "Every student here is equipped with biometric identifiers—facial recognition, iris scans, and even heartbeat monitoring....Leila reflects on her biometric registration process and the ethical questions about privacy and security…However, she couldn't shake off the feeling that such systems could be misused." **Implication:** The prolific use of biometric data to identify and monitor students leads to questions regarding invasiveness. **Diminution**: Invasive data collection threatens privacy and has the potential for misuse, especially under occupation. **Enhancement:** Regulations which protect privacy and align use with the UNESCO principle of intentional and ethical use could optimize use, especially under a sovereign education system.

Story 5-UDHR 12 and CRC 16: "Each student wore a biometric wristband that monitored their engagement levels, learning progress, and emotional well-being... The biometric technology not only tracked academic performance but also monitored emotional well-being. If a student exhibited signs of stress or anxiety, the system would discreetly alert the school's mental health professionals..." **Implication:** Biometric monitoring and tracking used to alert mental health intervention. **Diminution**: The invasiveness of data collection infringes upon privacy and has the potential for misuse depending on the nature of the mental health intervention, especially under occupation. **Enhancement:** Regulation which protects privacy and is balanced with intentional and ethical use principles would support emotional well-being, especially under a sovereign education system.

Estonia

Education in Estonia is set amidst a backdrop of digitization and post-Soviet reconciliations. Society is characterized by its low levels of religiosity, a strong connection to nature, and cultural influences from Baltic Germans and Slavs. Historical influence drawn from imperial rule by Sweden, Poland, Denmark, Russia, and the USSR also shapes the sociocultural identity of a country which borders Russia. Education plays a significant role in shaping the nation's identity, fostering an "aim high, work hard" mindset (Education Estonia, 2023). The country's national language policy seeks to integrate Russian-language instruction schools into the Estonian education system, which underscores complex socio-linguistic and cultural tensions lingering from recent Soviet rule and heightened since the invasion of Ukraine. Since its independence, Estonia has undergone a digital revolution in its education system, achieving high PISA scores, and its strategic goals for 2035 to prioritize climate neutrality, the preservation of

the Estonian language, gender equality, safety, improved fertility and health, and security through NATO and EU membership (Government of Estonia, 2022).

As seen in the five stories set in Estonia, the most significant human rights concerns are related to CRC 3-best interests of the child, UDHR Article 12 and CRC Article 16- right to privacy. In general, these stories present positive possible futures where biometric technology in education is used to support students and learning. However, while the use does not pose significant threats to human rights, it does require an ethical and intentional integration so that data collection is not invasive, the overreliance on technology does not affect students at the expense of human connection, and that students are not penalized if they choose to opt out of the technology use.

The following examples illustrate some of the highlighted human rights implications.

Story 1-UDHR 12 and CRC 16: "Every morning, he woke up to the soft hum of his home assistant...who had been programmed to adapt to his learning style...detected through his biometric wristband…It was a sleek device that not only tracked his heart rate and stress levels but also monitored his focus and energy levels." **Implication**: The story describes a system where students are constantly monitored through biometric wristbands. **Diminution**: Potential misuse and infringement on privacy due to the extent of data collection. **Enhancement:** Regulation which protects privacy and balances UNESCO principles of intentional and ethical use and a renewed approach towards quality education.

Story 1-CRC 3: "When he began to show signs of fatigue, Kaja prompted a break, suggesting a quick physical activity that re-energized him." **Implication:** Aims to personalize learning and provide support through constant monitoring. **Diminution**: Potential for over-reliance on technology could have negative impacts on a child's development by undermining emotional self-regulation. **Enhancement:** A balanced of UNESCO principles that promote a new social contract, ensure intentional and ethical use, and renewing the educational focus optimizes biometric monitoring for student well-being.

Story 2- UDHR 12 and CRC 16: "Every school in Estonia had integrated biometric technology into their educational framework...ELI, short for Educational Learning Interface, was designed to adjust the curriculum based on each student's learning style and emotional state, a feature made possible by the constant data collection from their biometric devices." **Implication:** The collection of data on a child's emotional state and cognitive engagement. **Diminution:** Potential

infringement on privacy and misuse of data collection. **Enhancement:** Regulation to protect privacy and UNESCO principle aligned use could optimize education.

Story 2- CRC 3: "Anna's biometric data indicated she had been feeling slightly anxious that morning, likely due to an upcoming project deadline. ELI adjusted her lesson to include more interactive discussions and group activities, aiming to foster collaboration and lessen her stress." **Implication**: Reliance on algorithms to adjust learning. **Diminution:** An over reliance on AI automation may undermine the best interests of the child by stunting full development of personality. **Enhancement:** When aligned with UNESCO principles, the intentional and ethical use will balance automated and human centered emotional support.

Story 3-UDHR 12 and CRC 16: "As she approached the entrance, a biometric scanner recognized her through a quick scan of her iris and fingerprints…The system, known as EduScan... allowed students to access their customized learning profiles, which included their strengths, weaknesses, and preferred learning styles." **Implication:** Biometric data is used for identification and monitoring, and tracking. **Diminution:** Potential threat to privacy if data collection is misused. **Enhancement:** Regulation to protect privacy balanced with UNESCO principles of intentional and ethical use of technology could enhance quality education.

Story 4- UDHR 12 and CRC 16: "Every morning, Liis arrives at school, her biometric wristband syncing with the school's AI system as she steps through the entrance. The moment she crosses the threshold, her health metrics, mood, and cognitive performance are assessed in real-time...Aira analyzes this data to adjust the day's curriculum to best suit Liis's current state." **Implication:** Extensive collection of biometric data for identification, monitoring, and assessment. **Diminution:** Extensive data collection may infringe on privacy. **Enhancement:** Regulation to protect privacy and balance UNESCO principles of intentional and ethical use to provide quality education.

Story 4-CRC 3: "You seem a bit stressed, so I've also scheduled a mindfulness session in the virtual garden." **Implication:** Intervention and personalized recommendations based on biometric data. **Diminution:** This may undermine the child's full development if an over reliance on automation and artificiality replaces human centered self-regulation or a healthy natural environment**. Enhancement:** A balance of UNESCO principles promote intentional and ethical use of technology to promote quality education and peaceful societies.

Story 5-UDHR 12 and CRC 16: "Her wristband, embedded with a chip that monitored her health and emotional state, vibrated gently as she entered the building...neural implant...recorded and analyzed their thoughts…A quick scan of her biometrics informed the system of her current mood and energy levels, allowing it to tailor her learning experience accordingly." **Implication:** Continuous tracking through invasive monitoring devices and neural implants. **Diminution:** Invasive surgical procedures raise serious privacy and health concerns. **Enhancement**: Strict regulations to protect privacy and health balanced with serious considerations regarding the intentional and ethical use of technology for the common good and promoting quality education should be weighed very carefully against the potential threat to health and privacy due to implants.

Canada

Education in British Columbia, Canada, is set amidst a backdrop of Pacific Northwest identity. It is a province committed to respecting human rights, multiculturalism, and gender equality, with community and recreation centers playing a significant role in integrating both locals and newcomers (WelcomeBC, 2024). Despite historical colonial attempts to suppress Indigenous cultures, traditions, and rights, these connections remain strong, with ongoing efforts to revitalize nearly lost languages and cultural practices. Canada, including British Columbia, is dedicated to achieving net-zero emissions by 2050, as mandated by the Canadian Net-Zero Emissions Accountability Act (Government of Canada, 2023), and is working to ensure that boys and girls acquire essential skills for sustainable development and that educational facilities are upgraded in alignment with the SDGs (Government of Canada, 2022). Furthermore, British Columbia is a key participant in the Cascadia Innovation Corridor, which aims to establish the world's first sustainable mega-region by addressing challenges such as the affordable housing crisis, transportation congestion, and the climate goals outlined in the Paris Agreement (Cascadia Innovation Corridor, n.d.).

As shown in the examples, British Columbia's most prominent human rights implications related to cognitive and emotional biometric technology are UDHR 12 and CRC 16-right to privacy. The stories present uses of biometric technology which are generally supportive of these rights, but there are some potential areas for misuse or unintended consequences regarding the collection of student data and the invasive biometric data collection. These potential infringements would require an ethical approach to the intentions behind the planned use of these

technologies so that they do not violate human rights. It appears that the socio-cultural background and legal frameworks support a holistic human rights approach towards integrating biometric technology in education. The implications show how ethical intentions can use the technology to promote education, however the privacy concerns are noteworthy if students cannot opt out.

The following examples illustrate some of the highlighted human rights implications. **Story 1-UDHR 12 and CRC 16**: "A warm pulse of light traced her veins, confirming her identity through biometric authentication...it read her heartbeat, her microvascular patterns, even the unique electrical signals of her nervous system... 'Your vitals indicate mild fatigue—would you like a recommendation for an energy supplement?'"...The school's AI monitored their brainwave patterns, adjusting the difficulty of the task based on their engagement levels. If Lila's focus dipped, the system would nudge her with a mindfulness prompt..." **Implication:** Extensive data collection, monitoring, and personalized automated suggestions. **Diminution:** The extensive potential for misuse increases with the pervasive biometric data collection. **Enhancement:** Strict regulations to protect privacy and an alignment with UNESCO principles to ensure intentional and ethical technology use towards quality education.

Story 2-UDHR 12 and CRC 16: "Nika's headband tracked her focus, emotional state, and even her neural activity, adjusting lessons in real time... 'Your cortisol levels suggest mild stress. Would you like a mindfulness exercise before today's session?'"..."If she struggled with a concept, Lumi would slow down, replaying explanations in a different format... If she excelled, the system accelerated, introducing advanced material." **Implication:** Data collection, monitoring, and well-being interventions based on stress levels. **Diminution:** The extensive collection raises concerns about privacy and potential misuse. **Enhancement:** Regulation to protect privacy balanced with UNESCO principles for intentional and ethical use would optimize this technology for quality education and student well-being.

Story 3-UDHR 12 and CRC 16: "Her neural feed projected a holographic Elder... as Lila 'walked' through the digital landscape, her biometric sensors tracked her engagement—heart rate, neural activity, even micro-expressions... The system rewarded her with an extra carbon credit...His biometric logs showed erratic focus spikes—his parents had to petition for an 'unplugged' learning option... Even empathy was quantified now." **Implication:** Neural data collection and biometric tracking connected to ecological values. **Diminution:** The potential

misuse of collected data and infringement on privacy, and reliance on artificial ecology. **Enhancement:** Regulation to protect privacy balanced with UNESCO principles would promote quality education, student well-being, and ecological values.

Story 5-UDHR 12 and CRC 16: "As she stepped into the grove, a holographic scan washed over her. Retina—confirmed. Cortisol—within range. Neural coherence—stable. A chime sounded, and the system granted her access... Her neural feed pinged—a message from the Ministry of Future Skills...Today was an Assessment Day, and her education pod had been preparing for weeks... The system rewarded emotional regulation as much as academic mastery." **Implication:** Biometric data is collected and used to identify, monitor, assess, and intervene. **Diminution:** Potential misuse and infringement on privacy. **Enhancement:** Regulation to protect privacy, balanced with UNESCO principles, would optimize this technology use for quality education and student well-being.

Pacific Northwest region of the United States

Education in the Pacific Northwest of the United States is set amidst a backdrop of cultural diversity and a regional sustainability push amidst federal divergence, geographically and culturally linked to British Columbia, Canada. Indigenous communities are still recovering from systemic mistreatment amounting to what historians agree was genocide (Alfaraz, 2020). Histories of migration and refugee resettlement lead to Spanish and Vietnamese being second and third most spoken languages, respectively, after English (Arroyo et al., 2024). The region's development has been shaped by the intersections of labor and space, influenced by industries, trade, cross-border relations, and shared ecological zones. Its values and interests are reflected in organizations focused on environmental conservation, nature-focused health and wellness, and the arts, with politically left urban identities and a rich history of social justice movements. The United States has rejected the UN Sustainable Development Goals and withdrawn from the Paris Climate Agreement (ESGToday, 2023), with the Department of Education deferring to states' rights and overseeing federal finances (U.S. Department of Education, 2025). However, the Cascadia Innovation Corridor, which includes British Columbia, Washington State, and Oregon, has drafted the Cascadia Vision 50 to address the affordable housing crisis, transportation congestion, and climate goals. (Connect Cascadia, n.d.)

As shown in the examples, the Pacific Northwest’s most prominent human rights implications related to cognitive and emotional biometric technology are UDHR 12 and CRC 16-

right to privacy, and CRC 29-aims of education. While the stories present uses of biometric technology which are generally supportive of these human rights, there are some potential areas for misuse or unintended consequences. These potential infringements would require an ethical approach to the intentions behind the planned use of these technologies. It is also worth noting that this location would presumably incorporate biometric technology in ways that are supportive of the holistic human rights approach if this region stays the course and collaborates with the Cascadia Innovation Corridor rather than aligning with the Federal U.S. government which divests from education and dismisses human rights frameworks. The following examples illustrate some of the highlighted human rights implications.

Story 1- UDHR 12 and CRC 16: "As Ava settled into her pod, the system scanned her biometrics—heart rate, eye movement, and brainwave activity—to assess her current state and optimize the day's lessons accordingly...The AI tutor...monitored her engagement levels through biometric feedback. Noticing a dip in attention...introduced an interactive challenge..." **Implication:** Data collection for monitoring and assessment for educational optimization. **Diminution:** Potential for misuse and privacy infringement. **Enhancement:** Regulation to protect privacy balanced with UNESCO principles promotes quality education and student well-being.

Story 2-UDHR 12 and CRC 16: "Each morning, as Sophia approached the school, facial recognition cameras identified her...Classrooms were equipped with AI-driven systems that monitored students' engagement and emotional states...neural interface devices...allowed students to interact with digital content using thought commands...While this approach had sparked debates about privacy, the school community had established strict data governance policies..." **Implication**: Biometric data collection for identification and monitoring. **Diminution**: Potential misuse of collected data and infringement on privacy. **Enhancement:** School data governance policy, regulations to protect privacy, and balanced UNESCO principles to promote quality education.

Story 2-CRC 29:."Holographic projectors brought distant ecosystems into the classroom...Biometric feedback systems assessed students' reactions and comprehension..." **Implication:** Biometric data used to assess student engagement with ecological education. **Diminution**: Potential for overreliance on artificiality and automation at the expense of human and ecologically centered education. **Enhancement:** Aligned UNESCO principles drive the aims

of education towards ecological values and disrupting climate change by engaging virtual education of ecosystems rather than potentially damaging the real ecosystem.

Story 3-UDHR 12 and CRC 16: "Each morning, as Maya entered the school, a biometric scanner identified her through facial recognition and assessed her vital signs. This data was integrated into the school's AI system, which customized her daily lessons…The AI acted as a personal tutor, adapting the curriculum in real-time to suit her individual needs..." **Implication:** Biometric data collection for identification, assessment, and customized AI lessons. **Diminution:** The potential for misuse and infringement on privacy. **Enhancement:** Regulation to protect privacy balanced with UNESCO principles towards quality education.

Story 4-UDHR 12 and CRC 16: "Each morning, as she approached the school entrance, facial recognition scanners identified her...In classrooms, biometric sensors monitored students' engagement levels...This data allowed educators to tailor lessons in real-time, ensuring that each student received a personalized learning experience." **Implication:** Biometric data collection for identification, monitoring, and lesson tailoring. **Diminution:** Potential for misuse and infringement on privacy. **Enhancement:** Regulation to protect privacy, balanced with UNESCO principles to promote quality education.

Story 5-UDHR 12 and CRC 16: "Each morning, as Maya approached the school entrance, a biometric scanner identified her through facial recognition and voice analysis...Her AI learning assistant...analyzing her academic performance, learning style, and emotional state...The AI also monitored her well-being, alerting school counselors if it detected signs of stress or anxiety." **Implication:** Biometric data collection for identification, analysis, monitoring, and wellness interventions. **Diminution**: Potential misuse and privacy infringement, as well as invasiveness of interventions. **Enhancement:** Regulation to protect privacy and balanced UNESCO principles to promote quality education and student well-being.

Story 5-CRC 29: "This seamless integration of biometric technology had become commonplace, streamlining administrative tasks and allowing educators to focus more on teaching…This AI tailored daily lesson plans to her individual needs, providing challenges in subjects where she excelled and additional support in areas where she struggled. The AI also monitored her well-being, alerting school counselors if it detected signs of stress or anxiety." **Implication:** Biometric data collection for personalized education and wellness, prioritizing teaching over administrative tasks. **Diminution**: Potential overreliance on AI automation at the expense of

human-centered teaching. **Enhancement**: The aims of education are promoted through intentional and ethical use of biometric technology to assess and intervene for student well-being and personalized learning.

Discussion

As biometric technologies are being integrated into education, the narrative stories generated technologies as an integral part of educational use for personalization and optimization. As the thematic analysis was conducted, it became apparent that the AI narratives did not outline novel biometrics but were simply a reflection of the current state. "What AI mirrors do is to extract, amplify, and push forward the dominant powers and most frequently recorded patterns of our documented, datafied past" (Vallor, 2024,p.10). The goal to measure the future in the present did not produce any innovative biometric technologies. It did, however allow for thematic analysis and quantification of the biometrics over the five locations, as is what is currently prevalent in biometric data collection.

The key findings indicated in our results highlight cognitive and emotional biometric technologies prefigured in education in 2050. These prefigurations, underscored by plausibility and a mirroring of current states, highlight the right to privacy, the aims of education, and the best interests of the child. While these rights implications answer our second research question regarding *what* potential human rights issues are highlighted in the narratives of the identified biometric technologies, it is important to note that a holistic approach to rights, acknowledging their interconnectedness, underscores the significance of respecting and protecting them in a broad, rather than narrow, approach. These rights would be undermined if the invasiveness of biometric data collection infringed upon privacy and undermined the aims of quality education, replacing human-centered teaching and learning with an overreliance on artificial automation that stifles the full development of the child. It is also important to note that the current unreliability with which biometric technologies can accurately measure emotional states emphasizes the need to rely on a balanced and principled approach to implementing these technologies in education. The UNESCO Future of Education Report identifies key principles which should guide technology integration to support the right to quality and accessible education, the ethical intention of education as a public common good, and proposals for renewed education which establish an expansive view of schools as global institutional spaces. These principles enlighten us with not only *which* rights to protect, but *how*.

While general trends have been identified in the stories, there are significant location-specific anomalies worth mentioning regarding their historic relationship to human rights frameworks and their geopolitical turning points. The UNESCO principles draw on the importance of addressing the past and present in looking to the future, and the five locations present various historical and ongoing factors through which to anticipate future concerns. The anticipatory concerns generated in the narratives remind us that AI as a mirror may or may not accurately take into account all factors that shape the landscape over which the future of education will unfold. There are inherent biases and blind spots that may be reflected in the prompting and narrative analysis. This reinforces the importance of human-centered analysis, to bring lived experience and critical engagement to AI-generated prefigurative data.

The AI mirroring of current states represents lower stakes prefigurations in South Korea, Estonia, and British Columbia for human rights violations when seen in the context of their past and present human rights commitments. These countries have relatively positive human rights track records, however, past and present issues require diligence to avoid inflaming injustice through biometric data collection. South Korea's gender inequality and digital sex crimes are of particular significance in regards to protecting data and privacy so as not to fuel the fire of rampant digital sexual harassment, especially as it relates to children's physical and emotional well-being in a country which suffers from high rates of youth death by suicide. We see potential scenarios where parental pressure facilitated by biometric data could lead to increased pressure and risk for girls, compared to an already compelling concern for boys as seen in **Story 3- CRC 3**: "At home, Ji-Hoon's parents monitor his progress through a family dashboard, which aggregates data from his school performance, biometric readings, and even his social interactions... internally he feels trapped between his aspirations and societal expectations." Estonia's ongoing politicized linguistic tensions could also undermine the aims of education by ignoring the cognitive and emotional strains on students from minority linguistic communities, thereby misinterpreting and misusing biometric data collection in this regard. British Columbia's historic mistreatment of indigenous communities has recently shifted towards restorative justice, however this justice risks stagnation at a performative level if it is reduced to appropriation of indigenous knowledge and artificial engagement with ecology. As highlighted in **Story 3-UDHR 12 and CRC 16**: "Her neural feed projected a holographic Elder... as Lila 'walked' through the digital landscape, her biometric sensors tracked her engagement—heart rate, neural activity, even

micro-expressions... The system rewarded her with an extra carbon credit...." This prefiguration of a holographic elder highlights how this appropriation in the context of virtualization of ecology questions whether the aims of education preserve or appropriate indigenous wisdom and ecology. We can assume these locations will continue on a trajectory that reflects their local and global human rights commitments and balances them with biometric edtech use.

However, there may be warps in the AI mirror when we look at the stories in Palestine and the Pacific Northwest because of their historical and ongoing precarious relationship with human rights frameworks. Education has been at a virtual standstill in Palestine since October 7, 2023, which begs to question how plausible the integration of biometric technology will be in the rebuilding of a society leveled to the brink of genocide, and the purported future foreign "administrators" whose development plans raise doubts about Palestine's sovereign decisions regarding education. Those future foreign administrators currently produce and use the world's leading military technology against Palestinians. The assumption that an education system and infrastructure will be rebuilt in line with human rights principles, which have been systematically challenged by geopolitical and occupying forces, does not reflect a prefiguration based on reality. We can look to the unsuccessful Oslo Accords and the long held over reliance on UNRWA as evidence of this.

Similarly, the United States' exceptional abstinence from codifying human rights law into its own national laws, as well as blows to the Department of Education driven by Project 2025, shows an unpromising atmosphere for incorporating UNESCO principles towards biometric technology integration. However, the current cross-border tensions between the U.S. and Canada's national governments may indicate a strengthening regional solidarity in the Pacific Northwest's Cascadia Innovation Corridor between Washington State and British Columbia. British Columbia generally fosters a more human rights centered approach to educational policy, and their geopolitical and sociocultural ties may promise increased collaboration. The UNESCO principles which emphasize the intentional and ethical use of technology to disrupt such threats as climate change and populist politics and injustice could further guide this regional collaboration. The current turning points for these locations emphasizes elements of plausibility and invasiveness of biometric technology use in their educational futures, dependent on the outcomes of current geopolitical factors.

The consideration of current turning points supports the use of AI in Fictional Design Research because of its role in structuring research-driven methods to present curated scenarios for critical discourse. There are works of science fiction related to some of our location choices, which may offer inspiration for critical discourse on education in 2050, but the artistic, futuristic, or predominantly dystopian stories fail to present the relevant angles of the future that which we are trying to capture. Additionally, an anticipatory approach to protecting human rights should be emphasized in light of the slow-paced legal procedures that delay justice for human rights violations. Rather than waiting for relevant judicial systems to process complaints, a proactive approach in anticipating the significant human rights concerns through the most significant biometric technology use projected in 2050 could help prevent violations in the first place and relieve the backlog of human rights cases. The variety of scenarios in five locations presents starting points for critical discourse to encourage proactive educational policy towards the integration of biometric technology. Rather than simply imagining what the future will hold, speculative fiction shows us what it could hold and allows us to correct our steering. The potential to use AI in Fictional Design Research allows for more fine-tuned analysis of each location's specific legal, sociocultural, and geopolitical profiles, which can be useful for national, regional, and institutional policy makers.

While human rights frameworks dictate what should be respected and UNESCO principles dictate how they should be respected, the use of speculative fiction dictates where, for who, and why. Traditionally, data-driven policy is considered well-founded, but in honor of protecting human rights before they are violated, perhaps speculative data-driven policy could point towards a better approach. In this way, innovation can be balanced with a human-centered approach.

Limitations and Opportunities for Future Research

The research provided the biometric data based on location and the year 2050. The biometrics suggested are within the realm of possibility and not imaginative. AI mirrors the current state, however, it did identify the most significant findings of the human rights to privacy, the aims of education, and the best interests of the child in relation to location-specific issues. These results provided the anticipatory insights to educational futures, but are limited in their depth and location-specific developmental, legal, and educational policy frameworks. The main focus of

biometric technologies identified were cognitive, physiological, and emotional. The future advancement of technology suggests an expanding integration and advancement of biometrics. Future research should include a further refinement of the prompts to elicit more accurate insights for location-specific legal and developmental conditions. A more specific analysis of alternative regional human rights jurisdictions would allow research to provide further insights. Profiling an extensive view of the education system would allow for a comprehensive educational policy approach.

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Author's Declaration

I hereby declare that I have written this thesis independently and that all contributions of other authors and supporters have been referenced. The thesis has been written in accordance with the requirements for graduation theses of the Institute of Education of the University of Tartu and is in compliance with good academic practices.

Susan F Wright Digitally signed by Susan F Wright Date: 2025.05.27 12:44:42 -06'00'

Kayleigh Kleiva

May 27, 2025

5/27/2025

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Appendix A

Below are examples of the three different prompts used for one location.

Prompts 1

Write a 1,000-word speculative fiction story about education in the year 2050, set in British Columbia, Canada. The narrative should balance both utopian and dystopian elements. Focus on a central character—a Canadian student or teacher—and explore their personal experiences within this futuristic educational system. Ensure the story reflects cultural, environmental, political, and social realities of Canada while imagining possible futures

Prompt 2

Write a 1,000 word speculative fiction story about education in 2050 set in the British Columbia province of Canada. The narrative should focus on one central character (for example a public school student, a university student, a teacher, or a professor, etc.), and describe their personal experiences within this futuristic educational system. Ensure the story includes the biometric tech in use. Consult news sources for the current events overview to contrast the story in 2050.

Ensure the story's setting reflects the following social and cultural features from these sources https://www.canada.ca/en/services/culture/canadian-identity-society.html https://www.welcomebc.ca/start-your-life-in-b-c/understanding-b-c-s-culture-and-systems,
https://www.canada.ca/en/environment-climate-change/services/climate-change/federal-sustainable-development-strategy/respecting-canadas-sustainable-development-commitments.html
https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

Ensure the story's setting also reflects the following sustainable development goals and priorities for education in 2050 from these sources https://www.canada.ca/en/environment-climate-change/services/climate-

change/federal-sustainable-development-strategy/respecting-canadas-sustainable-development-commitments.html

Ensure boys and girls acquire essential skills for sustainable development

Build and upgrade educational facilities in alignment with SDGs

The Canadian Net-Zero Emissions Accountability Act, which became law in June 2021, enshrines in legislation Canada's commitment to achieve net-zero emissions by 2050."

Some B.C. entities are party to the Cascadia Innovation Corridor (includes British Columbia, Washington State, and Oregon) drafted the Cascadia Vision 50 to become world's first sustainable mega-region by addressing the

Affordable housing crisis ,Transportation congestion, Climate goals of the Paris Accord

Prompt 3

Write a 1,000 word speculative fiction story about education in 2050 set in the British Columbia province of Canada. The narrative should focus on one central character (for example a public school student, a university student, a teacher, or a professor, etc.), and describe their personal experiences within this futuristic educational system. Ensure the story includes the biometric tech in use. Consult news sources for the current events overview to contrast the story in 2050. Ensure the story's setting reflects the following social and cultural features from these sources https://www.canada.ca/en/services/culture/canadian-identity-society.html https://www.welcomebc.ca/start-your-life-in-b-c/understanding-b-c-s-culture-and-systems https://www.canada.ca/en/environment-climate-change/services/climate-change/federal-sustainable-development-strategy/respecting-canadas-sustainable-development-commitments.html https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

Ensure the story's setting also reflects the following sustainable development goals and priorities for education in 2050 from these sources https://www.canada.ca/en/environment-climate-change/services/climate-change/federal-sustainable-development-strategy/respecting-canadas-sustainable-development-commitments.html

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