

Designing Bio-Tech Ethics Cards: Promoting Critical Making During an Online Workshop with Youth

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There are ethical concerns surrounding how youth interact with biowearable technology and the potential effects it has on their psychological and physiological health. We need to give youth the tools to critically reflect and explore ethical issues surrounding biowearables in order for them to make informed decisions about how they interact with them. To address this, we developed the Bio-Tech Ethics cards as part of a critical making workshop. They are a set of design cards designed to scaffold critical reflection during a critical making workshop where youth prototype a biowearable from a kit. We focus this short paper on the requirements, initial design and revisions we made after studying card use in our workshop. We identified key design elements that are important in the cards and that may generalize to the design of other card sets meant to be integrated into a critical making process.

CCS CONCEPTS • Human-centered computing~ Social and professional topics~Children

Additional Keywords and Phrases: Design cards, critical making, reflection, biowearables, design ethics, computer ethics, youth.

ACM Reference Format:

Zoe Dao-Kroeker, Alissa N. Antle, Alexandra Kitson, Yumiko Murai, and Azadeh Adibi. 2021. Designing Bio-Tech Ethics Cards: Promoting Critical Making During an Online Workshop with Youth. In Proceedings of the 20th International Conference on Interaction Design and Children, June 24–30, 2021, Worldwide, Online. ACM, New York, NY, USA, 6 pages.

1 INTRODUCTION

Biowearables are technologies worn on-body that can sense and track a wearer's physiological and psychological processes (e.g., smartwatches and fitness trackers). These devices are becoming increasingly prevalent not only with adults, but also with children and youth [8]. Youth are relying on biowearables to tell them what to do, what to eat, how they are doing or feeling, and even who they are. This raises potential ethical concerns around the possible impacts of normative values around personal optimization on youth's psychological development. There is a need to give youth the tools to critically reflect and explore these potential issues so that they can make informed decisions about how they interact with biowearables. A recent review showed that 8% of child-computer interaction research addressed the potential impacts of technology on children, and only 1% are actually teaching children about these issues [16]. Little research has explored how to develop critical reflection skills with youth during the design and making processes [3]. To address this need, we developed a set of critical reflection cards to scaffold the critical reflection process during a workshop where youth prototyped a biowearable from a kit that had purposefully designed for under-determined decision points. These are areas that are open ended portions of the code that allow for youth to make their own decisions. Our goals were to support youth (aged 12-14) to reflect on ethical issues that might arise with long-term biowearables use. Our research question was, *How can we design an ethics-related card set to support youth to critically reflect on the potential impacts that biowearables could have on them?*

We developed a workshop (7 x 90 min. sessions) to enable critical reflection on potential ethical issues during the design and prototyping of a biowearable using a kit we developed. The kit included a breathing sensor, a tangible motor-operated pinwheel and an LED display. We used micro:bit controllers and the MakeCode platform for programming the inputs, outputs, and mappings of the breathing sensor. Our workshop participants had to make decisions about which inputs, outputs, and mappings they would use for their biowearable prototype, and we used these under-determined decision points as opportunities for critical reflection based on the Bio-Tech Ethics cards and facilitation. For more information on the kit, see [2]. Over the course of the workshop, the Bio-Tech Ethics cards were introduced and used during making activities in order to gradually build up participants' conceptual understanding of potential issues, introduce language to express these issues, and foster awareness, discourse and reflection about ethical issues in biowearables that might impact them. In this paper, we detail our iterative process of designing and developing this set of Bio-Tech Ethics cards, identify some of the challenges of using the cards in our pilot

study, and provide insights that contribute to a growing body of work on design cards and specifically using card sets to support reflection on ethical considerations during technology design.

2 RELATED WORK

There is a long history of using cards in design processes to bring conceptual and procedural information into the design process (e.g., [4,9,17]). A recent review of analogue design tools for collaborative ideation identified 55 different sets of cards that have been developed in academia and industry [10]. Sets of cards have been shown as a beneficial way to introduce content into a design process, where it can be applied *during* the process of making and/or design [9]. Compared to other formats (e.g., slides, booklets, posters) the hands-on form factor of cards supports flexible usable scenarios well suited to design processes. This allows for utilizing other physical materials, such as our kit for prototyping a biowearable-tangible system.

Roy and Warren [13] conducted a review of cards in design research and found that cards had been used to support creative thinking and problem-solving, systematic use of design methods, domain specific design, future thinking and collaboration. While most design cards involve support for the design process or problem-solving, our goals are to support critical reflection during design and making processes, also called critical making. Following from [12], we conceptualize critical making as a way of engaging ethics, values and social issues through interaction with physical and computational materials during design and making (e.g., prototyping). It is a process that brings together both creative physical exploration and conceptual reflection. None of the 155 card sets identified in [13] and only four of the 55 card sets identified in [10] dealt with ethics or values. The Envisions card sets stated in [7] have content related to key concepts in value sensitive design, including emphasizing the range of effects of a technology, highlighting the dimension of time and longer-term implications for a range of people who may be impacted. The Moral IT card set [15] have a constrained number of cards, and cluster them by ethical issues. The cards were designed using open questions and images to promote thinking, emotional responses and for aesthetic reasons. A three-part card deck designed to support discussion about ethical issues in machine learning included three colour-coded card types: people cards, about contexts of usage; data cards about sources of data and ethics cards about issues that may arise [5]. Analysis of our own and these card decks suggests a few common features: different kinds of cards highlight different kinds or elements of consideration, cards are colour-coded by type, open questions are used to frame issues, images are used to trigger reflection and add aesthetic elements. Additionally, the number and size of cards can be used to constraint the amount of information that can be presented, ensuring content is simple and concise. For content about ethical concepts, there must also be a focus on ensuring that language is accessible to the target users [4]. Following from [4,6] content templates can facilitate deriving content from more complex sources. To date, there are no design cards that we are aware of created to support youth's *critical reflection* on *ethical issues* explicitly, and that are meant to be used *during* the process of learning to make biowearables; that is cards to support *critical making*.

3 DESIGNING OF THE REFLECTION CARDS

The reflection card requirements were derived from our prior work in this space (e.g., [4,6]) and key features that may be beneficial as discussed in the Related Work. In terms of the cards' key features, we derived the following requirements, listed below as R1-R11.

- R1. Use plain language and images that are accessible to end-user (youth) [4,6]
- R2. Use open questions to promote reflection [5,15]
- R3. Group content by type [4,15]
- R4. Organize content with structure templates [4,6]
- R5. Differentiate card types with colour (or alternative design feature) [4,15]
- R6. Relate ethical issues to end-users (youth's) lived experiences [4]
- R7. Emphasize a range of effects of biowearable systems [7]
- R8. Highlight the dimension of time and longer-term implications [7]
- R9. Raise ethical issues embedded and hidden in technical decisions [5]
- R10. Include relationship between people, data and ethics [5]
- R11. Connect ethical issues to specific points that arise *during* prototyping process [1]

Card content was derived from previous work identifying four cases where biowearables might negatively impact children and youth's development with long-term use [1]. The cases concern potential negative impacts of specific aspects of biowearables on children's identity formation, the development of autonomy and agency, and what sources of information children turn to for authority about themselves. We extended these four cases and added personhood and authenticity, which had been identified in the research leading to [1]. We further describe content development in the next section in the context of card design.

The iterative design process of the card set started out with deciding on how the cards could address our requirements, ideating on card set structure, individual card layout, content structure and key elements of visual design. Based on our requirements, we decided on a deck of 12 cards divided into six pairs of two-sided cards [R3]: six Concept Cards focused on the ethical issues related to developmental constructs, each paired with a Reflection Card related reflecting on that concept during to the workshop design process [R11]. The first set of six cards explained the six developmental concepts (based on [1]) and exemplified the ethical issues associated with each of identity, personhood, autonomy, authority, agency, and authenticity. Simple icons were chosen that related to each developmental concept [R1]. For example, for the Identity concept card, the image was a person's profile with a question mark inside it (see Figure 1). [R1]. The front of each card also had the following written content structured using a template [R4]: a title (e.g., "Identity is ..."), a simple definition [R1] (e.g., "... about who you think you are. It includes how you think and feel about yourself including self-esteem, appearance, values, and who you want to become as you get older." and a question [R2] related to each concept (e.g., "Who am I?"), which was used to explain the concept and help youth relate the concept to themselves [R6]. The back of the six Concept Cards had two sections: issues and examples. Text described two issues related to the concept and a range of biowearable devices [R7], which were posed as a statement followed by a question [R4] (e.g., "A biowearable device may tell that you have high daily stress. How might this negatively impact how you come to think about yourself as you grow up?). Each card also had an example formatted as a statement followed by a question, that illustrated the issue using a particular biowearable device and scenario youth might relate to [R6] (e.g., "During Covid-19 your stress tracker tells you that your stress level is HIGH. Do you start to think of yourself as someone who is stressed out?"). The six Concept cards were meant to explain the developmental concepts and related ethical issues and try to help youth relate to them personally.

The content for the cards was developed iteratively by two of the research team who had experience working with children and biowearables, and reviewed by two researchers in educational technology and our community partner, who specialized in workshops design for youth. Content was written based on the templates for each section of the four card faces, based on focus, topic, voice and sentence structure, as outlined above [R4]. For each section, we wrote several options. For issues (general ethical issues) and examples (specific cases) we took some content identified in [1] and fleshed this out based on our experiences working for over 20 years developing products for children and youth. Once we had a stable content set, we analyzed the set to ensure consistency across cards and content categories, that language was non-technical [R1] that a range of issues were represented [R7], and that examples would be youth-focused [R4]. One researcher showed examples to several teens for feedback. We then chose the final content for each card and revised again based on reviews from our team about language accessibility.

Each Concept Card was paired with a corresponding Reflection Card. Reflection Cards were designed to support youth to reflect on the ethical issues outlined on each Concept Card during the workshop design process [R11]. Reflection Cards addressed the relationship between developmental concepts, potential ethical issues and technical decisions that could be made during making [R10]. The front of each Reflection Card focused on the design of user experience related to biowearables and prompted youth to think about user experience related to the kinds of longer-term social impacts that biowearables might have [R6, R8]. The content on this card was written using personal pronouns such as "me" to support youth to reflect on the impact that the concepts and issues (from each related Concept Card) might have on themselves [R6]. The icon chosen for social impact and user experience (front) related to the youth's lived experience by conveying an image that visually represented a person deciding between different paths [R1], drawing the attention and understanding how the device might have an effect on themselves in the future [R8]. Content for the front of each Reflection Card was also structured using open questions and covered a range of biowearables (e.g., "How might this affect me long-term?") [R2, R7]. The back of each Reflection Card contained content explicitly related to the decisions being made during making in the workshop as participants used our biowearable kit to prototype their ideas [R11]. There were three opportunities for reflection; one for each of the points that required technical decisions: input, output and the mapping between inputs and outputs [R10]. Each open-ended question was designed to support reflection on how technical decisions might impact long term use [R2, R4, R9]. For example, for input, the content was "How does the breath

data I choose relate to things about myself that are important to me?” The icons for input, output and mapping were chosen to tie into the biowearable kit [R1]. As such, input was represented with a breathing chart; output with a pinwheel with an LED light panel; and mapping with gears with the two other icons inside of them showing their connection to each other [R1].

The content for the Reflection Cards was developed following the same process as for the Concept Cards. In particular to ideate questions related to possible impacts for each kind of technical decision, we drew from different normative models underlying breath-based biofeedback systems, informed by [11,14] and taken from our analysis of normative values and different models of emotion regulation for breath-based biofeedback.

Other considerations included visual design. One key decision was that each card pair was the same hue (colour) and that the front of cards was more saturated than the back of card [R5]. This enabled visual grouping of Concept and Reflection Card pairs by hue and distinguishing front and backs of cards by saturation [R3]. The colours were chosen to be bold enough to attract attention but also be neutral enough in tone for text to be legible enough in a small format. The different tones for each card face were also chosen to highlight key areas of the cards [R4]. We also used bold fonts in questions to focus the attention on the most important parts. For example, we used bold for the part about how the design could have an impact on youth, rather than on the technology description in the question (refer to Reflection Card in Figure 1) [R5]. The font size was chosen to be large enough to read at arms’ length during physical making, but small enough to include the content required for each section. The titles were used on headers and footers to describe each card face’s content [R4, R5]. The lighter square and circular elements in the background underneath the content of the cards were used to highlight and break up the text for readability at a quick glance [R5]. The initial card design used in our workshop is shown in Figure 1 and included in our supplementary material.

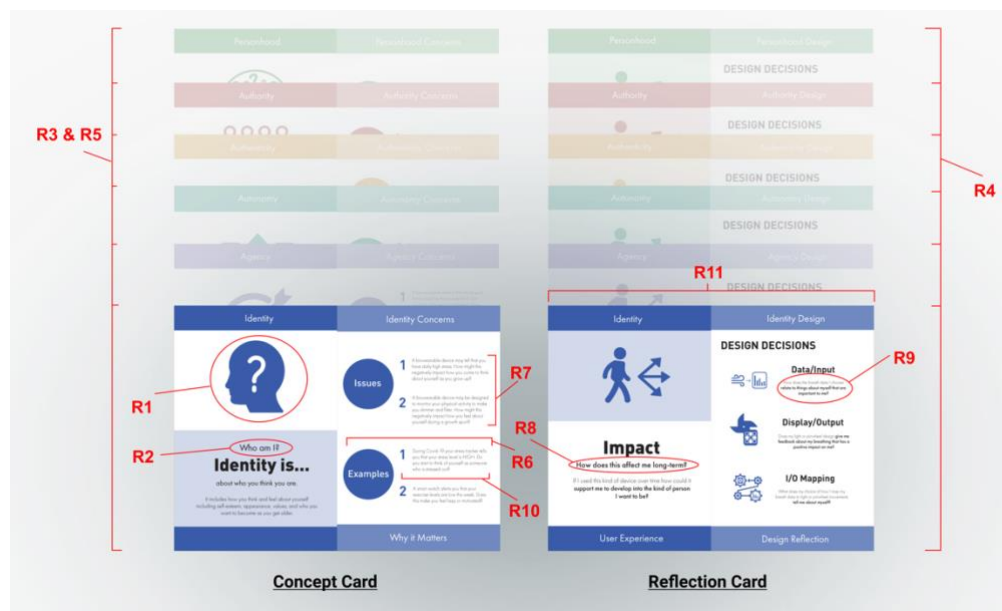


Figure 1: Bio-Tech Ethics card pair for Identity; sample design features where requirements are met shown in red.

4 WORKSHOP PILOT AND CARD REDESIGN

The workshop study was run in 7 x 90 min. sessions over two weeks and included five participants aged 12-14 (3 F, 1 M), two facilitators, two tech supports, two data collectors, and a coach from a community partner who specializes in maker workshops for children. Due to Covid-19, the workshop was run remotely using video conference software and Google Docs for synchronous activities. For more details on the workshop design and study methods, see [2]. We collected and analyzed data including observation notes, video and chat records, Google Docs, and participant end-of-day surveys. Individually and then as a group we reviewed observational notes, survey responses and used video and chat records to confirm our notes. Our analysis indicated several instances where participants engaged reflectively with ethical and social issues during the making process. Detailed analysis and examples of critical reflection during making are described in [2]. Participants read the cards silently and out loud,

discussed social impacts when prompted by facilitators and by the end of the workshop explained some of their decisions by referring to card content during the making process (see Figure 2). This demonstrated that our set of Bio-Tech Ethics cards seemed to support our participants to use appropriate language. Besides, over the course of the workshop they developed awareness, engaged in discourse (in chat and verbally) with peers and facilitators on their reflections about ethical issues in bio wearables. While there was some critical reflection, as evidenced in [2], more study is needed to definitely tell whether and to what extent critical reflection happened as a result of our Bio-Tech Ethics cards. We also identified three main challenges related to using the cards to scaffold this critical reflection during the workshop. The first challenge [CH1] we identified early in the workshop from the survey results was that our participants were not relating personally to some of the card examples. For example, one participant responded to the survey question “What did you like least about the workshop today?” with “If I’m being honest, I don’t think that using a biowearable will change my entire personality.” –P01. The second challenge [CH2] we identified in the survey results was that participants did not completely understand how they were supposed to reflect on what they were creating as they prototyped their ideas using the biowearable kit. For example, the same participant wrote “I didn’t understand the cards and struggled to think of anything that would go with them” –P01. The third challenge [CH3] we observed was that both the participants and the facilitators were struggling with referring to a specific card or pair of cards. They would often hold the card up to their web camera, but the text was too small to be identifiable at a glance, especially with poor video quality. As a result of these three challenges, we revised the cards.

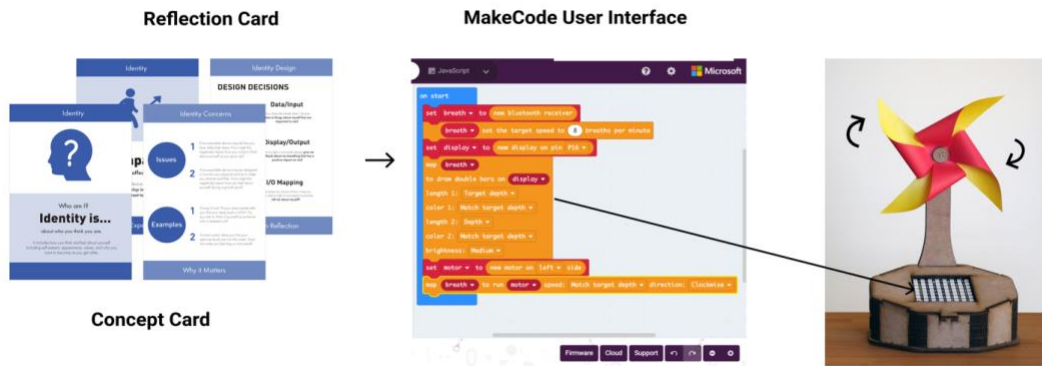


Figure 2: Bio-Tech Ethics Cards (Identity shown) used in the pilot workshop study alongside the MakeCode and pinwheel.

We made several changes to the Bio-Tech Ethics cards to address the three challenges we identified (see Figure 3). First, we added a large number 1 and 2 in the background of the front face of each card in order to communicate the order that each card pair was to be used addressing [CH2]. This new feature also provides a large visual identification to support people to refer to specific cards during video conferencing with poor quality screen resolution [CH3]. Second, we added top-level headings (e.g., “How can biowearables negatively impact people?”) to the back of the Concept Cards and the front of the Reflection Cards so that there could be a more distinct connection between the content and the participants’ own experience [CH1]. Third, we added the titles in the main portion of the cards (e.g., “What is it?”) in the header so that participants could focus their attention to the general concepts rather than be overwhelmed with details [CH2] and also see what the card is about at a quick glance [CH3]. Fourth, we added the card’s topic name to the footer in order to give both participants and facilitators the ability to refer to the names of the cards [CH3]. This way, the card’s name could easily be seen at a quick glance when trying to find each of the topics, not just know they are different cards. Fifth, we divided the content on the back of both the Concept and Reflection Cards by breaking it up with circular shapes and objects so that both cards could match in clearly being different from the front of the cards and divide up the space of the text heavy portions so that it could be read easier at a quick glance [CH3]. The rest of the colours and the main titles written remained the same because it worked well, it allowed them to see the different topics of the cards and know that each one has their own distinct set of reflective questions and examples. For the full card set, please see our supplementary material.

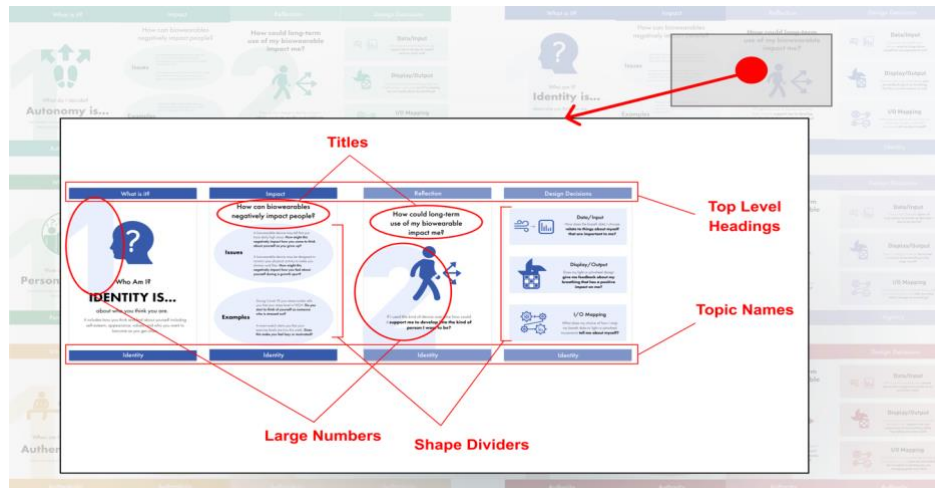


Figure 3: Revised Bio-Tech Ethics card design for Identity pair with key changes highlighted.

5 FUTURE WORK AND CONCLUSION

Our goal for the workshop was to support youth to develop awareness about ethical issues related to long term use of biowearables during the process of making their own biowearables. To support critical reflection during making, we created a deck called Bio-Tech Ethics cards. Based on our own and other’s work we derived 11 requirements (see above) that we addressed in the card set structure, an individual card, content structure and visual design of 12 cards. These requirements are agnostic to biowearables and as such they may be useful as a core set of requirements for others seeking to design cards around ethical issues in technology design. We generated card content based on the specific structure of each section’s template and using conceptual content informed by [1,11,14] and our extensive experience working with children and youth. Our card set provides an exemplar of one of the ways these requirements can be addressed, using biowearable-specific content derived from the literature identifying a range of ethical issues associated with this space. To the best of our knowledge, this is the first set of cards designed specifically to be used during the making process of a biowearable in order to scaffold critical reflection on potential ethical issues.

Our pilot study provided preliminary evidence, described in more detail in [2], that participants used the Bio-Tech Ethics cards during the workshop and engaged in some critical reflection during making. In this paper we focused on identifying the places where there were challenges to supporting critical making based on the design of the cards. We highlighted three challenges that we thought could be addressed through card redesign (vs workshop redesign). The main changes that were made to the cards were related to how they were meant to be used (1-2 order, key terms in headers/footers), highlighting the key elements of content on each card (e.g., examples related to youth’s life experiences). But we left supporting text intact, and used clearly identifiable colours, numbering, titles, shapes, and icons to more easily differentiate and reference the cards.

At this stage, we do not know if our card revisions will successfully address the challenges we identified. We plan to run a second workshop in order to investigate the ways that our workshop procedure and materials scaffold critical making. The Bio-Tech Ethics cards are one element of this redesign. While we focus on the structure, layout, content and visual design features of the cards in this paper, the success or failure of the cards resides, in part, on how they are introduced and built into activities, and how reflection based on the cards is prompted. These are topics beyond this paper but are important considerations when designing cards for use in educational settings. Our Bio-Tech Ethics cards are a promising tool for giving youth language to think about and discuss potential ethical concerns about biowearable technology as they assemble their own biowearable prototype. Those interested in introducing conceptual thinking into technical and design processes could build off our contribution to create variations of card decks that scaffold critical reflection for other kinds of ethical issues, for other technologies, and with other audiences.

ACKNOWLEDGMENTS

Thanks to SFU Innovates, NSERC Discovery program and Alisha Collins and the staff at Brilliant Labs.

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