



MyBioethics: How Ed-Tech Enables Discovery-Driven Empirical Bioethics Research

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Abstract

Digital tools have granted new opportunities to engage people with bioethical discussion and rehearsed decision-making. The ongoing development of the MyBioethics mobile application links these together within a digital space designed to encourage deliberation and research participation by inviting users into the process of discovery. Besides educational purposes, this has enabled a unique way to gather real-world observations. A research procedure was designed to harness the functionality of a mobile application. Quantitative data was generated by dilemma scenarios and integrated surveys that measure and inform users about their psychological and epistemic tendencies. The resulting analysis enabled the possible influence of these factors on moral judgment formation to be investigated—leading to the preliminary identification of prospective relationships. The adopted methodology is crowdsourced and explorative. We seek to generate hypotheses as well as facilitate ethical reflection among users. This work is a proof-of-concept. The main finding is the tentative confirmation of the approach. A digital teaching tool can function to advance empirical bioethics research. The gathered data unveiled prospective areas of academic interest and yielded observations that may contain valuable reflective insights for individual end users. Digital bioethics brings along new opportunities to engage a diverse user base in a way that provides educational resources, challenges ethical preconceptions and intuitions, allows inclusion in research efforts, and encourages autonomous decision-making. Ed-tech applications appear suitable for investigating personal tendencies that are influencing our moral judgments. Digital environments could be designed to surface unarticulated factors behind our held positions and challenge unquestioned moral notions.

Keywords Digital bioethics · Teaching tool · Exploratory research · Crowdsourcing · Moral deliberation · Moral intuition

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1 Introduction

The information age has provided bioethicists with new digital methods to engage people in education and interactive deliberation (Schneider et al., 2023). Prior empirical research has indicated that interactive and visual teaching tools that provide a pleasing user experience can be effective in supporting bioethics learning (Sleigh et al., 2023). New learning environments designed to take advantage of this effect can provide favorable circumstances for passing on information as well as increasing users' deliberative and moral competencies. We consider the capacity of strangers to make sense of difficult topics a crucial aspect of social health and believe that this can be greatly diminished or built up by digital technology.

Combining text, audio, and visual information can improve both engagement and knowledge acquisition by promoting motivation while managing the extraneous cognitive load of digital learning (Skulmowski & Man Xu, 2022). Teaching tools that take advantage of the functional potential and ubiquity of smartphones surely have a role to play in the effective dissemination of bioethical ideas, concerns, and proposed solutions in society. Yet, rather than designing applications to channel information only one way, we propose cultivating joint efforts with participants so that they can share their observations and have a sense of involvement and ownership in bioethical efforts.

A recent turn in empirical bioethics research has sought to take advantage of digital methods and acquire new research competencies to generate insights (Salloch & Ursin, 2022). Besides facilitating online public spaces for the exchange of ideas, digital bioethics can involve the design of research functionality that can be embedded in these learning environments. Data streams generated from user interactions can be analyzed for the purposes of scientific exploration. This would enable a more accessible form of empirical ethics research that can be both community-centric and largely automated.

Within the ongoing MyBioethics mobile application project, the set-up of an online in-app research procedure has resulted in the identification of novel connections between personal tendencies and expressed judgments. Here, we demonstrate the research capacity with some preliminary findings. We hope to generate interest in digitally supported teaching and connected research as well as initiate discussion about improving cross-disciplinary collaboration for content generation and data analysis. Discovering unexpected relationships between ethical decisions and measurable constructs of epistemic, intuitive, and analytical cognition can generate new hypotheses worthy of further investigation. Once considered relevant, these constructs and their respective questionnaires can expand the toolkit of empirical bioethics.

1.1 MyBioethics 101

With the MyBioethics mobile application, users can learn about bioethical dilemmas and express their perspectives through voting. The app adopts a game-like function with completable levels combined with an interactive capacity for facilitating communication with fellow users. The foremost objective is to teach bioethics by

introducing any English-speaking person with a smartphone to ongoing discussions concerning a wide variety of topics. These include both practical ethical dilemmas encountered in real life, as well as more theoretical thought exercises. MyBioethics functions to raise public awareness of ethical challenges connected to health care, biotechnology, and the environment. In general, it aims to increase users' capacity to deliberate and make informed decisions regarding bioethical issues, helping each to enrich and revise their perspective, and so discover their voice. Besides providing tools and resources for rational deliberation, the content can challenge initial moral intuitions by making underlying psychological factors visible.

This mobile application was developed through a collaboration of Finnish bioethics researchers and international colleagues. At the time of writing, MyBioethics is available in 74 countries and has over 650 registered users. This will extend to cover the United States once institutional challenges have been resolved.

1.2 User Experience

The first time the application opens, it directs a new user to create an account. Thus far, the country of residence has been the only collected background information. A voluntary more fleshed-out user profile is under consideration, yet we do not wish to get fixated on demographic groups or factors like gender and age. The created username functions to link all user activity, enabling the analysis of generated data.

After completing registration, users are free to choose from a growing selection of lesson modules, listed in Table 1. Once selected, users can either read or listen to the slides that introduce them to the topic at hand. Each lesson includes multiple dilemma scenarios that provide possibilities to participate by voting on what one considers to be the more ethical alternative. Once an answer has been submitted, the app

Table 1 Released lessons and their usage

Lesson	Completed*	Slides	Duration (min)	Dilemmas
Animal ethics	47	13	60	4
Commodification	96	15	30	2
Ethical argumentation	290	10	15	2
Genetics	289	11	20	2
Healthcare autonomy	296	10	15	2
Healthcare inequality	103	13	15	2
Healthcare LGBTQ	63	10	15	2
High-cost drugs	27	19	30	4
Informed consent	82	20	30	7
Moral imagination	263	10	15	2
Neuroethics	95	14	20	2
On psychedelics	14	18	45	3
Patienthood	148	18	30	3
Professionalism	29	11	15	2
Self-experimentation	160	17	30	2
In total	2,002	209	385	41

See the updated list: www.mybioethics.com/abstracts

*User completed all dilemmas of the lesson (29.4.2024).

will disclose the vote tally and give the user a chance to elaborate on the expressed judgment. Besides an open forum for written comments there are also Likert scales available to report the self-perceived moral certainty and significance of the selected answer. Users also have the option to disclose the decisive issue that most significantly influenced their vote from a list of general options—including considerations like autonomy and justice—or by suggesting a unique rationale.

In addition to lessons, the app includes a selection of standardized survey measures for dispositional orientations and other psychological and epistemic tendencies that might influence ethical decision-making. Once completed, the displayed average and score distribution will help users compare their thinking and intuition with that of others. User-friendly information enables them to reflect on the significance of the measured tendency—e.g., for optimism—for their personal sense of right and wrong. The purpose of these surveys is two-fold: to enable discovery-driven research on bioethical decision-making and to inform users on found connections so they can personally assess how much this factor played a role in their vote. Finally, the app encourages the user to reflect on whether this potential influence would even make sense or be ethically justified.

2 Intended Employment

This project seeks to establish an engaging online portal for moral deliberation and provide insights that enable users to carefully consider their positions on bioethical questions. Dilemmas are designed to involve citizens in societal sense-making by voicing their opinions and uncertainties. Many of the lessons assess issues related to policy and public health while incorporating considerations important to individuals. We plan to broadcast the vote tallies and other findings on our social media.¹

While much of society's attention is pointed toward digital content, it is sensible to create online spaces that embrace the improved connectivity and functionality allowing one to comfortably voice opinions, elaborate, respond, and possibly even participate in research. Rather than scattering this attention and undermining user autonomy (Zimmerman et al., 2023), the content on MyBioethics is designed to maintain focus on the task at hand. By encouraging users to devote time and effort to developing their ethics skills, we in turn seek to enhance their decision autonomy.

Public bioethics has traditionally utilized means of deliberative democracy, including citizens' juries (Moore, 2010; Street et al., 2014). As the objective of MyBioethics is to also prioritize broad participation and democratize knowledge-making, the project is likely to take on a life of its own as it matures. It is impossible to fully predict how any educational technology will be used in practice (Selwyn, 2010). Yet, the technical design impacts whether the application exaggerates social conflict or provides a more self-reflective user experience. For interpersonal online interactions to be high quality, instructional for users, and supportive of learning, the design of these experiences needs to be purposeful and informed by research (Mehall, 2021).

¹ www.instagram.com/mybioethics.

Rather than seeking unanimity that brings the conversation to its end, digital bioethics should facilitate open and high-quality processes of deliberation that encourage the pursuit of the common good. Members of our online jury are encouraged not merely to agree with the group or get bogged down in first impressions but to consider the motivations behind their reasoning. Learning how to arrive at convincing justifications is not all that ethics has to offer. Besides rational and deliberative talents, awareness of guiding intuitions, personal dispositions, and implicit judgments is also worth cultivating.

Ethical questions will forever keep surfacing in people's lives and pull a segment of them to investigate moral concepts, theories, and notions more systematically. We consider the possession of deliberative tools and executive control over moral judgments more important than being fully immersed in every bioethical conversation. Without having to involve politics or other categories of group identity, app users can discover deep personal factors that inform their judgments. These can assist them in formulating a concept of themselves as certain kinds of ethical thinkers. Diverse lessons, perspectives, and dilemmas challenge them both through rational arguments as well as by shining a light on their "gut reactions." We hope to provide suitable challenges for those who enjoy effortful thinking—while not forgetting those who prefer avoiding cognitive overload. Users are not only interrogated for their views but welcomed into active roles as storytellers and citizen researchers.

2.1 Teaching

While MyBioethics aspires to allow self-learning and self-discovery, it also has functions that enable it to be effectively used with more traditional teaching. For students of applied ethics, medicine, nursing, and biosciences, the app can illustrate real-life ethical dilemmas that users are likely to encounter as professionals. The case examples are primarily intended to be practical even if supported by diverse theoretical knowledge, while a minority are more hypothetical and seek to kindle the user's imagination.

Moral learning should be viewed as a complex psychological process (Schlaefli et al., 1985). Rather than focusing on judgment alone, moral motivation and other component processes should be considered in the design of educational tools. This can encourage students to more comprehensively deal with morally challenging and distressing situations. Exploring and getting familiar with diverse perspectives aids one to better sense nuances that may turn out to have unexpected ethical relevance in a case under consideration.

As they are adopted, digital tools may make ethics education more self-driven compared to being directed by a teacher. However, an online learning environment cannot replace important aspects of on-campus learning and should remain a supplementary resource—exceptional circumstances aside (Shirazi et al., 2022). A recent study found that online discussions of real-life dilemmas can increase students' ability to justify their choices (Juujärvi & Myyry, 2022). Importantly, increases in ethical sensitivity and motivation were also noted. We wish to reproduce these outcomes using MyBioethics among Finnish University students but focus more on online self-learning. In future work, we seek to demonstrate the app's pedagogical value as a tool

for improving deliberative competencies, while not excluding moral imagination and intuition.

So far, the app has been actively used during three university courses for first- and second-year students. More recently, it was also tried out with doctoral students who were attending a research ethics course. Observations from its previous use have indicated that MyBioethics can complement more traditional teaching methods. Dilemmas that students consider before each lecture can function as starting points for classroom discussions where they can voice their votes, elaborations, and comments. Student feedback on the app has been promising and broadly positive.

To broaden the scope of bioethics learning in the future, those who wish to raise awareness, disseminate educational information, provoke discussion, inquire about opinions, or apply a more critical perspective should use and co-develop such digital hubs. In the future, online learning and deliberation can be further enriched by the inclusion of surveys, quotes, guidelines, game elements like quizzes, and creative art projects that mix science, ethics, and artistic expression.

2.2 Exploring

Dilemma vote tallies are just the surface of the empirical angle. Through MyBioethics, we hope to uncover cross-disciplinary research interests, allowing bioethics to interact with diverse fields and gain more prominence. These engagements could pinpoint easy-to-measure factors that appear to influence ethical decision-making. Besides granting new tools for identifying cross-personal differences and conflicting ethical priorities, this research could be framed as the discovery of undertones that make up individual voices, each having their part to play in enriching societal conversations. For this reason, tendencies that have no obvious normative preferences about them, like the sense of relationship with nature, were integrated into the application. Supposing that these differences influence moral judgments, such alternative outlooks would each appear valid and promote healthy pluralism.

In the spirit of academic collaboration and knowledge sharing, we welcome collaborations with researchers and institutions that share our desire to engage the public in deliberation and increase moral awareness and motivation. Joining forces can only enhance the depth and breadth of our investigations, allowing for richer insights and broader applications in the field of bioethics. Such collaborative endeavors could be made to benefit future scholars. Graduate and doctoral students who have authored theses might find opportunities to transform these works into lesson modules as well as use data or preliminary findings in their research.

Continuous low-cost empirical research could be carried out using these platforms. Digital learning environments like MyBioethics could also function as alternative low-barrier publishing channels for preliminary findings.²

² For example, see: www.mybioethics.com/research.

3 Driven by Discovery

The research effort that has been built around the functions of the MyBioethics application represents an exploratory methodology. This means that there are no guiding hypotheses, rather the research aims to generate them. The relationships between the explored variables are unknown to the research team and its members avoid being guided by expectations (Schwab & Held, 2020). This approach to research is generally considered preferable when the aim is to “find the unexpected”. For the present method, prior assumptions play only a modest role in the selection of surveys. When employing pre-developed questionnaires or other quantitative instruments, exploratory research benefits greatly from automated data processing. Digital research instruments are hence used to freely probe for connections between data items: vote, survey score, country, certainty, etc. When a survey gets multiple preliminary ‘matches’ from different dilemmas, this enables the identification of topics or themes that are shared between the dilemma scenarios, finally leading to the generation of a hypothesis.

The ongoing shift toward a more open science framework is changing who can partake in bioethical research (Lyreskog et al., 2022). Purpose-built digital applications can provide ethicists with new opportunities to engage and involve the public in the ongoing global ethics conversations and the investigation into mechanisms of moral judgment. MyBioethics meets the proposed definition of crowdsourced science by involving a self-selected group through an open call to undertake tasks in a collaborative online process to generate scientific knowledge (Lenart-Gansiniec et al., 2022).

Many ethically relevant issues can feel overwhelming in the polarized information environment; competing discourses rarely encourage independent voices. To prevent public demoralization, bioethics should embrace participatory and deliberative approaches that empower people to freely discover and try out their values, intuitions, preferences, and concerns. Ethical complexities and pluralism of opinions should not be considered overwhelming but an enriching part of being a human in the information age.

3.1 Theoretical Underpinnings

The prevailing view in moral psychology perceives intuitive cognition and emotional processing as essential to moral judgment formation (Brand, 2016). Rather than basing our opinions on rational arguments, people largely intuit whether something is wrong and rationalize to support and make sense of this moral feeling (Haidt, 2001). These can be thought of as implicit mental influences distinct from explicit conscientious reasoning. To truly understand answers given to ethical dilemmas, instead of only considering rationales, ethicists should explore this moral sense. Many classic bioethical topics, from abortion to animal testing, evoke strong emotional responses. Investigating the formation of moral judgments can therefore benefit from the arsenal of instruments designed to measure relevant dispositions. A specific mindset or inclination to feel a particular way can result from the unconscious side of cognitive

processing. Such factors can stay hidden from us, even while being prominent tones of our ethical voice.

While discussing methodologies for different forms of bioethics research, Ives and Draper propose measuring “lay intuition” to allow researchers to identify topics that the public perceives as morally acceptable or significant and so integrate empirical data with philosophical models (2009). Instead of screening intuitions to primarily inform social policy or ethical theory, we wish to outline some significant features of the moral sense so that the insights of moral psychology can be brought to bioethics. Only digital technology can facilitate both the non-stop gathering of non-expert responses and the dissemination of arising instructive discoveries. Designed tools could advance the theoretical accounts by testing them against the streams of data on moral judgments.

Factors responsible for pulling and pushing our moral intuition generally escape articulation and thus can be hard to argue against. However, social intuitionism should be considered as a set of descriptive, rather than normative claims. A discovery-driven attempt to generate insights about the moral sense could also facilitate critical self-reflection. By identifying prominent sways that affect bioethical decision making, we hope to provide app users with an opportunity to override the initial judgment with reason or encourage perspective-taking that may lead to the discovery of competing intuitions (Haidt, 2001). Post-hoc rationalizations can give space to self-critical rational deliberation once the implicit factors are made visible. Even if non-rational, intuitions should not be invariably considered something to discard and detach from, but individually assessed for their moral merit. Unconscious intuitive cognition appears to have dominion over moral responses and snap judgments. However, future intuitions can become informed and modified by prior conscious reasoning and empathizing (Pizarro & Bloom, 2003). Deliberation has relevance in interrogating our moral feelings.

3.2 Mapping the Layout of Decision-Landscape

Uncovering connections across dilemma scenarios and exploring whether these could be partly explained by measured personal dispositions constitutes an empirical attempt to demystify moral intuition. Findings would not only support the intuitionist thesis but also provide new venues for prospective research. Factors underlying our intuitions likely inform and frame our perspective on diverse questions even if these would not directly dictate our ethical positions. At least regarding topics that generally evoke strong emotions, the development team expects to find statistically significant differences in selected psychological and epistemic measures. Assessing subjective proclivities toward things like nature might uncover diverse factors that notably move people in matters of morality, while factors of epistemic cognition can provide more general descriptions of the user’s relationship with intuition, rationality, and ethical knowledge (Knight, 2020). Effect sizes are not likely to be strong with any single factor, so a more comprehensive model may be compiled with multivariable regression analysis or neural networks. Early attempts at using these have been encouraging.

Possible relationships across surveys are also monitored. This can ensure that a single underlying disposition is not inadvertently measured twice using overlapping instruments as well as increase knowledge of these constructs and their relationships with each other. Life experiences undoubtedly shape our views, but without completely altering the inherent dispositions of our minds. Unlike our ever-changing mood, features of our personality and surveys that measure these generally demonstrate good temporal invariance. These likely have a greater influence on experience than vice versa. Yet, if these scores were linked with key life events, like moving to X, graduating from Y, or becoming a parent, this would call into question their stability across the lifespan. The impact of past experiences on dilemma answers or survey scores would clearly be impossible to satisfactorily map out and analyze with brief surveys. However, some significant determinants of life experience, like birth order position or sex, might be worth including in the voluntary user profile.

3.3 Related Approaches and a Unique Angle

The Moral Sense Test project by Harvard's Moral Psychology Research Lab has employed a similar approach to empirical ethics research (Morgan & et al., 2015). Presently in the data collection phase, this research also uses online crowdsourcing and hypothetical examples to study moral intuitions. The approach includes psychological measures like the disgust scale—developed by Haidt and colleagues (1994). In total, this testing website has six integrated surveys and no direct parallels to the factors selected for MyBioethics. Another example is the YourMorals website which primarily uses the Moral Foundations Questionnaire based on the respective theory (Deghani et al., 2007). Additionally, this online research portal collects extensive demographic information, has an emphasis on political psychology, and includes one of our selected surveys, Need for Cognition, which measures satisfaction experienced from effortful thinking (Iyer et al., 2012).

For our project, contextual dilemma scenarios provide an opportunity to see the measured tendencies in action. Research functionality is integrated into an appealing learning environment, so participation is intended to feel more like exploring a digital science center than filling out a form. The selection of surveys for MyBioethics is partly informed by the explored themes and issues, exemplified by the inclusion of the Nature Relatedness survey. The presently integrated measures are displayed in Table 2. A periodically updated list with prospective additions can be found on our website.

These types of original online investigations have demonstrated the capacity to explore the landscape of moral psychology from unique angles by screening candidate dispositions for their weight in moral judgments. Besides enabling a more comprehensive learning experience and participatory exploration, we wish to bestow users with personal insights and moments of moral realization. The findings are screened, and the hypotheses are generated, mainly with the user in mind. For MyBioethics, uncovering and challenging initial judgments is more important than testing or building meta-ethical theory.

Table 2 Presently integrated surveys

Research survey	Measured tendency	Original publication	Version publication
Existential Quest scale (EQs)	Flexibility toward existential questions	(Van Pachterbeke et al., 2011)	(Rizzo et al., 2019)
Need for Cognition scale (NCs)	Tendency to engage in deep thinking	(Cacioppo & Petty, 1982)	(de Holanda Coelho et al., 2020)
Nature Relatedness scale (NRs)	Sense of connection with nature	(Nisbet et al., 2009)	(Nisbet & Zelenski, 2013)
Need for Affect scale (NAs)	Desire to experience emotion	(Maio & Esses, 2001)	(Appel et al., 2012)
Life Orientation test (LOt)	Dispositional level of optimism	(Scheier & Carver, 1985)	(Scheier et al., 1994)

See updated list, averages, and score distributions: www.mybioethics.com/research

4 Preliminary Findings

Some information on empirical findings is included to illustrate the research capacity of MyBioethics. Once an adequate set reaches the confidence level against type one error, we will consider publishing our exploratory results in a journal focused on moral psychology. Some dilemma descriptions are presented ahead in addition to the statistical information to provide examples of tentative influences and prospective hypotheses. Yet, the main findings are the observations about crowdsourced bioethics research with a digital tool.

4.1 Uncovering Influences

A total of nine preliminary connections between ethical dilemmas and measured personal factors are displayed in Table 3.³ Positive correlation value, a hypothetical positive relationship, means that a user with a higher survey score has an increased likelihood of having selected option A for the dilemma. For example, users who report having a stronger sense of connection with nature are generally more opposed to the legalized selling of non-vital organs according to the second dilemma of the *Commodification* lesson set. By itself, a correlation does not mean much, but when combined with a low probability value and a considerable sample, these associations become more interesting.

4.2 Analyzing Observations

Here we illustrate two preliminary connections to Nature Relatedness. Figure 1 displays the answer distribution of these dilemmas in relation to survey scores. In both cases higher tendency was associated with answer option B. Abbreviated dilemma questions can be found in Table 4. In the app, each case is presented with more detailed descriptions which are not included here. These dilemmas are presented to

³ When the revised version was submitted, these values had evolved, and new findings had emerged—we will present these in future work. See updates on the relationships: www.mybioethics.com/relationships.

Table 3 Preliminary findings from three integrated surveys

Dilemma	Survey	Effect size (<i>r</i>)	H_0 probability (<i>p</i>)	Sample (<i>n</i>)
Ethical Argumentation #2	EQs	-0.17	0.05	125
Informed Consent #3	“	0.24	0.05	68
Neuroethics #1	“	0.22	0.11	54
Patienthood #2	“	0.22	0.11	53
Moral Imagination #2	NCs	-0.16	0.11	106
Self-experimentation #1	“	0.22	0.03	99
Healthcare Autonomy #2	“	-0.18	0.06	106
“	NRs	-0.23	0.05	78
Commodification #2	“	-0.23	0.07	66

The data from these surveys was normally distributed. Positive effect size means that users with higher scores are more likely to answer **A**, while effect size equal to zero means that there is no relationship between the dilemma and the survey. Effect sizes were estimated with the Pearson correlation

H_0 stands for the null hypothesis. As this value gets close to 1.00, it asserts there to be no difference between users whether they answered **A** or **B**, regarding the survey in question. In confirmatory research, *p*-values < 0.05 are generally considered to constitute a statistically significant difference. For the present discovery, we display < 0.15. Two-sample two-tailed pooled t-test (assuming equal variance), software: JMP

The displayed sample size only includes the overlapping entries (both dilemma and survey are completed by the user). The sample threshold for inclusion is 50 and a considerable number of each answer is also required

demonstrate the process of generating an exemplary overarching hypothesis, which could provide a uniting explanation for these observations. Again, exploratory results like the ones outlined here can only generate hypotheses, never confirmations.

Individuals with a strong sense of connection with nature could have their moral sense tilted against “unnatural acts” or perceived violations against nature. So, decision making regarding an excessive and ultimately unwinnable struggle against a genetic illness and the selling of body parts could well be influenced by this factor. For someone who feels part of or protective of the natural order, it is easy to see how technology-driven disruptions to the original, unsullied, or “intended” state of affairs can spark negative intuitive reactions. This disposition to feel a certain way might therefore carry a normative charge. Thus, hypotheses for future research could include: The sense of connection with nature predisposes one to generally value the quality of naturalness over other considerations or be suspicious of human interference and to commit the naturalistic fallacy when justifying ethical decisions. The way that the natural state gives people ideas about how the world ought to be has received interest both from ethicists and psychologists (Brinkmann, 2009). Whether non-moral factors of environment and biology can have objective moral weight will remain in question, yet these factors most likely have subjective sway over our judgments—to a varying degree.

However, so far users opposing organ markets have still generally been slightly more likely to honor the patient’s wishes in the dilemma about healthcare autonomy. The user’s need for cognition also appears to factor in this decision likewise increasing the likelihood of voting for refusal as the score gets higher. Both these points illustrate that nature relatedness is just one factor among many—pushing against other dispositions and considerations.

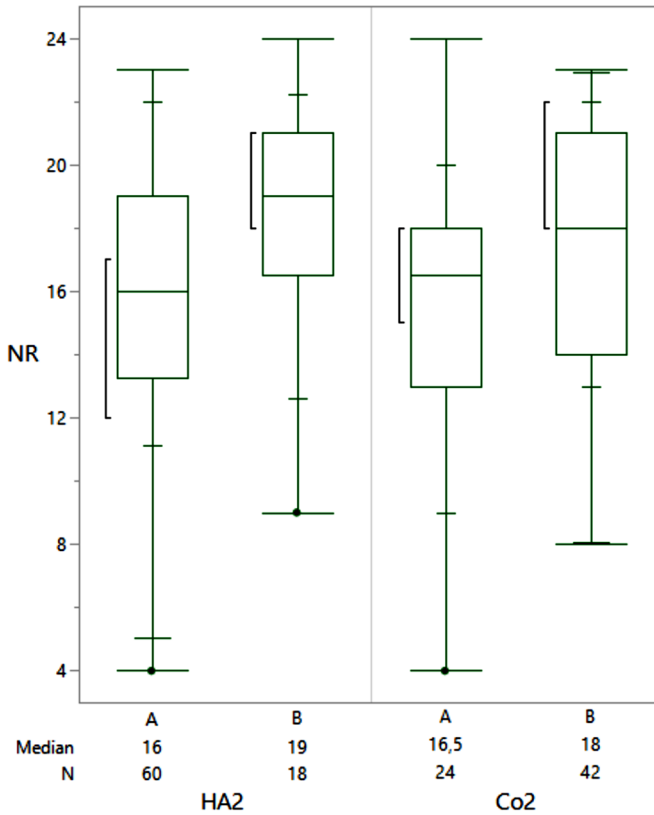


Fig. 1 Example dilemma answers by nature relatedness. A quantile box plot presenting Nature Relatedness (0–24 points) in relation to answers given to the dilemma examples. **A** and **B** are the answer options. Healthcare Autonomy #2 is on the left and Commodification #2 is on the right. For both, the score distribution connected to option **B** is visibly higher

Table 4 Dilemma answers associated with higher nature relatedness

HA2 B: Refuse the expensive experimental treatment for the small boy with the inherited disorder. Intervention would not offer a cure but likely slow the rate of progression.	$r: -0.23$	$p: 0.05$	19% of votes*
Co2 B: Not in support of legalizing the selling of nonvital organs. Even if the decisions to sell are made without coercion or manipulation.	$r: -0.23$	$p: 0.07$	61% of votes*

A negative correlation means that the answer option **B** was linked to higher scores in Nature Relatedness

*Vote percentages were calculated from all votes, including users who had not yet responded to the NR survey

To explore these and other dilemmas in detail, the app is available for download at the MyBioethics website. We welcome any attempts to formulate, test, and confirm hypotheses based on our exploratory research findings. The development team is pleased to share anonymized data if requested by our fellow academics.

5 Discussion and Limitations

The open science movement has brought up some challenges regarding empirical research that uses crowdsourced data collection. While collaborative initiatives help to improve access and participation, they can come at a risk of blurring the distinction between exploratory and confirmatory research (Nilsen et al., 2020). Discovery-driven approaches that lack an experiment protocol cannot—and should not—be used to produce conclusive evidence. Both systematic generation and structured testing of hypotheses are necessary for attaining confidence in the results. Even though our exploratory method produces quantitative data, its findings should be considered indicative. We also highlight this point for our users. MyBioethics development team encourages other researchers working on similar collaborative platforms to clearly make the distinction between explorations and attempted confirmations. We also encourage them to be forthcoming about the sought-after outcome of their research method.

5.1 Generalizability and Priming

Naturally, we do not have selective control over users filling out surveys, answering lesson dilemmas, or installing the application in the first place. So far, the sample consists largely of Finnish university students, which certainly raises concerns about the general applicability of findings. Although we have the necessary functionality to perform cross-country (or -institution) analysis, the results will unavoidably be biased in favor of people interested in bioethics as well as willing and able to try out a digital tool.

The self-selection of lessons and surveys contributes to biases in both distributions and associations of data. However, because the objective is to uncover the influence of relatively stable personal dispositions, the confounding effect of most demographic differences should be relatively modest. Joining together research and information dissemination also inevitably predisposes to the priming effect, which may distort the signal, yet without completely falsifying it. Despite the noise, a statistically promising finding notes that further exploration—or confirmation—should be considered.

5.2 Potential Impact on Intuitions

Although subsequent confirmatory research should test all worthwhile hypotheses and establish causal relationships, we can make well-founded guesses about the causal direction based on prior theory. At least the social intuitionist model sees the link between intuition and judgment as only unidirectional (Haidt, 2001). In turn, personal reflection and social persuasion are perceived as capable of impacting intuitive judgments. Therefore, reflective insights may play a greater role in adjusting our moral notions than extensive argumentation. Uncovering and exploring implicit intuitive structures can be advantageous for developing a self-concept, even without breaking away from prior judgments. Although we aim to provide these insights to users through displayed findings and so unlock contradicting intuitions, the dispositions underlying epistemic and normative activity are likely to endure. Factors that

might help to fill in the effect of social persuasion should be also considered and possibly included in the future.

5.3 Risks of Exploration

Due to its loose and open-ended design, exploratory research is known to sometimes generate false-positive findings, especially when the results are selectively reported. To counter this, we display a periodically updated table of all calculated correlations, probabilities, and sample sizes on our website (automatically calculated with Microsoft Excel). If any survey measure demonstrates discrepancies in relation to a given topic or theme, this undermines any supposition or proposed explanation founded on it. For this article, it makes sense to display only a few strong preliminary findings to illustrate the exciting prospect of uncovering connections across diverse topics.

The risk that a researcher retrospectively creates a hypothesis to fit the observed data or merely adjusts a broader theory to accommodate it should be considered whenever conducting or consuming this type of research. As the data continuously cumulates and tunes the findings, it may be difficult to decide exactly when it should be analyzed and published. A predetermined quota or scheduled updates may prevent picking the timing based on preferred values.⁴ For MyBioethics, any revised findings are promptly visible to active app users.

Overall, it appears that digital tools can perform a variety of research functions to advance empirical bioethics while expanding the field in the direction of open science. After importing standard methods and tools from other fields while first growing into an empirical discipline (Hurst, 2010), bioethics could further grow its reach and impact by again expanding its toolkit. However, the roles should remain methodologically clear and play to the strengths of each respective application. New functionality may provide more flexible study designs, but this variety should not confuse the criteria by which evidence is evaluated. Methodological concerns should be addressed so as not to undermine the scientific rigor of empirical or digital bioethics (Hurst, 2010).

Within an increasingly digital and interconnected society, it is important to acknowledge differences in the reliability of voices, sources, and methods while also recognizing the value of diverse vantage points. Yet, rather than being limited by the demands and required expertise of hypothesis testing, more participatory science should be driven by discovery and facilitated by digital technology. We highlight that this work is primarily a proof-of-concept of what is likely to follow in the arena of digital bioethics.

⁴ During the review process, a significant number of votes were submitted evolving the preliminary results. However, we retained the original values in Table 3 so as not to be unduly selective over timing. However, one finding was removed from the original ten because its values had significantly changed. This well illustrates the need to consider these exploratory findings preliminary and update them when needed.

6 Summary

In this article, we introduced a unique online environment designed to enable bioethics learning, deliberation, and reflection. Foremost, our work supports the view that digitally mediated methods can be useful in bioethics communication. Teaching applications that use dilemma scenarios to illustrate ethical challenges and trade-offs can also advance exploratory ethics research. The work contributes to the literature by providing a method description of bioethics research conducted via mobile application, including some preliminary findings. The approach is informed by trends in moral psychology and in turn works to operationalize related theory in the era of digital bioethics. A broad variety of expressed moral judgments together with briefly surveyed personal dispositions enables automated data discovery and the statistical identification of prospective relationships. Disciplines of applied ethics can obtain a better understanding of prevailing societal disagreements by identifying key factors guiding individuals' moral judgment formation.

Besides effective information dissemination, a digital platform can facilitate both the discovery and useful implementation of research findings. Observations that challenge our initial reactions or established positions have practical value in addition to testing and developing theory. Crowdsourced science can thus be made to directly benefit people who are contributing to the research. For users, personal insights about potential covert influences on one's decision-making about a given issue provide a unique opportunity to reflect on whether such factors had a notable or justifiable impact.

If technological tools can be designed to create engagement and raise users' awareness of personal moral attitudes, this impact should be beneficial to users and societies alike. Because no individual voice can carry all that is ethically relevant, conditions should be created where voices can grow more independent from unexamined intuitions, algorithmic distractions, and societal polarization. Apps that are designed to encourage discovery—in both empirical and self-reflective sense—need to become a more common feature of our digital society. Knowledge about the implicit factors that influence our opinions and decisions should not be harnessed for financial or political ends but provided to all individuals who wish to preserve and enhance their autonomy.

Future work should demonstrate, review, and debate the educational and research potential of methods enabled by digital technology. To purposefully design digital bioethics, the field needs to resolve how to best employ these tools to benefit specific objectives, initiatives, and sub-disciplines. Researchers of applied ethics could embrace alternative publishing channels to ease the flow of preliminary findings and generated hypotheses to the confirmatory stage as well as design accessible and engaging ways of bringing resulting discoveries to inform public deliberation.

Authors Contribution The authors confirm sole responsibility for the following: conception and design of the approach, data collection, analysis and interpretation of preliminary findings, and manuscript preparation. The creation of the app's educational content involved many writers who also indirectly contributed to this work. The integrated surveys have their respective sources, which we have acknowledged here and in the application.

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Data Availability Authors have permission from Duckling Codehouse Oy (publisher and copyright holder of MyBioethics) to analyze and publish data gathered via the application. The owner Heikki Saxén is one of the authors and hereby approves the use. The data that support the preliminary findings presented in this article are available from the corresponding author, Joel Janhonen, upon reasonable request. Alternatively, contact the MyBioethics development team at [Support](#). We only share or publish data that has been anonymized, and we do not include any demographic information that could risk re-identification.

Declarations

Informed Consent When first launching the MyBioethics application, all users need to accept our [Terms of Use](#) and [Privacy Policy](#)—created based on the General Data Protection Regulation. Consent includes approval for using the resulting data for research purposes. Because this work utilizes data from a third-party source—primarily gathered to support and enable the functionality of the application (including dilemma voting)—applying for a formal ethics committee approval was not possible in advance. The research method compiles existing data from an online source, qualifying it as secondary research.

Competing Interests The mobile application and the connected website were developed in collaboration with the Finnish Institute of Bioethics, a non-profit organization. The authors of this work are researchers and board members at the institute. Due to legal reasons, the application was published by Duckling Codehouse Oy, which also is the holder of its copyright. Authors have varying personal business relationships with this company, and they have at times received compensation for their work developing the application and its content. However, given that the software is free and contains no advertisement, any increase in app use or number of downloads does not directly financially benefit them, the institute, or the company. This research will be used to apply for future funding.

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