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Getting It Wrong the Right Way: Development and Early Implementation of a Gamified Sexual and Gender Diversity in Cancer Care Curriculum

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Abstract

Background

Sexual and Gender Diversity in Cancer Care (SGDc) patients experience inequities across the cancer continuum, driven in part by healthcare providers' (HCPs) limited knowledge and low confidence communicating about sexual orientation, gender identity, pronouns, and relationship diversity. To address this gap, a virtual education curriculum was developed to improve HCPs' knowledge of SGDc patients' experiences and strengthen their ability to communicate inclusively.

Methods

Guided by Kern's curriculum development model, adult learning principles, social learning theory, and gamification, an interdisciplinary team based in Toronto, Canada, co-developed a virtual SGDc e-learning program comprising a Knowledge Hub and bilingual gamified virtual patient encounters. The curriculum was iteratively refined with input from SGDc HCPs and patient partners. Early implementation was evaluated using the RE-AIM framework, drawing on Google Analytics platform data to characterize reach, adoption, and implementation. Effectiveness was not assessed.

Results

Between May 17, 2024, and December 31, 2025, the program was accessed by 2,217 unique users from 34 countries. Most learners were based in Canada (n = 1,366, 61.9%), and 840 (38.1%) were international. A total of 798 learner avatars were created, and 554 virtual patient scenarios were completed (69.4%). Learners generated 5,800 page views, primarily to the home page (n = 3,403, 58.7%) and game module (n = 1,292, 22.3%), with fewer visits to the Knowledge Hub (n = 418, 7.2%). Mean session duration was 1 minute and 45 seconds. The program was accessed predominantly on desktop devices (n = 1,799, 81.5%).

Conclusions

A framework-guided process supported the development and early implementation of a gamified SGDc e-learning program that achieved reach across 34 countries, adoption by individual learners and by the host institution, and engagement concentrated in its interactive components. The program offers an interactive environment designed to support learners in practicing inclusive communication with virtual SGDc patients and chosen family members. Future evaluation will examine the impact of the e-learning program on provider learning and patient experience to guide iterative refinement and broader dissemination.

Background

Problem Description and General Needs Assessment (Kern's Step 1)

Despite advances in cancer care and in health equity for Two-Spirit, lesbian, gay, bisexual, transgender, queer, questioning, intersex, asexual, and additional sexual and gender diverse (2SLGBTQIA+) communities, a significant gap remains at their intersection, resulting in unmet needs and inequitable outcomes for 2SLGBTQIA+ patients with cancer. Sexual and gender diversity in cancer (SGDc) patients have distinct needs and face multiple barriers across the cancer care continuum compared to the general population [1-3]. Gender-diverse patients often face even greater barriers to accessing inclusive care [4]. These barriers, together with the negative healthcare experiences commonly reported by SGDc patients, are associated with lower cancer screening rates and delayed diagnoses, which collectively contribute to poorer outcomes [5].

These disparities have multiple sources, but many stem from gaps in healthcare provider (HCP) education, resulting in limited knowledge, communication skills and the reproduction of cisnormative and heteronormative assumptions in clinical practice [1, 6, 7]. Content specific to the 2SLGBTQIA+ population remains thinly integrated into health professions curricula. A survey of medical schools in Canada and the United States found a median of 11 curricular hours devoted to this content in 2022, up from a median of five hours in 2011 but still short of what the authors judged necessary for competent care [8]. No national standard for sexual and gender minority health education exists across Canadian medical schools [9]. A national survey of health professionals in training reported a mean of 4.75 hours of such content overall, including 4.17 hours among nursing students [10]. In oncology specifically, only one in ten providers in a survey spanning 75 countries agreed that their medical school or postgraduate training had prepared them to understand the health needs of LGBTQ patients, while three quarters wanted this content added to curricula and further education for themselves [11]. These educational gaps leave HCPs underprepared to communicate in an inclusive manner and understand the unique needs of SGDc patients.

Available Knowledge

Education on 2SLGBTQIA+ health is essential to address the unique clinical and psychosocial needs of SGDc patients, which are often misunderstood or overlooked by HCPs [1]. Many patients encounter assumptions regarding their sexual orientation, gender identity, relationship diversity, or reproductive goals, as well as limited recognition of chosen family or complex dynamics with biological family members. Incorrect assumptions by HCPs about patients' gender, sexual orientation, pronouns, and health-related experiences contribute to feelings of invalidation and distress, with downstream effects on psychological and sexual health [12, 13]. From patients' perspectives, these are not simply gaps in provider knowledge but repeated microaggressions and potentially discriminatory experiences that accumulate over time and contribute to harm.

These experiences have been conceptualized through Minority Stress Theory, which explains how external stigma, prejudice, discrimination, and internalized stress compound challenges for SGDc patients and worsen health outcomes, and through intersecting identities, which describes how overlapping marginalized statuses amplify these stressors [14, 15]. Difficulties disclosing identities extend beyond fears of negative interpersonal reactions, as disclosure may expose patients to tangible risks, including breaches of privacy affecting employment, social relationships, and personal safety [16, 17]. Gender-diverse patients may also feel compelled to conceal their identities in certain clinical contexts, particularly reproductive health care, to access care safely or to avoid misrecognition, inappropriate clinical responses, or the burden of providing ad hoc education to HCPs [18].

While most providers report confidence in their general clinical abilities, few indicate sufficient knowledge to address the specific needs of SGDc patients [19, 20]. Among UK oncologists surveyed on self-perceived knowledge, attitudes, and behaviours (n = 258), 84% (n = 217) felt comfortable caring for 2SLGBTQIA+ patients but only 8% (n = 21) felt knowledgeable, and very few routinely inquired about sexual orientation, gender identity, or pronouns [19]. A review of palliative and end-of-life care for SGDc survivors concluded that specialized education developed by experts in clinical, cultural, and communication competencies is needed to close these gaps [21]. Most HCPs nonetheless express a desire for targeted education, particularly on communication [20, 22].

Engaging educational approaches are needed to strengthen HCPs' competence in SGDc care, yet many existing methods, particularly online learning, fail to hold users [23]. Reported barriers to e-learning include difficulty understanding lesson content, time constraints, inadequate learning materials, low-quality assessments, limited encouragement, language differences, variable instructor accessibility or enthusiasm, and minimal peer interaction [23]. These challenges point to the need for an interactive, competency-based educational intervention tailored to HCPs caring for SGDc patients.

Rationale

A quality improvement approach was used to address the gap in SGDc education for HCPs. Specifically, the Kern model for curriculum development was applied to guide the design and implementation of an SGDc Inclusive Cancer Care e-Learning Program [24, 25]. The tool integrated evidence-based educational strategies intended to strengthen HCPs' knowledge, confidence, and communication skills, drawing on adult learning principles of relevance, self-direction, and practical application [26]. We also drew on Bandura's Social Learning Theory, which frames learning as observation, modeling, and reinforcement that strengthen self-efficacy and behavioral change [27]. These principles informed the integration of knowledge acquisition, opportunities to practice inclusive communication through gamified scenarios, and feedback to reinforce learning. Together, these components were intended to help HCPs recognize potentially harmful assumptions, apply inclusive communication strategies, and build confidence in responding to SGDc patients' needs. Lastly, a gamified e-learning format was selected with the aim of promoting engagement and knowledge retention [23]. The Introduction constitutes Kern's first step,

problem identification and general needs assessment; the Methods below describe how the remaining five steps were carried out.

Specific Aims

There is an important need to address the gap in HCPs' expertise in understanding the unique needs of SGDc patients and effectively responding to these needs through inclusive communication. The primary aim of this project was to address this gap by developing and implementing an engaging, freely accessible virtual education tool with the aim of enhancing HCPs' knowledge of SGDc-related topics and their ability to communicate inclusively.

Methods

Context and Study Design

The e-learning curriculum was developed at the Princess Margaret Cancer Centre, a large academic cancer centre in Toronto, Canada, which comprises 12 programs, more than 3,000 HCPs and employees, and manages approximately 400,000 patients annually [28]. The project was conducted as a curriculum development and quality improvement initiative led by the organization's SGDc program in collaboration with multiple partners. The interdisciplinary team comprised three physicians, a psychologist, a social worker, an advanced practice nurse educator, a research analyst, two visual designers, three developers, four content experts, and three patient partners, all of whom identified as members of the 2SLGBTQIA+ community or as allies.

Community Engagement and Co-Development

Sexual and gender diverse community members took part in this work as patient partners and content experts rather than as research subjects. Three patient partners, recruited from the SGDc program's established patient partner roster, contributed alongside four content experts with clinical and community expertise in sexual and gender diversity. Partners were engaged from the goal-setting stage onward. At Step 3, they shaped the learning objectives and the content pillars, and at Step 4, the virtual patient profiles, dialogue scripts, and response options. At Step 5, they took part in the review and piloting rounds conducted between January 2023 and April 2024 and commented on the resulting revisions to scenarios, interface design, and Knowledge Hub content. Throughout, they attended to whether the patient characters reproduced stereotypes and whether the depicted harms were recognizable rather than sanitized, and their contributions across the six steps are summarized in Table 1. Feedback was collected through virtual meetings and written correspondence and was reviewed by the project working group. Concerns raised by patient partners about identity, language, and representation were treated as binding on content decisions, not advisory, and were implemented as raised, while clinical accuracy remained the responsibility of the clinician members of the team. Partners contributed to this work without financial compensation. Community members were not involved in

designing the targeted needs assessment survey, which sampled HCPs only, nor in the design of the analytics-based evaluation at Step 6.

Kern step	Academic and clinical team	Community partners and content experts	Design and development team
Step 1: Problem identification and general needs assessment	Narrative review of SGDc care and education gaps; framing of the educational problem	Not involved at this step	Not involved at this step
Step 2: Targeted needs assessment	Design, administration, and analysis of the local HCP survey; review of available local resources	Not involved at this step	Not involved at this step
Step 3: Goals and objectives	Drafting of goals and pillar-level learning objectives	Review and revision of objectives and of the four content pillars	Advice on what was deliverable within the platform
Step 4: Educational strategies	Selection of theoretical framing; drafting of virtual patient profiles and dialogue scripts	Review of patient profiles, scripts, and response options for representation, language, and recognizability of depicted harms	Interface, character, and scene design; branching script architecture; plain-language and responsive implementation
Step 5: Implementation	Coordination of piloting rounds; integration with the institutional learning portal; French translation of scenarios	Participation in review and piloting rounds; feedback on revisions	Technical build, defect resolution, prototype testing, and release
Step 6: Evaluation	Specification of RE-AIM dimensions; analytics extraction, analysis, and interpretation	Not involved at this step	Analytics instrumentation on the platform
Manuscript	Drafting, revision, and final approval	Not involved at this step	Review of technical descriptions

Table 1 Contributions of the academic and clinical team, community partners and content experts, and design and development team across Kern's six steps.

Curriculum Development Framework

The Kern Cycle for medical curriculum development was applied to guide the design, delivery, and evaluation of a virtual SGDc education tool for HCPs [24, 25]. The six-step framework comprises problem identification and general needs assessment, targeted needs assessment, goals and objectives,

educational strategies, implementation, and evaluation. Step 1 is presented in the Background, which established the educational gap in SGDc patients' needs on the basis of a narrative review we conducted [1]. The subsections that follow describe how Steps 2 through 6 were carried out, and the output of each step is reported in the corresponding subsection of the Results. Figure 1 maps each step to the corresponding activity in this project and to the section in which its output is reported.

Kern's Step 2: Targeted Needs Assessment

The targeted needs assessment characterized the knowledge, attitudes, and learning preferences of HCPs at the host centre. It drew on a cross-sectional survey administered in gynecologic oncology outpatient clinics, which examined recognition of SGDc patients' needs, self-rated knowledge, and routine practices related to asking about sexual orientation and gender identity [20], together with a review of the educational resources available locally at that time. Patient partners and content experts were engaged from the design stage onward and contributed to the interpretation of these findings; the survey itself sampled HCPs only and did not collect data from 2SLGBTQIA+ community members, which we note as a limitation of this step.

Kern's Step 3: Goals and Objectives

Curriculum goals and learning objectives were developed before educational strategies were selected. Four content pillars, pronouns, sexual orientation, gender identity, and relationship diversity, were drawn from the Gender, Sex, and Relationship Diversity framework and were selected to address hetero-, cis-, and mononormativity while equipping HCPs with competencies for affirming SGDc patients' identities and needs [29, 30]. Objectives were drafted by the SGDc program working group, comprising physicians, a psychologist, a social worker, and an advanced practice nurse educator, and were then reviewed and revised together with content experts and patient partners until consensus was reached.

Kern's Step 4: Educational Strategies

Educational strategies combined foundational knowledge, delivered through a centralized Knowledge Hub organized around the four content pillars defined in Step 3, with experiential learning through gamified virtual patient encounters that embedded those same pillars in simulated clinical conversations.

Each section followed a consistent framework, beginning with clear learning objectives and concise explanations of key concepts and terminology, contextualized to patient care (Figure 2A). Knowledge Hub content was written to convey information and to prompt reflection on assumptions and routine clinical practices that may influence communication, such as default pronoun use or reliance on gendered language. Practical guidance, illustrative examples, and actionable strategies were incorporated throughout, including explicit guidance on how to ask about pronouns respectfully, respond when mistakes occur, and recover from missteps in a way that maintains patient trust, and curated resources were provided to support further learning. This design was intended to support

comprehension, retention, and application of knowledge in clinical settings, and was aligned with adult learning principles [26]. These were design intentions rather than measured outcomes: reflective engagement, comprehension, and subsequent application in practice were not assessed in the present evaluation.

To facilitate experiential learning, gamification elements, including narrative progression, choice-based interactions, and immediate feedback, were used to increase engagement, reduce anxiety about making mistakes, and support repeated practice. A simulation-based approach was developed using virtual patient scenarios featuring four unique patients representing the diversity of the SGDc patient population. These scenarios were incorporated into “choose-your-own-adventure” scripts, inspired by video game design, which integrated content from the Knowledge Hub into realistic clinical interactions [31]. Foundational concepts introduced in the Knowledge Hub were embedded in the simulations, allowing learners to apply this knowledge in context and observe the impact of different communication choices. Each patient was constructed so that identity, relationship structure, and prior experience of health care intersected with a specific cancer diagnosis and point in the cancer trajectory, and each scenario was set in a routine cancer-care encounter, so that the communication task could not be separated from the clinical one (Table 3).

In line with Bandura’s Social Learning Theory, learners observed modeled communication strategies through patient responses, received reinforcement via real-time feedback, and were given opportunities to build self-efficacy through iterative practice in a low-risk environment. Character and scenario development was informed by research on 2SLGBTQIA+ representation in video games, which finds that the presence of queer identities has increased over time while representation across the community remains uneven, and points to the need for characters whose identities reflect that diversity [32, 33]. Qualitative work with transgender and non-binary players further shows that gender expression in interactive environments is often constrained by design features, which supported our use of a structured, choice-based approach allowing meaningful expression within simulated scenarios [34]. The scenarios were structured so that learners actively practice conversations addressing the four pillars covered in the Knowledge Hub, pronouns, sexual orientation, gender identity, and relationship diversity, with the aim of reinforcing both knowledge and communication skills (Figure 2B).

Scripts were developed by the SGDc program and reviewed by patient partners and content experts. Learners select dialogue options reflecting different communication approaches, ranging from inclusive statements that demonstrate affirming care to neutral statements reflecting passive care, as well as microaggressions and discriminatory remarks that enact harmful bias, which makes the consequences of communication choices visible. These choices generate dynamic patient responses and immediate feedback to reinforce inclusive practices and identify areas for improvement (Figure 2C). Scenes were created collaboratively with graphic designers and program developers to produce visually engaging modules with real-time feedback (Figure 3). Content underwent a plain-language review, the platform was built to render responsively across device types, and the virtual patient scenarios were made available in both English and French, Canada’s two national languages. No further assistive functionality

was built into the platform, and learners requiring captioning, text enlargement, or screen-reader support rely on the native accessibility features of their own devices.

Kern's Step 5: Implementation

Implementation followed an iterative, phased approach. Feedback on curriculum concepts, patient profiles, and patient interactions was obtained from patient partners and subject-matter experts between January 1 and April 30, 2023, to ensure content accuracy, appropriateness, and usability, and internal piloting with SGDc HCPs and researchers followed from July 13, 2023 to April 30, 2024, assessing usability, engagement, and content. All feedback was reviewed collaboratively by the project working group, and agreed-upon revisions were prioritized for implementation.

Technical Development and User Experience

The e-learning platform was developed in collaboration with a software development team. The SGDc program provided clinical content and learning objectives, and the development team engineered the interactive platform using a minimal viable product approach that prioritized the core learning pathways addressing HCPs' primary confidence gaps in SGDc-affirming care. Curriculum objectives were translated into design mockups, then into technical specifications, and engineers developed and tested interactive prototypes before production deployment, with final validation of both functionality and data tracking.

Several design choices supported user experience and engagement. The interface was designed to minimize distractions and to limit interactions to those relevant to the learning objectives. Illustration and visual storytelling carried much of the emotional content, particularly in depicting the patient characters, and visual cues such as facial expressions and subtle emotional responses were used to illustrate the impact of suboptimal clinical interactions, with the intention of helping learners understand and empathize with patient experiences. Learners were also invited to personalize their experience by entering their name, selecting pronouns, and choosing an avatar, which was intended to strengthen a sense of presence and increase emotional investment in the learning paths.

Piloting and technical testing with user experience designers, researchers, SGDc HCPs, and patient representatives identified usability problems and functional defects that could prevent learners from completing the learning paths, and changes were iterated on the basis of collaborator feedback. Demonstrations at hospital rounds, conferences, and professional meetings generated further insight that was incorporated before full-scale launch [35]. Translation of the virtual patient scenarios into French was performed by a section editor on the project.

Kern's Step 6: Evaluation

A quality improvement study was conducted to evaluate the early implementation of the e-curriculum rather than its educational effectiveness. Consistent with Kern's sixth step, the evaluation was operationalized using the RE-AIM framework [43, 44], which distinguishes reach, effectiveness, adoption,

implementation, and maintenance as dimensions of program impact, and which has been applied to analytics-based evaluation of digital health professions education [45]. Three dimensions were addressable with the available data. Reach was characterized by the total number of active users, defined as individuals who engaged with the program, as well as their distribution by country, and browser language. Adoption was characterized by learner avatar creation and by institutional integration of the program into our organization's learning portal. Implementation was characterized by page-level views within the curriculum, separately for game modules, the Knowledge Hub, and the four pillar sections on pronouns, gender identity, sexual orientation, and relationship diversity, scenario completions, average session duration, and device type (Supplementary Table 1). Effectiveness was not assessed, as no learner-level knowledge, attitudinal, behavioural, or patient-experience data were collected, and maintenance fell outside the observation window. The program was designed for use by HCPs involved in cancer care; however, no active recruitment occurred, and no individual-level demographic data were collected. Evaluation metrics were obtained from Google Analytics linked to the learning platform [36]. Descriptive statistics summarized these metrics during initial implementation from May 17, 2024 to December 31, 2025, providing evidence of real-world uptake and use.

Positionality

The perspectives of the author team shaped both the design of this curriculum and the interpretation of its early implementation. The team comprised clinicians, educators, and researchers in psychiatry, psychosocial oncology, radiation oncology, nursing, and social work, together with research staff, visual designers, and software developers, all of whom identified as members of 2SLGBTQIA+ communities or as allies. Of the 9 authors of this manuscript, 7 identify as members of 2SLGBTQIA+ communities, and the author group does not include members who identify as trans or non-binary. We write from positions of relative institutional privilege as staff of a large academic cancer centre within a publicly funded Canadian health system, and the curriculum carries the marks of that setting: it is built around Canadian bilingual requirements, grounded in a single-centre needs assessment, and premised on forms of institutional support for SGDc care that are not available in many jurisdictions. No author writes from the position of a patient receiving cancer care within the population the program depicts, which is why community partners were engaged at the goal-setting, design, and piloting stages. Our clinical proximity to this content also carries a particular risk, namely that a misstep we regard as survivable within a simulated encounter may not be experienced as survivable by a patient. In clinical practice, the reproduction of cisnormative and heteronormative assumptions may reinforce feelings of invisibility, perpetuate stigma and discrimination, and undermine trust between SGDc patients and their HCPs. That asymmetry is one reason the claims made here are confined to reach, adoption, and implementation, and why patient experience is named as a priority for subsequent evaluation.

Ethical Considerations

The quality improvement initiative received approval from University Health Network's Quality Improvement Review Committee (#21-0275). Our reporting followed the Standards for QUality

Improvement Reporting Excellence in Education [37].

Results

Targeted Needs Assessment Findings (Kern's Step 2)

A survey conducted at the host centre in gynecologic oncology outpatient clinics found that while 79% of respondents recognized that the 2SLGBTQIA+ population has unique risks and needs, only 44% felt knowledgeable about caring for 2SLGBTQIA+ patients and 27% about caring for transgender patients [20]. Furthermore, 39% reported routinely asking about sexual orientation and 35% about gender identity, while 33% acknowledged assuming patients were heterosexual [20]. At the time of this survey, no educational resources specific to SGDc patients were available at the centre. Together with the narrative review conducted in Step 1, these findings established the local need that the curriculum was designed to address.

Curriculum Goals and Learning Objectives (Kern's Step 3)

Step 3 produced a set of learning objectives for each of the four content pillars, specifying pronoun use for gender affirmation, the spectrums of sexual orientation and gender identity, and diverse relationship structures (Table 2). These objectives governed both the selection of educational strategies in Step 4 and the content of the two curriculum components.

Pillar	Key Learning Objectives
Pronouns	• Explain the importance of pronouns to gender identity • Understand the effects of misgendering • Acquire strategies for inclusive language in clinical settings
Sexual Orientation	• Understand that sexual orientations are a spectrum • Understand the importance of avoiding assumptions in patient interactions • Apply communication skills for inclusive patient encounters
Gender Identity	• Increase understanding of gender identity diversity • Understand implications for cancer care (e.g., transitions, screening) • Demonstrate use of non-binary inclusive language in clinical documentation and patient communication
Relationship Diversity	• Identify forms of relationship diversity (e.g., non-monogamy, chosen family) • Demonstrate inclusive assessment of support networks • Apply strategies to eliminate relational stigma in clinical encounters

Table 2 Learning objectives for the SGDc e-learning curriculum pillars.

Curriculum Components (Kern's Steps 4 and 5)

The curriculum development process produced a virtual SGDc education program with two components: a centralized Knowledge Hub and a gamified, simulation-based set of virtual patient encounters. The Hub comprises a landing page and four pillar pages on pronouns, sexual orientation, gender identity, and relationship diversity, integrating key concepts, clinical applications, and curated resources. The experiential component features four virtual patients, two chosen family members, and multiple HCPs across the four pillars, allowing learners to explore how similar conversations unfold differently depending on a patient's identity. For each patient and topic pairing, learners progress through four sequential interactions, each offering multiple response options that elicit distinct patient reactions (Figure 2B). This structure yields 16 unique scenarios and approximately 256 scenes delivered through a web-based platform.

Each virtual patient pairs a specific cancer diagnosis and point in the cancer trajectory with a configuration of identity, relationship structure, and prior experience of health care, so that the communication task the learner practises is inseparable from its oncological context (Table 3) [46]. Chetan, a 40-year-old non-binary patient who uses ze/zir pronouns and is in a polyamorous relationship, has recently been diagnosed with the same breast cancer from which zir mother died after a late diagnosis, and checks in for a procedure at a nursing station where an emergency contact must be recorded without presuming a spouse. Max, a 57-year-old trans man whose legal name remains Mia, is undergoing treatment for ovarian cancer, a diagnosis that requires providers to discuss a sex-specific organ while addressing him correctly, and arrives for a procedure with his common-law partner. Lexy, a 24-year-old queer, bisexual woman receiving treatment for acute myeloid leukemia, attends a routine appointment at which sexual orientation must be asked for a new patient information system, in the presence of a mother who attends every appointment and does not accept her identity. Ross, a 75-year-old out cis gay man with prostate cancer who lived through the peak of the AIDS epidemic and is supported by chosen family rather than by next of kin, is admitted for a procedure and seeks a provider who can answer questions about his identity alongside questions about his cancer.

Virtual patient	Cancer context	Identity and relationship context	Clinical moment enacted in the scenario	Pillar
Chetan, 40	Breast cancer, recently diagnosed; mother died of the same cancer after a late diagnosis	Non-binary, ze/zir pronouns, assigned female at birth; first-generation Canadian, parents from India; polyamorous relationship with two partners	Check-in at a nursing station before a procedure, where an emergency contact must be recorded without presuming a spouse	Relationship diversity
Lexy, 24	Acute myeloid leukemia, on treatment as a young adult	Queer, bisexual woman, she/her pronouns; Canadian-born, Filipino and Korean family; monogamous relationship; mother attends appointments and does not accept her identity	Routine appointment at which sexual orientation is asked for a new patient information system while her mother is present	Sexual orientation
Max, 57	Ovarian cancer, on treatment	Trans man, he/him pronouns, legal name unchanged; migrated from Jamaica; repeated experience of misgendering and intrusive questions in health care; common-law relationship	Check-in before a procedure at which he is addressed by his legal name and an assumption is made about his partner	Gender identity
Ross, 75	Prostate cancer, admitted for a procedure	Out cis gay man, he/him pronouns; single and sexually active; lives alone with substantial support from chosen family; lived through the peak of the AIDS epidemic	Admission to an inpatient unit, where the learner must ask how he wishes to be addressed rather than infer pronouns from his name	Pronouns

Table 3 Cancer-specific design of the four virtual patients, showing how each diagnosis and point in the cancer trajectory is paired with an identity and relationship context and with the clinical moment the learner practises.

These scenarios are where the recovery mechanic of the curriculum operates. In the gender identity scenario, for example, the opening exchange addresses Max by his legal name and makes an assumption about the partner accompanying him. Learners who select such a response see the resulting patient reaction and are then offered further dialogue options, including options that acknowledge the error, correct the record, and return to the clinical task without centring the provider's discomfort. The scenarios were therefore designed to give learners practice in repairing an exchange after a genuine misstep rather than only in identifying the correct phrase at the outset.

Piloting and stakeholder review produced iterative revisions to the virtual patient scenarios, the interface design, and the Knowledge Hub resources prior to launch. The completed program was integrated into

the host organization's learning portal on May 17, 2024, and was concurrently made freely available on a public server for international use. The virtual patient scenarios were released in both English and French, while Knowledge Hub content remained available in English only.

Early Implementation Outcomes (Kern's Step 6)

Reach of the SGDc e-Learning Program

During the initial implementation period, the SGDc e-learning program was accessed by 2,217 active users from 34 countries, with an overall engagement rate of 48%. Uptake was highest in Canada (62%, n = 1,366), followed by the United States (24%, n = 537), the United Kingdom (6%, n = 124), Germany (1%, n = 25), and China (1%, n = 22). Most learners accessed the program using an English browser (96.2%, n = 2,122), with a smaller proportion in French (1.9%, n = 42).

Adoption of and Implementation Patterns Across Curriculum Components

A total of 798 learner avatars were created during the observation period. Adoption also occurred at the institutional level, through integration of the program into our organization's learning portal in collaboration with the Cancer Education program. Of the avatars created, 554 virtual patient scenarios were completed (69.4%).

Across this period, the platform accumulated 5,800 page views. These counts are not directly comparable across components, because the virtual patient encounters comprise 16 scenarios delivered through approximately 256 scenes, whereas the Knowledge Hub comprises four pillar pages and a landing page. With this asymmetry in mind, views were distributed across the home page (n = 3,403, 58.7%), the game module (n = 1,292, 22.3%), the About Us page (n = 646, 11.1%), and the Knowledge Hub (n = 418, 7.2%). Within the Knowledge Hub, 212 views (50.7% of Hub views) reached one of the four pillar sections, distributed across pronouns (n = 100), gender identity (n = 49), relationship diversity (n = 33), and sexual orientation (n = 30), while the remaining 206 views (49.3%) did not progress beyond the Hub landing page. Learners spent an average of 1 minute and 45 seconds per active session. The program was accessed primarily using desktop devices (n = 1,799, 81.5%), with additional access via mobile phones (n = 410, 18.6%), tablets (n = 7, 0.3%) and smart TVs (n = 1, 0.05%).

Discussion

This study describes the development and early implementation of a novel, gamified e-learning program designed to support SGDc-affirming communication among oncology HCPs. Assessed against the reach, adoption, and implementation dimensions of RE-AIM, the program achieved national and international reach, was adopted both by individual learners and by the host institution through its learning portal, and was implemented with markedly different patterns of use across its interactive and foundational components. By integrating a centralized Knowledge Hub with simulation-based virtual patient encounters delivered bilingually, the program addresses persistent gaps in SGDc education and

mitigates language barriers in the Canadian healthcare context. These findings indicate that a freely accessible, simulation-based approach can be delivered and taken up at scale across diverse healthcare settings, while its educational effectiveness remains to be established.

Considered as a reach outcome, the extent of international uptake was unanticipated. Although most users were located in Canada (n = 1,366, 61.9%), a substantial number accessed the program from outside Canada (n = 840, 38.1%), across Europe, Asia, Oceania, and the Middle East. The Canadian share likely reflects integration of the program into our organization's learning portal, and the international share its availability on a freely accessible public server. The predominance of English-language users may also reflect the Knowledge Hub not yet being fully translated into French, which limited dissemination and uptake within Quebec-based health care organizations during the initial implementation period.

Considered as an implementation outcome, the program was accessed predominantly on desktop devices, with more limited use on mobile phones and other platforms, a distribution consistent with engagement in workplace or other structured learning environments. Digital educational interventions should nonetheless remain accessible and usable across devices.

Engagement with the Knowledge Hub was lower than anticipated, although the magnitude of that difference should be read with care. Because the virtual patient encounters comprise approximately 256 scenes while the Knowledge Hub comprises five pages in total, the two components cannot generate comparable numbers of page views, and the Hub's 7.2% share of total views therefore overstates the difference in learner interest. Two features of the data are more informative. First, approximately half of all Hub visits (n = 206, 49.3%) did not progress beyond the landing page, which points to navigation and discoverability as the constraint, not to disinterest in foundational content. Second, engagement within the Hub was uneven across topic areas, with pronouns attracting the most views (n = 100); because pronouns was also the first section presented, this ranking cannot be interpreted as topic-level interest. Set against 798 avatars created and 554 scenario completions (69.4%), the overall pattern is consistent with learners entering the program through its experiential components, as has been reported in gamified learning environments more generally [31, 38]. A mean active session duration of 1 minute and 45 seconds sets a boundary on how all of these engagement figures should be read, including those for the virtual patient encounters, since brief sessions are compatible with exploratory rather than sustained use. Read as an implementation outcome and not as a judgement of the educational value of foundational content, this finding identifies the routing of learners into the Knowledge Hub as the most defensible priority for subsequent refinement. Potential refinements include increasing the Knowledge Hub's visibility within the program, incorporating prompts directing learners to relevant foundational content following virtual patient encounters, and completing its French translation to improve accessibility.

The program was designed as an environment in which HCPs can explore, practice, and refine their inclusive communication skills without clinical consequence, although whether learners experienced it in

this way was not assessed in the present evaluation. By allowing learners to 'get it wrong in the right way', the virtual scenarios are constructed to surface common missteps and uncertainties that clinicians may hesitate to voice in real clinical encounters, and to provide immediate, nonjudgmental feedback intended to support corrective learning [38]. The playful, game-based format was designed to reduce anxiety about making mistakes and was intended to encourage curiosity and experimentation instead of fear of causing harm, and may therefore be particularly valuable for providers who are concerned about getting it wrong when discussing sexual orientation, gender identity, pronouns, or relationship structures with SGDc patients [19, 20].

Prior institutional data at our centre, consistent with the broader literature, suggest that awareness of SGDc patients' unique needs does not consistently translate into routine inclusive practices, such as asking about sexual orientation and gender identity [20]. While these gaps are often framed in terms of knowledge, comfort, confidence, or communication, they may also reflect implicit biases and normative assumptions, such as heteronormativity and cisnormativity, that shape clinical encounters, often unintentionally [1]. From a queer theoretical perspective, communication is not simply a neutral clinical skill, but also a means through which cisnormative and heteronormative assumptions may be reproduced or challenged in everyday healthcare interactions. Pairing a knowledge component that addresses assumptions embedded in language, documentation, and clinical routines with experiential learning through simulation was intended to address both of these, and not knowledge acquisition alone. These dynamics are particularly salient in oncology, where cancer care systems are frequently structured around binary and gendered assumptions that can create additional barriers for transgender and gender-diverse patients [39].

Improving HCPs' communication with SGDc patients carries direct benefits for patient care. Inclusive, affirming communication helps patients feel safe, seen, and heard, which can reduce anticipatory fear of discrimination and strengthen trust in both individual HCPs and the healthcare system more broadly [1, 39]. That trust is especially consequential in oncology, where it may encourage SGDc patients to seek care earlier, participate in screening, and remain engaged throughout diagnosis and treatment, which matters given documented delays in cancer detection and disparities in outcomes in SGDc communities [5]. However, communication training alone cannot address the broader structural and institutional factors contributing to these inequities. Such training should therefore be considered one component of a more comprehensive approach to improving equity in cancer care.

The current version introduces key SGDc patient experiences and provides practice with four distinct virtual patients, but it cannot address the full scope of issues relevant to SGDc care, and four avatars cannot capture the diversity of identities within the 2SLGBTQIA+ community. Subsequent iterations will incorporate additional, more complex content areas, including intersectionality theory and minority stress theory, to deepen learners' understanding of the structural and psychosocial factors shaping patient experiences [40]. Establishing the program's effectiveness, its influence on HCP behaviour, and its bearing on patient experience will require evaluation beyond platform analytics: the Kirkpatrick Model of training evaluation will be used to assess learner satisfaction, knowledge acquisition, behavioural

change, and perceived impact on patient care [41]. The General Self-Efficacy Scale [42], grounded in Bandura's self-efficacy theory, will measure changes in learners' confidence in using inclusive communication practices following program completion [27]. This planned evaluation is contingent on further development funding, which is currently being sought.

Limitations

Several limitations warrant consideration. This evaluation addressed only three of the five RE-AIM dimensions. Effectiveness was not assessed, as no learner-level data on knowledge acquisition, attitudinal change, clinical practice, or patient experience were collected, and the observation window was too short to characterize maintenance. Platform analytics captured quantitative usage data only, limiting insight into qualitative learning processes such as reflective engagement or the application of skills in real-world care. Future evaluation efforts will be required to assess educational effectiveness, user satisfaction, and whether participation contributes to changes in provider communication or clinical practice.

Additionally, iterative refinements were informed by a small pilot sample (n = 4 HCPs; n = 3 patient partners), which may not fully capture the range of learner needs and perspectives. Future evaluations engaging larger and more diverse groups of learners and patient partners will be important for subsequent iterations of the program. Community partners were engaged in goal setting, content design, and piloting, but not in the design of the targeted needs assessment or of the analytics-based evaluation, which limits the extent to which community priorities shaped what was measured. Patient partners also contributed without financial compensation, which constrains the equity of our engagement model and is a practice we would change in future work.

Lastly, reliance on Google Analytics introduced several measurement limitations. Analytics data are session- and event-based and do not reliably distinguish unique learners, limiting the ability to determine how many individuals completed specific activities or the extent of repeated engagement by the same user. Page-view counts are also a function of how many pages each component contains, so shares of total page views cannot be compared directly across components of differing size. Average session duration is similarly session-based and does not distinguish a brief, purposeful visit from an abandoned one. Completion of learning activities was operationalized using page views of completion screens, which serve as proxy measures and do not confirm depth of engagement, comprehension, or learning outcomes. Furthermore, platform analytics do not capture offline learning, reflective processes, or subsequent application of skills in clinical settings.

Conclusions

We developed a gamified SGDc e-learning program for oncology HCPs that achieved national and international reach, adoption by individual learners and by the host institution, and engagement concentrated in its interactive content. The program provides an accessible platform designed to allow

HCPs to practice SGDc-affirming communication in a risk-free environment. Its educational effectiveness has not yet been established. Future research will assess user satisfaction, learning outcomes, patient experience, and impacts on clinical practice, which will inform subsequent program refinements. Our goal is to strengthen SGDc education for HCPs and, in turn, improve the care that SGDc patients receive.

Abbreviations

2SLGBTQIA+: Two-Spirit, lesbian, gay, bisexual, transgender, queer, questioning, intersex, asexual, and additional sexual and gender diverse identities

AI: Artificial intelligence

HCP: Health care provider

RE-AIM: Reach, Effectiveness, Adoption, Implementation, Maintenance

SGDc: Sexual and gender diversity in cancer care

SQUIRE-EDU: Standards for Quality Improvement Reporting Excellence in Education

Declarations

Ethics approval and consent to participate

This project, including the eLearning evaluation reported here, was reviewed by the University Health Network (UHN) Quality Improvement Review Committee (QIRC), Toronto, Ontario, Canada (QI ID 21-0275). On September 2, 2021, the QIRC determined that the project was quality improvement and fell outside the scope of research requiring Research Ethics Board review. A Chair of the UHN Research Ethics Board reviewed and confirmed this determination, and the project received a formal exemption from UHN Research Ethics Board review. The UHN QIRC also reviewed and approved the project's ethical, privacy, and consent procedures, including the study protocol, consent forms, and data collection instruments. Written informed consent was obtained from all directly involved participants before participation, using the consent forms approved by the QIRC. Informed consent was not required for the retrospective analysis of routinely collected, anonymous website usage data, as no identifiable information was collected and no participants were actively recruited for this component of the evaluation, consistent with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2, 2022) [47]. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

B.L. has received support from the Quality Improvement Physicians Grant, University Health Network.

G.K. S. has nothing to declare.

M.K. has nothing to declare.

M.-A. A.-G. has nothing to declare.

S.S. has nothing to declare.

Y.C. has nothing to declare.

J.N. has nothing to declare.

J.C. has nothing to declare.

C.S.-Q. has received education scholarship support from Academic Scholars Award, Department of Psychiatry, University of Toronto, and Young Leaders Program and Cancer Experience Program, Princess Margaret Cancer Center, University Health Network and the Quality Improvement Physicians Grant, University Health Network. He is on the board of directors for the Canadian Academy for Consultation and Liaison Psychiatry. He is the Provincial Quality Lead Psychiatry – Psychosocial Oncology at Ontario Health, Ontario, Canada.

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Authors' contributions

Conceptualization, B.L., G.K.S., M.K., M.-A.A.-G., S.S., Y.C., J.C., and C.S.-Q.; Methodology, B.L., G. K.S., and C.S.-Q.; Software, B.L., Y.C., and C.S.-Q.; Validation, B.L., M.K., and C.S.-Q.; Formal Analysis, B.L., M.K., J.N., and C.S.-Q.; Investigation, B.L., M.K., J.N., and C.S.-Q.; Resources, C.S.-Q.; Data Curation, B.L., Y.C., and J.N.; Writing – Original Draft Preparation, B.L., G.K.S., & C.S.-Q.; Writing – Review & Editing, B.L., G.K.S., M.K., M.-A.A.-G, S.S., Y.C., J.N., J.C., and C.S.-Q.; Visualization, B.L., and Y.C.; Supervision, C.S.-Q.; Project Administration, B.L. and M.K.; Funding Acquisition, G.K.S., M.K., S.S., J.C., and C.S.-Q. All intellectual content and critical analysis within this manuscript were developed solely by the authors. The

authors assume full responsibility for the final content and any errors. All authors have read and approved the final manuscript.

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Figures



Figure 1

Mapping of Kern's six-step framework onto project activities and reporting sections. The RE-AIM dimensions assessed and not assessed at Step 6 are shown in the nested panel. The refinement loop indicates that early implementation findings informed refinement priorities for educational strategies and implementation.

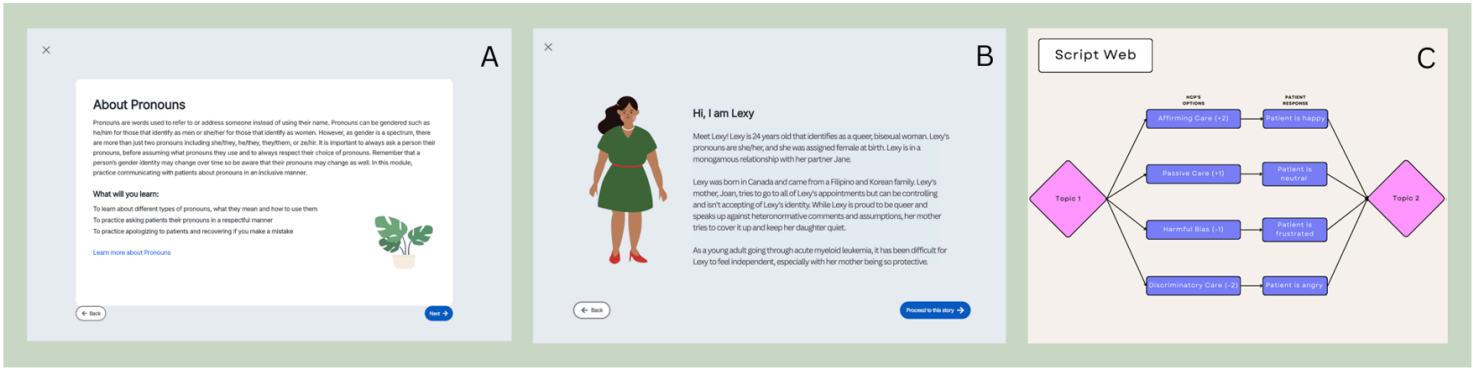


Figure 2

Key components of the virtual patient simulation. (A) Example of learning objectives and key concepts presented at the outset of a virtual patient interaction to orient learners to the core pillar and communication goals. (B) Representative virtual patient profile illustrating the integration of personal, social, and clinical characteristics designed to reflect intersecting identities and diverse lived experiences within the SGDc community. (C) Script web architecture of the branching dialogue used in the virtual patient simulation, in which learners select communication responses ranging from affirming to discriminatory, generating dynamic patient reactions and immediate feedback to reinforce inclusive practices and identify areas for improvement.

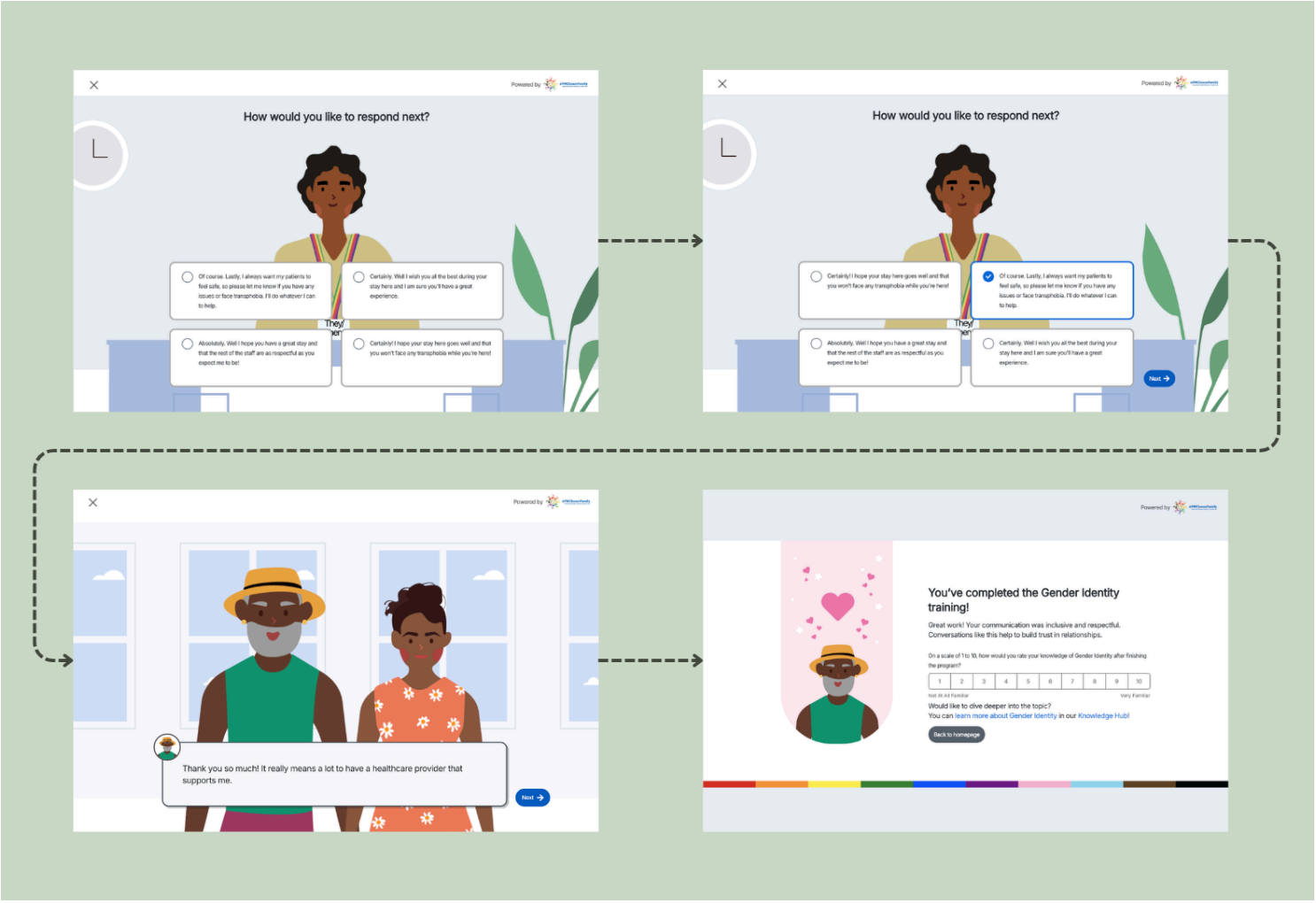


Figure 3

Visual interface of a virtual patient scenario. Sequential panels illustrate character design, dialogue presentation, and real-time feedback following learner responses.