

A Serious Game Series for Learning NICU Care

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Abstract: Opportunities for medical and nursing students to experience neonatal intensive care unit (NICU) environments are limited by patient safety concerns and the complexity of neonatal care. Narrative-based serious games offer a route to vicarious clinical experience, yet the reasons why narrative should support learning in this particular setting are rarely made explicit, and educational content covering the transition from hospital to home remains scarce. This paper reports a two-phase, learner-driven design study conducted in Japan. In Phase 1 we developed and released “First Steps in the NICU: Discovery Edition” (First NICU), a six-chapter narrative visual novel; its development and its acceptance among the first 160 players have been reported previously. Here we present a previously unreported needs analysis drawn from the same voluntary post-game survey, now extended to 180 respondents (82 healthcare professionals or students, 98 members of the general public). Asked which topics future serious games should address, 105 of 180 respondents (58.3%) selected home support for children with medical complexity and 87 of 180 (48.3%) selected discharge support from the NICU, with school attendance for such children selected by 88 of 180 (48.9%); 144 of 180 (80.0%) selected discharge or home support, or both. Asked which scenes were most memorable, 82 of 180 (45.6%) named the brief discharge-support episode set in the general care unit, although it is one chapter of six and contains no acute clinical event. These learner-identified priorities directly informed Phase 2, the ongoing development of “First Steps in the NICU 2: Discharge Support Edition”, which simulates multidisciplinary discharge planning, parent education for home medical care and coordination with community services, and which introduces interactive mini-games for procedural tasks. We set out how each Phase 2 design decision was derived from Phase 1 findings and from narrative learning theory, and discuss what this sequence suggests for designing narrative serious games that span a care continuum. Because no objective assessment of learning was undertaken, the evidence reported here concerns acceptance and learner-expressed priorities rather than educational effectiveness.

Keywords: Serious games, Medical education, Neonatal intensive care unit, Discharge support, Narrative learning, Learner-driven design

1. Introduction

Neonatal intensive care units (NICUs) provide highly specialised care for premature and critically ill newborns. Opportunities for medical and nursing students to experience NICU environments nevertheless remain limited, primarily because of patient safety concerns, the complexity of neonatal care and the vulnerability of the patients, all of which restrict hands-on learning. In Japan, where this project was undertaken, undergraduate neonatal placements are typically brief and observational, and the COVID-19 pandemic further reduced access to clinical training (Rose, 2020), underlining the need for alternative educational approaches.

Serious games have emerged as promising tools in medical education (Gentry et al, 2019; Gorbanev et al, 2018; Graafland, Schraagen and Schijven, 2012), offering interactive and experiential learning in a safe environment. Previous studies indicate that serious games can enhance learner engagement, improve knowledge acquisition and support the development of clinical reasoning (Boeker et al, 2013; Maheu-Cadotte et al, 2021). In neonatal care, most existing serious games address specific technical skills such as resuscitation (Sawyer, Umoren and Gray, 2017); fewer attempts have been made to simulate the broader NICU experience, including communication, decision-making and family-centred care.

What is at stake in NICU education, however, is not primarily procedural. Learners must interpret an unfamiliar and emotionally charged environment, and recognise the perspectives of parents and of other professions. Narrative is well suited to this task, and this is why we adopted it. Storyline is among the most frequently embedded design elements in serious games for the health professions, appearing in 53% of published games

(Aster et al, 2024), yet that same review found that only four of 91 studies grounded their choice of design elements in any theory at all. Storyline was theoretically grounded in only two of those studies, which between them cited three theories: narrative engagement, analogical reasoning and a model of instructional design. Narrative engagement holds that an integrated storyline promotes decision-making competences that transfer to related situations. Aster et al further observe that narrative elements are assumed to foster empathy by allowing identification with the storyline or with game characters, and identify whether this holds in medical education as an open question. Naul and Liu (2020) reach a compatible conclusion from the wider serious-games literature: narrative supports learning when it is intrinsically integrated with the content rather than decorative, and when characters invite identification. Narrative can also supply the concrete experience and reflective observation stages of Kolb's (1984) experiential learning cycle for settings that a learner cannot enter directly.

These positions correspond to three design commitments that have governed the project from the outset: that clinical content be delivered through the story rather than alongside it; that the learner occupy an observer role mirroring the legitimate position of a student in a real NICU; and that family and interprofessional perspectives be voiced by characters rather than described in exposition. Stating them explicitly here allows our first game to be read against them. In "First Steps in the NICU: Discovery Edition" (hereafter First NICU), the player, a high-school student visiting a hospital, explores the NICU, interacts with healthcare professionals and encounters neonatal care, communication and family-centred support through branching dialogue and decision-making. The development process and an evaluation of the game's acceptance among the first 160 players have been reported previously (Miyosawa et al, 2025). That evaluation found high perceived educational value but, being based on a voluntary post-game survey without pre- and post-testing, could not establish learning gains. The present paper does not repeat those findings.

Two questions were left open. First, education on the transition from hospital to home following NICU care remains scarce. Discharge planning for infants who have received intensive neonatal care requires multidisciplinary collaboration and preparation for home-based medical care, yet this process is difficult for learners to observe directly. Second, and more practically, we did not know which part of the neonatal care continuum learners themselves wanted to encounter next.

This paper therefore reports a two-phase design study. We first present a previously unreported needs analysis from the Phase 1 survey, now extended to 180 respondents, and then describe how its findings shaped Phase 2, the ongoing development of "First Steps in the NICU 2: Discharge Support Edition" (hereafter First NICU 2). Our aim is not to demonstrate educational effectiveness, since no objective assessment of learning has yet been undertaken, but to make explicit how learner-identified priorities and narrative design principles together determined the design of a serious game series spanning intensive care and discharge support.

2. Methods

2.1 Study Design

The project followed a two-phase, iterative design approach in which evaluation of one artefact informs the design of the next. Phase 1 comprised the development, release and evaluation of First NICU, together with a needs analysis of what players wished to learn subsequently. Phase 2 comprises the design and ongoing development of First NICU 2. Phase 1 is complete and partly published; Phase 2 is work in progress, and no evaluation data are yet available for it. This distinction is maintained throughout the paper. All work was conducted in Japan.

2.2 Phase 1: Development of First NICU

First NICU was developed over approximately 14 months by a multidisciplinary team comprising a neonatologist, medical students and an art student. It was built initially in TyranoBuilder and later rebuilt in Unity with the Naninovel engine to support multilingual release; the multilingual version was released in November 2024. The game is a six-chapter narrative visual novel in which the player assumes the role of a visiting student and progresses through branching dialogue and scenario-based decisions (Figure 1). It is distributed free of charge on iOS, Android and Steam. Full development details are reported elsewhere (Miyosawa et al, 2025).



Figure 1: Overview of the neonatal intensive care unit simulation game stages. Adapted from Miyosawa et al (2025), available under a CC BY 4.0 licence; panel captions abridged

- (A) High school scene: the player prepares for a NICU visit.
- (B) NICU exploration: the player learns about equipment, care, and clinical environments.
- (C) Lunch with staff: informal interaction with healthcare professionals.
- (D) Emergency scenario: simulation of neonatal resuscitation and acute care.
- (E) General care unit: introduction to discharge planning and family support.
- (F) Report compilation: reflection on the NICU experience.

2.3 Phase 1: Data Collection

On completing the game, players were invited to take an optional web-based survey. The survey collected demographic information and ratings of gameplay and educational value on five-point Likert scales. Those rating items and their results have been published (Miyosawa et al, 2025) and are not reproduced here. Two multiple-response items were not analysed in that report and constitute the new data presented in this paper: which scenes players found most memorable, and which topics they wished future serious games to address. Responses submitted between July 2022 and April 2026 were included, giving 180 respondents; the previously published analysis covered the first 160 responses, collected up to November 2024. Download counts were obtained from platform analytics.

2.4 Analysis

Multiple-response items were tabulated as counts and percentages of all respondents, and are reported separately for healthcare professionals and students and for members of the general public. Because these

items were exploratory and the comparison was not pre-specified, no significance testing was performed and the percentages should be read descriptively. Because respondents could select any number of options, percentages sum to more than 100; the mean number of topics selected per respondent was 3.5 of 8 (median 3), and 22 of 180 respondents selected all eight. Rankings should therefore be read relative to one another rather than as absolute levels of demand. Tabulation was performed in Python 3 using the pandas library.

2.5 Phase 2: Design and Development of First NICU 2

First NICU 2 focuses on discharge planning and the transition from hospital to home following neonatal intensive care. Its scope and its principal design decisions were derived from the Phase 1 findings reported in Section 3, and are set against those findings in Table 4. The sequel retains the narrative structure and the observer stance of the original (Figure 2); its content is described in Section 3.6. Development is ongoing, and the design described here has not yet been evaluated with learners.



Figure 2: Overview of the sequel game “First NICU 2: Discharge Support Edition”

The sequel is structured as a six-chapter narrative-based serious game focusing on discharge support and the transition from hospital to home.

- (A) Chapter 1: Family-centred ward rounds.
- (B) Chapter 2: Neonatal transport.
- (C) Chapter 3: Multidisciplinary conference.
- (D) Chapter 4: Acute phase management in the NICU.

(E) Chapter 5: Exploration of discharge support services.

(F) Chapter 6: Pre-discharge community support conference.

3. Results

3.1 Reach of First NICU

As of March 2026 First NICU had been downloaded 3,328 times (2,560 on iOS, 612 on Android and 156 on Steam). Restricting the comparison to the two platforms covered by the earlier report, iOS and Android downloads rose from 2,799 in May 2025 (Miyosawa et al, 2025) to 3,172 in March 2026. Following release of the multilingual version in November 2024, survey responses submitted in English were received for the first time.

3.2 Respondent Characteristics

Responses were received from 180 participants (Table 1). Healthcare professionals and students in medicine or nursing accounted for 82 of 180 (45.6%) and members of the general public for 98 of 180 (54.4%). The largest age group was 20–29 years (68/180, 37.8%), and 123 of 180 respondents (68.3%) identified as female. Most participants completed the game in under one hour (113/180, 62.8%).

Table 1: Respondent characteristics (N=180). Demographic data for the first 160 respondents were reported in Miyosawa et al (2025); 20 respondents are newly included here

Characteristic	n (%)
Profession	
Pediatricians	13 (7.2)
Physicians other than pediatricians	3 (1.7)
Non-physician healthcare professionals	31 (17.2)
Medical students	21 (11.7)
Nursing students	14 (7.8)
Non-healthcare working adults	51 (28.3)
Non-healthcare university students	7 (3.9)
Elementary, junior high and high school students	26 (14.4)
Other	14 (7.8)
Age group (years)	
10–19	29 (16.1)
20–29	68 (37.8)
30–39	42 (23.3)
40–49	29 (16.1)
50–59	10 (5.6)
60 or above	2 (1.1)
Gender	
Female	123 (68.3)
Male	57 (31.7)
Time to completion	
Under 1 hour	113 (62.8)
1–2 hours	58 (32.2)
2–4 hours	3 (1.7)
Over 4 hours	6 (3.3)

3.3 Scenes Recalled as Most Memorable

Players were asked which scenes had left the strongest impression, selecting as many as applied (Table 2). Instructional scenes predominated: learning how to care for the baby was named by 120 of 180 respondents (66.7%), NICU exploration and the baby's admission by 101 each (56.1%). Of note for the present argument, the discharge-support episode set in the general care unit (Figure 1(E)) was named by 82 of 180 (45.6%), even though it is one chapter of six and contains no acute clinical event. The comparison of interest is with the emergency and resuscitation sequence shown in Figure 1(D), which corresponds to the item "the baby's admission" (101/180, 56.1%). The discharge scene was also recalled more than twice as often as the informal lunch scene (39/180, 21.7%) or the closing report-writing sequence (32/180, 17.8%).

Table 2: Scenes recalled as most memorable (N=180, multiple responses permitted)

Scene	n (%)
Learning how to care for the baby	120 (66.7)
NICU exploration	101 (56.1)
The baby's admission	101 (56.1)
Discharge support in the general care unit	82 (45.6)
Chatting over lunch with staff	39 (21.7)
Report writing and ending	32 (17.8)
From high school to NICU admission	14 (7.8)

3.4 Topics Learners Wished to Encounter Next

Players were also asked which topics in perinatal care and care of children with medical complexity they would like future serious games to address (Table 3). Home support for children with medical complexity was selected most often (105/180, 58.3%), followed by school attendance for such children (88/180, 48.9%) and discharge support from the NICU (87/180, 48.3%). Taken together, 144 of 180 respondents (80.0%) selected discharge support from the NICU, home support, or both.

Home support ranked first in both respondent groups and discharge support was selected by similar proportions of each. Among healthcare professionals and students (n=82), home support was selected by 57 (69.5%) and discharge support by 40 (48.8%); among members of the general public (n=98) the corresponding figures were 48 (49.0%) and 47 (48.0%). The groups diverged only in rank order: child development and after-school services ranked fourth among the general public (42/98, 42.9%) and last among healthcare respondents (32/82, 39.0%), although the underlying proportions were close. Interest in the post-NICU trajectory was therefore not confined to clinically trained respondents. These proportions are descriptive and were not tested statistically.

Table 3: Topics requested for future serious games (N=180, multiple responses permitted)

Topic	All (N=180)	Healthcare (n=82)	General public (n=98)
Home support for children with medical complexity	105 (58.3)	57 (69.5)	48 (49.0)
School attendance for children with medical complexity	88 (48.9)	43 (52.4)	45 (45.9)
Discharge support from the NICU	87 (48.3)	40 (48.8)	47 (48.0)
Infant care institutions	81 (45.0)	43 (52.4)	38 (38.8)
Child development support and after-school services	74 (41.1)	32 (39.0)	42 (42.9)
Disaster preparedness for children with medical complexity	69 (38.3)	37 (45.1)	32 (32.7)
Use of administrative services	67 (37.2)	36 (43.9)	31 (31.6)

Topic	All (N=180)	Healthcare (n=82)	General public (n=98)
Employment support for children with medical complexity	66 (36.7)	35 (42.7)	31 (31.6)

3.5 From Phase 1 Findings to Phase 2 Design

Table 4 sets out how each principal design decision in First NICU 2 was derived, either from the Phase 1 findings above or from the narrative design commitments stated in Section 1. The purpose of presenting the derivation explicitly is to make the design rationale inspectable rather than asserted.

Table 4: Derivation of Phase 2 design decisions

Design decision in First NICU 2	Derived from
Subject matter: discharge planning and transition to home	Requested by 80.0% of respondents (Section 3.4); discharge scene recalled by 45.6% (Table 2)
Retention of the observer protagonist and branching dialogue	Design commitment: learner occupies the legitimate position of a student (Section 1)
Parents and community providers as speaking characters	Design commitment: perspectives voiced rather than described; narrative identification (Naul and Liu, 2020)
Multidisciplinary conference chapters	Discharge planning requires interprofessional coordination that learners cannot observe directly
Interactive mini-games for procedural tasks	Adds active experimentation to the narrative, completing the experiential cycle (Kolb, 1984)
Community services chapter beyond the hospital	School attendance and home support ranked highly alongside discharge (Table 3)
Retention of two acute-care chapters (transport, acute management)	Continuity with Phase 1: the discharge trajectory begins during intensive care

3.6 Resulting Design of First NICU 2

The sequel is structured, like the original, as a six-chapter narrative. Two chapters (neonatal transport and acute phase management) remain in the intensive-care setting, from which the discharge trajectory begins. In the others, players encounter multidisciplinary discharge planning meetings, parent education for home medical care, coordination with community healthcare services and simulation of home care environments. In addition to the narrative structure carried over from the original, the sequel incorporates interactive mini-games covering procedural tasks encountered across the care pathway, from acute respiratory management in the unit to the enteral feeding that parents themselves must carry out at home (Figure 3). These are integrated into the storyline at points where the narrative calls for them, rather than appended as separate exercises.



Figure 3: Examples of mini-game components in “First NICU 2: Discharge Support Edition”

- (A) Respiratory circuit assembly (drag-and-drop).
- (B) Enteral feeding simulation (control of infusion speed and volume).
- (C-1) Continuous positive airway pressure (CPAP) support.
- (C-2) Endotracheal intubation.

4. Discussion

4.1 Principal Findings

Players of a narrative serious game about the NICU told us, in substantial numbers, that what they wanted to learn next lay beyond the unit: 80.0% asked for discharge support, home support, or both. The pattern was corroborated by a separate item in the same survey: the game’s brief discharge-support episode was recalled as memorable by 45.6% of respondents despite its small position as one chapter of six and its lack of dramatic incident. Read together, these two findings identify the hospital-to-home transition as the point where learner interest was most concentrated, and they supplied the warrant for developing First NICU 2 rather than, for example, a game about acute neonatal management.

4.2 Implications for Narrative Game Design in Healthcare Education

Three observations may transfer beyond this application. First, the salience of a low-drama discharge scene suggests that narrative weight in clinical serious games need not follow clinical acuity. Designers commonly allocate their strongest narrative resources to resuscitation and emergency scenarios; our data suggest that scenes concerning continuity, family and transition may be recalled comparably well. We did not measure why they were recalled, and can only note that the pattern would be consistent with the assumption, flagged by Aster et al (2024) as untested in medical education, that narrative elements foster empathy through identification with the storyline or its characters.

Second, a completed serious game can function as an instrument for identifying the next educational target. Because players have already been immersed in the domain, they are better placed than an unexposed sample to say what is missing. Embedding a forward-looking needs item in a post-game survey is inexpensive and, in our case, produced a ranking that the development team had not anticipated.

Third, designing across a care continuum rather than around a single episode requires the observer stance and the character set to persist between titles, so that learners carry forward an established point of view. We retained both deliberately; whether this improves learning, as opposed to coherence, remains to be tested.

4.3 What the Present Evidence Does and Does not Support

The evidence reported here concerns acceptance and expressed preference. It does not demonstrate that either game improves knowledge, skills or behaviour. No objective assessment of learning was conducted at any point in the project; the previously published Phase 1 evaluation likewise relied on self-report without pre- and post-testing (Miyosawa et al, 2025). Statements elsewhere in the serious-games literature about enhanced learning should not be read into our findings, and we have deliberately avoided that formulation.

Several further limitations apply. Participation in the survey was voluntary and self-selected, so respondents were probably more favourably disposed than the general population of players, and those who abandoned the game are unrepresented. The survey instrument was not formally validated. The needs item offered a fixed list of topics that we ourselves compiled, which will have constrained the answers; the free-text option attracted few additional suggestions, but this does not establish that the list was exhaustive. Respondents were overwhelmingly Japanese, and priorities regarding home medical care are shaped by national health and welfare systems, so the ranking should not be generalised across jurisdictions. Finally, First NICU 2 is incomplete, and a design derived from stated preferences is not thereby shown to be educationally effective.

4.4 Future Directions

The immediate priority is completion of First NICU 2, followed by an evaluation capable of detecting learning rather than approval: a pre- and post-test design with an objective knowledge measure, and, if feasible, a comparison against conventional instruction on discharge planning. We also intend to examine whether the two titles played in sequence produce a different understanding of the care trajectory than either played alone, since that is the specific claim implied by a series-based design. Extending multilingual support would permit the needs analysis to be repeated in other health systems.

4.5 Conclusion

This paper reports a two-phase design study in which the evaluation of a narrative serious game about the NICU was used to determine what should be built next. Players identified the transition from hospital to home as their principal unmet interest, and a discharge-support scene was recalled by 45.6% of respondents, ranking fourth of seven scenes despite containing no acute clinical event; both findings informed the design of a sequel covering discharge planning and community-based care. The contribution is methodological as much as applied: it illustrates how learner-expressed priorities, gathered through an artefact learners have already used, can be combined with narrative design principles to extend a serious game across a care continuum. Whether the resulting series improves learning is a question that remains open and that we intend to address next.

Acknowledgements

This work was supported by the Nakayama Foundation for Science, Technology and Culture and the Mitsubishi Foundation Research Grant for Home Health Care. The authors gratefully acknowledge this support.

Ethics Declaration: This study was approved by the Ethics Committee of Shinshu University (approval number 5794) on March 14, 2023. The survey had been administered from the release of the game in 2022 as voluntary, anonymous player feedback, and the approval covers the retrospective analysis of those previously collected responses as well as their continued collection. Participation was voluntary throughout, all responses were anonymised, and no personally identifiable information was collected.

AI Declaration: Generative artificial intelligence tools were used to support language refinement and drafting during manuscript preparation. The authors reviewed and revised all outputs and take full responsibility for the final content.

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