







EDUCATOR'S BLUEPRINT

Educator's blueprint: A how-to guide for creating analog serious games for learning in medical education

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Abstract

Serious games are an emerging tool for teaching and learning within medical education. These games can be used to facilitate learning or to demonstrate complex concepts in short bursts of interactive learning. This educator's blueprint will provide 10 strategies for creating a serious game, focusing on card and board games. These strategies include creating a project charter; determining the nature of the game; establishing game mechanics; selecting the best medium; prototyping and playtesting; reviewing sensitivity to equity, diversity, and inclusion; reviewing and refining content; funding game development, manufacture, and distribution; marketing and publicizing the game; and future-proofing the game. This blueprint hopes to help aspiring serious game designers and educators to conceptualize the steps for successfully creating a new serious game for medical education.

KEYWORDS

game-based learning, gamification, play, serious game

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INTRODUCTION

Educators have increasingly adopted game-based methods for health professions education, using a variety of media across differing settings.¹ These include content-reinforcing quizzes within lectures, card and strategy board games helping to teach a specific point or topic, and digital games that allow for layered presentations of game and teaching elements and even simulation. Playing allows learners to explore relationships and real-world issues in a safe, flexible way, without consequences to themselves (or patients) if they make mistakes or “lose” the game.²

We identify games specifically designed for the purpose of education as serious games.² There are a myriad of medical educational-themed games, ranging in complexity from simple matching games to in-depth board games and digital procedural simulation. Some are “print and play,” or otherwise freely available, while others require purchase or subscription. Common principles apply to the design of both digital and analog games for health care professionals’ education. We focus here and analog games such as card and board games.

FRAMEWORKS FOR GAME DEVELOPMENT

Game design can be informed by conceptual frameworks in a similar fashion to educational interventions. These describe various aspects of gameplay and interaction. There are a variety of models that can be useful. Annetta’s “6 ‘I’s”³ (instructional, informed teaching, increasing complexity, interactivity, immersion, and identity) connect educational goals to player actions and internalization of learned material. Olszewski and Wolbrink produced an extended framework that covers practical aspects of game development including mapping, prototyping, and production.⁴ Although both frameworks were written primarily about digital games, we find their principles equally applicable to analog game design. Other authors have described

how play and game rules can support motivation for participation and learning.⁵

We have divided the key themes of game design into four phases—preparation, design, iteration, and evaluation (Figure 1)—and further subdivided these into the following 10 strategies. Although we present them in numerical order, strategies will likely need to be revisited and refined, especially as iteration, playtesting, and postimplementation feedback lead to refinement of design. We have focused this blueprint on strategies for card and board games, based on published literature and our own experience developing serious games in a variety of formats. Throughout this review, we refer to game creators as “designers” and end-users as “educators” or “learners.”

There is significant overlap between our steps here and other frameworks for development of educational interventions such as Kern’s six steps.⁶ We discuss the specific use of games for education and therefore focus on the later three steps of Kern’s process of (4) educational strategies, (5) implementation, and (6) evaluation and feedback. Like Kern’s process for developing a curriculum, we emphasize the importance of the assessment phase as a critical midpoint in game development in the form of playtesting. Beyond the curriculum development process, we extend this guide to tips for distribution of the educational tool beyond the location in which it was developed in our final three steps.

TEN STRATEGIES FOR CARD AND BOARD GAME DESIGN

Create a project charter

A project charter outlines the overall premise of the game and critical aspects of design. Writing the charter, like a grant application, can help designers anticipate potential challenges and guide the process of design. This can also help appreciate potential challenges

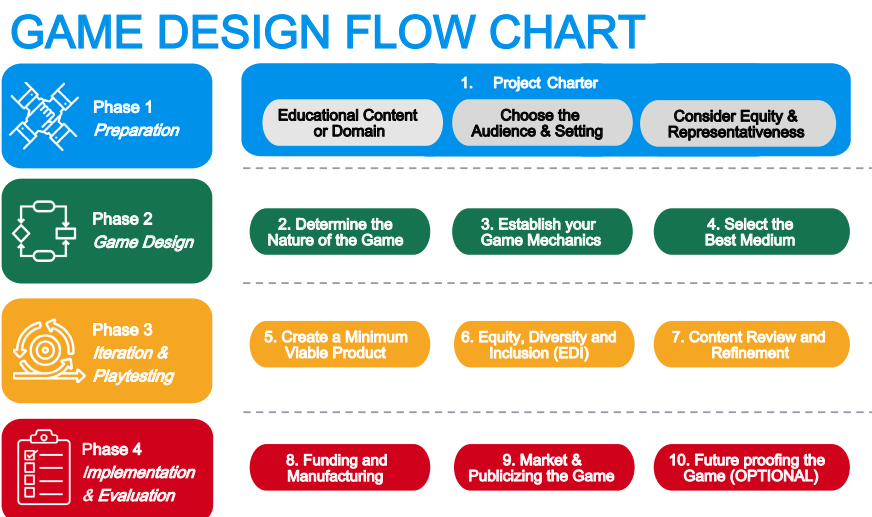


FIGURE 1 Game design flow chart using the 10 strategies.

and set realistic goals for the project. When questions or challenges come up in the design process going back to the charter can guide decision making. We have framed the charter as a series of questions to consider:

What do you want to teach?

Serious games can target a broad range of educational goals. They can be used to introduce new information or concepts or to reinforce existing knowledge. The visual and verbal elements of game design represent the *theme*, which includes the content blueprint for learning. Game design can be used to reinforce content, such as spectrum of activity of antimicrobials or a region of anatomy, skills such as learning to read an ECG or using closed-loop communication, or attitudes such as prioritization of vaccination. Games can even reflect more complex ideas like leadership management of an emergency department.

Why do you want to teach this using a game?

Games are built using abstracted versions of real relationships and concepts. What key ideas or processes are important to teach, and how can they be translated into gameplay? How does exploration, play, competition, or collaboration add to learning the content or concept above? Can you recreate an entire complex process, or would it help to take one aspect of it that can be usefully represented? Importantly, some aspects may be inappropriate for translation into games. For example, interactions that are inherently unsafe or that invite opportunities to recreate negative interpersonal reactions without a means to critically examine or ameliorate these may better be taught in a different format.

Who is your target audience?

Understanding who is being taught and what knowledge and experience they bring to the game will inform both the educational content included and the gameplay. For example, a game primarily directed toward medical students may have different content and expectations of the players than one directed at physicians in training. Other audiences may benefit from the game but may need additional scaffolding or adapted rules. Planning for the intended audience will help designers balance the content and background knowledge needed with desirable difficulty for learning.⁷

What is your intended setting?

Games can be played independently, in small groups, in person, or remotely. Some games are structured entirely by the participants, while others benefit from a facilitator; indeed, the same game may

be played independently by one group but require facilitation with another.

Who owns the intellectual property?

Although you are designing the game, your role as an educator and the content you include may be subject to usage restrictions if you plan to distribute or commercialize your game. Work designed while working for a university or academic center may be owned by your university. Content published in academic journals is typically copyright protected, and designers will need work on gathering permissions from relevant sources as part of the design process.

Will you need to have any disclaimers to prevent your liability?

Depending on audience, setting, and legal context, it may be helpful to include a disclaimer regarding game content to prevent it being misconstrued as medical advice.

Determine the nature of the game

The nature of a game includes both the narrative and the gameplay experience. What is the story being told by the game? The narrative provides motivation, such that resolution of the story, often through learning and applying knowledge, is part of successful play. A serious game's theme should reflect the narrative in addition to the educational content. For example, many classic games, including *Tic-Tac-Toe*, *Go*, and *Chess*, represent conflicts over territory. The themes of the former two games are very abstract, while the latter has countless variations in appearance of the core six pieces, reflecting different aesthetics but retaining the pieces' roles. A slightly more thorough theme example is found in the playful misinterpretations and colloquialisms that represent "diseases" treated in *Operation*. In *Operation* the game board represents an ailing patient and technical error, touching the edges of cutouts in the board with a grasper and closing an electrical circuit, is identified by a buzzer. This example highlights the second point, that gameplay should support the game's narrative. What real-world interactions are being modeled within the game? How can players act and interact?

Serious games benefit from intentional pairing of learning theory with play. For example, a designer using competition between players as an incentive may also want to reward exploration or application of content knowledge within the game. Conversely, a collaborative structure may mutually reward players who cooperate towards game outcomes that are less incentivized (or not possible) individually. To return to *Operation*, the gameplay rewards finesse and thus presents a variety of objects that require different techniques to retrieve without the player getting buzzed or "patient" being harmed.

More than just quiz questions: establish your game mechanics

Game mechanics, which describe not only rules but the broader ways in which players interact, strategize, and achieve goals, make an educational activity a *game*. We suggest that this can occur via addition, as in *gamification*, or by integration, as in serious games. An example of gamification is writing quiz questions with educational content for use in an existing game. This can increase student engagement with the questions, but other mechanics can have more robust outcomes. In serious games the mechanics are integrated with the theme.⁵ Designers should match game mechanics to educational content and desired outcomes to create incentive structures to learn or engage with the theme.

Integration of the educational content into the core mechanics of the game has been demonstrated to provide better learning outcomes than using a game as scaffolding for quiz questions. This was done in a math game where players learned divisibility of numbers by fighting zombies assigned number values with thematically relevant weapons (e.g., a five-finger gauntlet was used on zombies with numbers divisible by five).⁸ Many games described in medical education literature use quiz questions as a basis, we can expect better outcomes when games are able to better integrate the content with mechanics. Card and board games may not mimic a clinical setting exactly; they have the potential to deliver a high degree of functional task alignment as has been demonstrated to be effective in simulation literature. This alignment is more important than “fidelity” in retention of skills.⁹

For example, in *Critical Care*,¹⁰ the designers used a mechanic of “patient illness” represented by a combination of injury to various organs and an abstracted concept of how much they are in “crisis.” Worsening illness will compound as patients are prone to getting more “complications,” which cascade and demonstrate the interdependence of the organs in critical illness. This mechanic encourages players to develop strategies to avoid complications as much as possible, which is thematically analogous to the practice of ICU medicine.

Serious games with medical themes often constrain player creativity so that appropriate player actions align with clinical practice. Players learn from interactions based on game mechanics, both from what actions are allowed and from how the game defines “success.” Poorly designed incentives arise when players misinterpret or exploit rules in a manner that violates the content or theme of the game, undermining the experience. For example, if a player can “win” a game by harming another player’s patient, or by using a therapy in a way that is inappropriate or dangerous in actual practice, the game outcomes may counteract its teaching goals. Outright violations of theme will likely feel like they “break” the game or render it unplayable. Well-designed incentives should correlate playing well or “winning” the game with better knowledge or learning.

The use of game mechanics enables learning goals that emerge dynamically from play, rather than being explicitly stated. [Figure 2](#) discusses the questions to consider when choosing game mechanics. [Table 1](#) gives examples of current games with their mechanics. Often, when developing a game, it is worth considering game



FIGURE 2 Questions to consider when choosing themes and mechanics.

TABLE 1 Examples of game mechanics used in card and board games for health professional education.

Game mechanic or mechanism	Games featuring the mechanic		Matching mechanic to learning goals
	Description of the mechanic	Classic or hobby game	
Tessellation (often a grid)	"The playing field is divided into spaces to regulate movement."	Chess, Risk	In <i>NeuroNavigator</i> neuroanatomy is described as a grid in which players move pieces. This mechanic allows for exploration of the relative position of anatomic structures.
Player judge	"One player, the judge, decides the outcome of the action."	<i>Apples to Apples</i> , <i>Cards Against Humanity</i>	A mechanism to both prompt discussion and give players a low stress way of participating (selecting from a set of cards). Described as a useful tool for "flattening the hierarchy" between players in <i>Clinical Coaching Cards</i> .
Communication limits	"Games may limit players from communicating with one another openly. These restrictions can be absolute as they relate to certain specific pieces of information or may restrict certain types of communication such as speaking."	<i>Charades</i> , <i>Pictionary</i> , <i>Taboo</i>	Dr. Jargon uses a <i>Taboo</i> -like mechanic in which players must describe a term without using specific delineated medical words. The goal is to practice communication in lay terms and avoid jargon.
Set valuation	"Set valuation is the logic or underlying mathematical model by which designers assign values to sets of game elements." Generally collecting a larger set will score more points.	<i>Sushi Go</i> , <i>Rummy</i> , <i>Ticket to Ride</i>	In <i>The Plexus</i> players collect sets of cards representing roots, trunks, cords and nerves of the brachial plexus to match the muscle groups they innervate. Players score more points by collecting longer continuous sets.
Victory points from player actions	"Players earn points by performing actions."	<i>Splendor</i> , <i>Dominion</i>	In <i>Empiric</i> players treat infections with variable points. Higher points are scored when an antibiotic is used to treat the most difficult infection it could be used for. This mechanic rewards good stewardship.
Roll and move	"A randomizer is used to determine how far to move a piece. The space landed on determines the action(s) a player can take."	<i>Monopoly</i> , <i>Chutes and Ladders</i> , <i>Candyland</i>	Roll and move is a well-understood game mechanic for learners. It is commonly used to deliver quiz questions though it does not in itself usually provide added value.
Events	"Actions occur outside the control of players that cause an immediate effect, change the state of the game, or impact subsequent actions."	<i>Monopoly</i> (Chance cards)	Demonstrates factors outside of players control that impact care such as "Short Staffed Nursing" in <i>Critical Care Game</i> or "Holiday Monday" increasing patients to see in <i>GridlockED</i> .
Stat check	"There is a target number required to succeed at some test. A random number is generated, which is compared to the target, if it meets or exceeds the target, the action succeeds."	<i>Dungeons and Dragons</i> , <i>Pathfinder</i>	Use of stat check mechanic allows for random chance mitigated by players decisions. In the case of this game players investing in packaging systems increased odds of success on dice rolls regarding drug manufacturing.

Note: Game mechanics definitions in quotation marks are from Engelstein and Shalev.³⁵ See Appendix S1 for references.

mechanics from games you have played. Inherently, familiar game mechanics are often tried and tested and therefore recognizable to learners. Users may be more likely to adopt shorter, lower complexity games.¹¹

Select the best medium

The medium of a game considers what the format of the game will take. This includes the physical components and the structure of the game. “Tabletop” games have traditionally used physical game components, though the simplest games require no materials at all other than people with whom to play.

Physical components can include cards, tokens, boards, coins, dice, spinners, timers, and numerous other artifacts to carry information, mark progress, introduce randomness or time pressure, or enable other mechanics. Cards are a common format as they can be traded, randomly drawn, flipped, and arranged within a game. They have the benefit of being printable, can be written or drawn on, and are often easily portable. Boards and tokens provide a structure for gameplay, allowing more complicated games to be played by scaffolding the rules. A gameboard may be abstract, such as a chess or checkerboard, or detailed, providing guidance and branch points for how to play. Similarly, gameboards may be fixed (*Monopoly*, *Chess*) or random (*Settlers of Catan*), and games may include multiple boards for individual players or aspects of play.

Consider whether components or tools from the clinical setting would be appropriate for your game. Can you select components that will improve your players' technical skills as they play? For example, a puzzle game that requires the configuration of three-way stop cocks or a dexterity game that requires the use of suture materials.

Tabletop games are not necessarily limited to physical components. *Empiric*¹² initially used quick response (QR) codes to take learners to additional online content and references that did not fit in the standard 2.5- x 3.5-in. size playing card.¹³ Many other games in the commercial space incorporate applications for scoring or augmented reality or to provide supplemental content.

Visual elements of the game are used to communicate multiple aspects of a game, including the theme, educational content, and in many cases important rules or mechanics of gameplay. If game designers have graphic design or artistic backgrounds, they may create game art themselves, but many game designers will collaborate with artists and graphic designers to create their final product. Many games can be constructed with only a few visual elements or words on cards, but many others benefit from consideration of how characters, symbols, and composition can support gameplay and learning.

Visual content and graphic design themes should also reflect the intended and potential game audience. Designers have a major opportunity to advance representation through content choices. The production of *Critical Care*¹⁰ intentionally worked with underrepresented demographics in the gaming industry, including women and people of color, for graphic design, art, writing, and editing. Characters and roles in game design should consider both individual

characteristics such as race/ethnicity/language/disability/sexual orientation/gender identity as well as professional diversity (doctors, nurses, nurse practitioners, physician assistants, interprofessional team) and the patient perspective as relevant for the content and audience. Including diverse characters and content can open the game up to more audiences and allow students and trainees to both see themselves in the game and have the chance to experience the game from a slightly different perspective.

Due to complexity, this paper will not address creating digital games or applications. However, digital formats do allow for increased interactivity, quicker repetition, multimedia, and automated scoring. Compared to a tabletop implementation a digital implementation of the same game was seen to have faster turns, less player interaction, and less change in player attitudes.¹⁴

Create a minimal viable product for prototype/ playtest

Early prototyping

Turning an idea into a physical prototype will allow a designer to quickly test whether an idea will work or not. Using simple materials will allow for flexibility and help to reduce the cost of changing, revising, or cutting game elements. Handwritten note cards, chart paper, and sticky notes are common materials to construct a draft of the game. Card content can be generated in *Microsoft PowerPoint* or Apple's *Keynote*. Designers may find that generating cards in a spreadsheet program allows for more flexibility in revision, and these can be used with other software such as *nanDECK* (Nand Technosoft), *Multideck* (Semicolon LLC), or *Adobe InDesign* (Adobe) to generate large numbers of cards using a common format.¹⁵⁻¹⁷

Iteration

Iteration is critical to game design.^{18,19} Initial *playtesting* should involve a variety of audiences to ensure that the core mechanics and the “core loop” of the gameplay are functional—the game makes sense, can be won, or completed and is fun. Players ideally will want to play again and learn how to play better. Designers should identify major issues before design progresses to more complex rules or expensive components.

A serious game's purpose is to teach content, not to teach the game itself. We suggest starting with a simple set of rules (one page or less). Taking notes on early sessions, including problem points in the rules, player feedback on mechanics and design, how long the game takes to play, and how likely players are to win or complete the game given a certain amount of time, can help shape the basic structure into a coherent game. We suggest also focusing on how long it takes to learn how to play: successful serious games may be played over and over, but many players' first experience will decide whether they will play again. Designers should minimize the cognitive load

needed to learn the game so that players are able to apply themselves to playing.

Some strategies to simplify game design include using familiar game mechanics, choosing, or creating effective iconography that players can intuitively recognize and limiting unnecessary text as a graphic element. Ultimately keeping things simple allows more time playing and learning than learning to play.

Designers may begin playtesting alone or with close partners and expand to experienced and then less-experienced board game players. As the game mechanics and rules near cohesion, new play testers should be asked about gaps in the instructions, pain points within the game, and uncertainties they have in the rules. Designers should take opportunities to watch new players play while resisting the urge to explain the game during testing to identify problems and misunderstandings.

Equity, diversity, and inclusion (EDI)

Evidence suggests that tabletop games suffer with a limited scope of character design and roles, and worse, many games encode gender and ethnicity stereotypes in character design and gameplay.^{7,20} Early consideration of EDI, including intentional representation during planning, design, and playtesting, can help increase the reach of your game while avoiding pitfalls.²¹⁻²³

Sensitivity reviewers play a valuable role in the design process and can be used to increase representation and understand how groups interpret their representation within the game.^{22,23} *Critical Care: The Game*¹⁰ utilized crowdsourcing on social media to recruit specialists in each of the professions included in the game, ranging from social workers to medical specialists and ICU therapists, to review and edited content to ensure that their fields were accurately represented in the game. Patients were included for sensitivity review including race and disability perspectives.

Content review and refinement

Content based in medical knowledge is inherently subject to change. For example, a card game about developmental stages for pediatrics was made obsolete by updated milestones in 2022.²⁴ Designers can demonstrate validity of their content through transparency, including plans for revisions. This evidence should include review by content experts, easily accessible citations, and indications of when the content was last reviewed and current. *Empiric*^{12,13} pediatric games are designed to last about 3 years with content updates based on new editions of the American Academy of Pediatrics Red Book guidelines.²⁵ User feedback can be valuable for content revision. Designers can solicit comments through post-publication surveys, provide contact information for unsolicited feedback, and monitor online communities where their games and content may be discussed or relevant updates may be published. Designers may also want to highlight where translating content

and concepts into gameplay and mechanics has created deviations from real contexts or clinical situations. Designers can acknowledge these differences in rulebooks and as part of debriefing game play.²⁶

Not all games present content that is rapidly changing. Games that facilitate users to present the content, as in *Tablerounds*,²⁷ are inherently adaptable as they are structured to provide stimulus but not specific answers or outcomes. Games with greater complexity (or more pieces, cards, or parts) may be much more difficult to update and are often better suited to content that is less likely to require updates or to limiting updates to easily substituted components.

Postpublication evaluation can also include player surveys and feedback on learning outcomes (this is analogous to consequences validity). Are players learning what the game is intended to teach or has gameplay caused unintended distortions or inaccuracies beyond content issues? Games will often abstract certain aspects of real systems and learners may come away with misperceptions of how these systems work or how they are supposed to interact within them. Simple debriefing questions like, “What did you learn from this game?” may be useful to learn how players have interpreted the game and its content.

Money matters: does your game need funding?

After successful playtesting, designers may want to produce high-quality versions of their games and publish them for others to enjoy. Methods of distribution range from hosting printable files online to manufacturing large quantities for commercial distribution. [Table 2](#) describes some benefits and limitations of each approach.

Game design can entail significant costs, including time spent in by game designers, costs of hiring or recruiting artists, play testers, and other technical specialists (e.g., graphic designers), before materials and production costs are considered. Not all games need funding. Many of the authors start with small games designed for local education sessions using personal time and resources, without significant additional support. If a game designer plans a more serious endeavor, external funding may be necessary. How much funding depends on the ambitions of the project, and designers may use a draft budget to determine what is possible and desirable. The draft budget should consider all phases of development, from prototyping through to production and marketing. These include:

- Early prototyping materials;
- Publishing of finalized products (often through a print-on-demand service such as The Game Crafter²⁸ or DriveThru²⁹ cards); and
- Marketing materials (custom website, flyers, posters, swag).

A budget will provide a sense of scale for funding but may also be used to reality check the expected costs to benefits of the project. Commonly used approaches to funding new games are:

TABLE 2 Benefits and limitations of manufacturing and distribution methods of game for HPE.

Method	Options include	Benefits	Limitations	Example of Med Ed games
Free to print.	Educators can print the games themselves from files online. Variable hosting methods are available: 1. Host a PDF online, i.e., via DropBox or GoogleDrive. 2. Share directly on social media. 3. Supplemental file for a publication, i.e., MedEd Portal	Lowest cost for users. Increases accessibility, especially internationally. If published as a journal supplement it may be peer reviewed.	Practical limitations to amount and types of components that users will print and assemble. Often lowest quality final product.	<i>Empiric</i> —Hosted as a PDF <i>Clinical Coaching Cards</i> —A supplement on MedED Portal
Print on demand.	Online services that will print and ship copies to customers as they are ordered. Some will provide a discount for bulk orders. Websites such as Gamecrafter or DriveThru Cards can help with this.	Lower financial risk to designers. Very little logistic work for designers.	Highest cost per unit to the customer. Higher cost per unit makes retail sales or selling challenging.	Gamecrafter—Print on demand: <i>GridlockED*</i> <i>The Plexus</i> <i>NeuroNavigator</i>
Self-publish and have game manufactured.	Often done via crowdfunding websites like Kickstarter or Gamefound.	Often a low cost per unit	Requires production of a larger number of units. Higher logistic work and financial risk for publisher.	<i>Tablerounds</i> <i>Pharmageddon</i>
License a game to existing game publisher.	Often final steps in game development, art resources, manufacturing, and distribution. Companies exist that publish for HPE such as Focus Games and Genius Games.	Help with logistics, marketing, and challenges.	Designer has less control of the process and final product. May need legal considerations around intellectual property and copyright.	<i>The Floor Game</i> — Published by FocusGames

Note: See Appendix S2 for references.

Abbreviation: Health Professions Education (HPE).

- **Self-funding:** Many game designers (especially those within medical education) often self-fund the development of these games. *GridlockED*, *Empiric*.
- **Crowdfunding:** Some enterprising groups can also use crowdsourcing (via sites like Kickstarter). *Pharmageddon* and *Critical Care: The Game* used this approach.
- **Local grants, charitable groups, and foundations:** Local institutions, charitable foundations, or starter grants may be open to funding serious games. For example, *The Lesion: Charcot's Tournament* (<http://www.thelesion.com>) was funded by a grant related to neurology education.
- **Research grants:** It may be possible to incorporate game design as a part of a research grant proposal for projects involving assessment of serious games as educational interventions.

Once the first edition has been published and sold, sales of the game may be parlayed forward and reinvested in the game, as the *GridlockED* team has done.³⁰

Market and publicize your game

Not all designers create serious games for commercialization, but most designers will want to maximize the attention their game

receives to reach more potential teachers and learners. Michael Hyatt suggests a conceptual framework for designers to publicize their games using "platforms."^{31,32} The platform strategy has been successfully applied to publicize academic research.^{33,34} Hyatt describes the following elements:

1. **Homebase:** The designer uses a digital homebase that they control to generate and disseminate publicity. Any communications from other sources will refer potential and interested players back to the homebase, which may also offer email lists for announcements, crowdfunding launches, and links for purchase. A game's homebase will often be a personal website with a custom URL (e.g., GridlockEDgame.com).
2. **Embassies:** Game designers can use social media platforms (e.g., Twitter, Facebook, Instagram) or other networks as outposts from which to communicate. Designers have less control over these sites but gain greater visibility. A consistent presence across different online platforms is more important than a large following in early stages.
3. **Listening posts:** Sampling what is being said about the game, and by whom, is as important as disseminating information. Game designers can use Google alerts for their game's title (if it is unique enough) and monitor social media outlets (once the game's handle has been circulated sufficiently) to follow response to their game.

Table 3 expands methods for publicizing games.

Designers may consider contracting with board game-specific marketing agencies and placing paid advertisements. Crowdfunding services such as Kickstarter serve as a powerful form of advertising as well, but these undertakings require significant investment of time, planning, and understanding of the process and commitments entailed.

Scholarly pursuits as a type of publicity

Just as serious games are for play and learning there are ample opportunities for game development to generate scholarly output. Academic scholarship may be valuable to many game designers within the academy and can also be a useful form of publicity. Traditional scholarly methods that are also natural ways to share a game include:

1. **Workshops:** Game designers can have the greatest impact pitching their games in person to share their passion directly with an audience at local didactic sessions, educational symposia, regional conferences, or on the “lecture circuit.” Presenting workshops about the game itself can have a twofold effect—more people learn to play the game as well as how to teach others using it.
2. **Conference abstracts:** Evaluating the educational impact of a game is an inherent part of serious game design. Conference presentations offer means to share not only the game but also its potential efficacy. Conferences can also be networking opportunities for serious game makers and producers outside a designer's discipline. Depending on funding, it may be worthwhile to purchase space in the exhibit hall at academic specialty conferences as well as games festivals. Alternatively, bringing games to conferences may afford ad hoc demonstrations between talks or in the exhibit hall.

TABLE 3 Examples of promotion strategies using example of the published games by authors.

	<i>Critical Care Game</i>	<i>GridlockED</i>	<i>Empiric</i>
Social media	Twitter, Facebook, Instagram @Lakshman	Twitter, Facebook, Instagram @GridlockEDgame	Twitter, Instagram @EmpiricGame
Paid ads on social media	Facebook advertisements were timed to drive interest to the crowdfunding campaign.	N/A	N/A Very low margin (USD\$0.94–\$1.34) on this print-on-demand game does not cover costs of paid advertisements.
Kickstarter	Crowdfunding websites require moderate insight and knowledge into the promise and perils of this. It offers the opportunity to gain significant initial funds to produce a first printing of the game, but as it functions as a preorder service, “backers” often have high expectations of delivery time frames and component quality. This can take a significant amount of time.	N/A	N/A
Conventions and conferences	As this game is sold outside the medical audience, the designers have promoted it at general gaming conferences as opposed to medical ones.	The main target audience is medical educators and/or clinicians, and so this game has made appearances at major medical education and emergency medicine conferences. This game is sold outside of medical audiences but has not made appearances at general gaming conferences.	While not used for promotion conferences have been an excellent way to play test and meet collaborators involved in review process.
Media coverage	Mainstream media and interviews.	Mainstream media and news (TV, radio), newspaper/magazine interviews.	N/A
Awards	Boston FIG award for Most Innovative Tabletop Game	<i>GridlockED</i> itself has not entered gaming competitions, but its companion prequel game (<i>TriagED</i>) has won an international gaming competition (GALA Award).	Gee! Learning Game Award finalist and local educational innovation award.

Note: See Appendix S3 for references.

3. **Publishing research:** Depending on the rigor of documentation and evaluation, there are several types of manuscripts that can track the course of creating serious game. Contributing to the serious games evidence base the usefulness of a game (and serious games overall) may raise awareness of the game and help convince skeptical educators that games a valid way to teach.

Future-proofing serious games

While it may be tempting to design a game, publish it, and consider it finished, most games will not inherently maintain interest. "Future-proofing" describes how designers can prevent their game from becoming obsolete and players losing interest. Designing games to have replay value, and ongoing engagement with players, often requires ongoing interaction between designers, teachers, and players and development of additional content, including new versions and expansions of the original game. Developing a community around the game and staying in contact with end-users is essential for the success of expansions and future.

Three strategies for future-proofing include:

1. **Editions:** New game editions may be necessary for revisions, which usually address issues with gameplay, or for updates to the content. Some game mechanics may be "broken," but not discovered until after extensive play, or novel applications of the game and theme might warrant updated rules. Scientific content inherently changes over time, if games rely upon specific accurate information, this may require frequent attention.
2. **Expansions:** Iterative development of a game may include expanding the core game to add new thematic and gameplay content. Expansions may "stand alone" or require the base game for play. In both cases, having a community passionate about the original product is largely required for a successful expansion. *Empiric* utilizes different card decks customized to clinical settings and populations outside of the original pediatric content, including adult, emergency, and veterinary medicine.
3. **Companions and collaborations:** Companion products can build on and use the success of an initial product to launch a new endeavor. The developers of *GridlockED* created *TriagED* as a new game with different gameplay and format that borrows and extends thematic elements and educational goals from *GridlockED*.

CONCLUSIONS

We present 10 key strategies for designing serious games. We hope these will provide structure for interested future game designers and inspire educators to create and share new medical education-themed games.

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The GAMER (Games And Medical Education Research) collaborative is an amorphous, nonhierarchical collaborative of medical educators who are interested in researching game-based learning. It is dedicated to innovation, evaluation, and research around game-based learning for health professionals' education.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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