New education method or tool

Medical Careers: an online game to study online gaming and process addictions

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Abstract

As part of an e-learning project for medical students, designed to highlight some problems and approaches around addictions, we created some virtual patients to accompany an online primer. For the section on process addictions, we created an online game, modeled on the classic board game ‘Careers’. In this article, we describe how we used the OpenLabyrinth educational research platform to create a virtual scenario that could be played by 1-4 students, using a web browser. The internal activity metrics generated by OpenLabyrinth afford a very detailed look at what learners do within the game and how the game performs. We note some frustrations at engaging project reviewers and some mismatched expectations about e-learning resource usage. The e-learning resources are available for wider use and we encourage groups who might be interested in simple gamification approaches and learning analytics to explore these resources.

Keywords: gamification, process addictions, virtual scenarios

Background

In 2012, the Association of Faculties of Medicine of Canada (https://afmc.ca) and the Palix (formerly Norlien) Foundation (https://www.palixfoundation.org) sponsored a series of eLearning resource development projects around the topic of Early Brain & Biological Development (EBBD) in relation to addictions. A team from Alberta and BC were successful in obtaining grant funding for the Towards Integrated Developmental Education (TIDE) Project. The purpose of the grant was to create a series of virtual patients (Ellaway, Topps, Lee, & Armson, 2015) and eLearning resources that were to be used as supplementary/adjunct learning materials for an e-Primer, namely the ‘AFMC Primer on Biopsychosocial Approach to Addiction’(Brager & Butt, 2017) that was to be developed by subject matter experts at the Centre for Addiction & Mental Health (www.camh.ca).

The e-Primer was an online textbook or standard reference on addictions, aimed at medical students, with topics
including neurobiology and neurochemistry of addictions, process addictions, toxic stress and brain development, adverse childhood experiences and many others. The TIDE Project was purpose-built to cross-link between the online textbook and the adjunct materials so that students could supplement their learning by working through these additional examples. Other online learning modules were developed by other groups, such as the University of Toronto.

The Norlien Foundation grant for the TIDE Project was intended to support four virtual patient cases, along with guides and instructional materials so that interested authors could create other teaching examples of their own.

The TIDE Project group proposed cases in the following areas:

- **Harriet** – a three-part case designed for small group work  
- **Polly** – focusing on opioid prescribing and polypharmacy problems  
- **Street Drug Guide** – a mobile reference guide to addictions  
- **Process addictions**

The project group actually delivered more than this with an additional six mini-cases embedded within the Street Drug Guide. We also constructed an editable reference booklet to go along with the Street Drug Guide, which could be adapted by different regions to showcase local resources and highlight emerging trends, without needing to modify the original virtual patient case material.

Our group considered it to be a delicious irony to construct an online game, designed to explore the perils and pitfalls of online gaming and other process addictions. Given that medical students were our target audience, we decided to base this around career decisions and specifically to emulate the old board game of Careers ([https://en.wikipedia.org/wiki/Careers_(board_game)](https://en.wikipedia.org/wiki/Careers_(board_game))).

**Design and Method**

We were particularly fortunate in receiving very helpful inside information from the estate of the original author of Careers, James Cooke Brown. In acknowledgement of this, we would like to spend a few moments relating the history of how that game was developed, as it is pertinent to the state of gamification in medical education today.

Dr. Brown first conceived of his board game in 1955 (see Figure 1), in response to what he saw as the excessive emphasis on the acquisition of wealth in the game of Monopoly. He also resented the aggressive nature of the zero-sum game and the behaviours that it encouraged. Many readers will have played Careers in their youth, but for those who missed out, here are some of the salient differences.
The key difference was that each player had to decide on their own formula for success prior to starting the game. This balance between fame, fortune and happiness, was emphasized throughout the game, with specific adventures being rewarded in some areas and penalized in others. Furthermore, there was an emphasis on education, with the ability to increase skills in certain areas in order to enhance the player's ability to win. This was a forerunner to many online games today where you need to acquire various skills, tools, weapons and protections in order to advance.

One of the interesting aspects of Dr. Brown's efforts in game design and making this game as fair and as playable as possible is that he used an early mainframe computer to run simulations of his scoring schemata. He would take punch cards in to the University of Florida and run them at night on spare computing cycles, iteratively improving
his score weightings. He was a pioneer in using computer simulation in game design. He went on to design a more complex game for adults with an additional 3 dimensions: power, virtue and enlightenment. This more multifaceted variant, Careers Senior, is more suitable for adult play but was never published commercially.

In this and many other ways, he was quite the polymath. He wrote a book, The Troika Incident (Cooke Brown, 1970), about eBooks and a web-like network, before DARPA had even conceived of the Internet. He designed his own trimaran, which is a type of multihull boat. He invented a logical language suitable for human-computer interaction called Loglan. (https://en.wikipedia.org/wiki/Loglan)

In our own efforts to create an online game similar in style and structure to Careers, in some ways we followed in the footsteps of James Cooke Brown. We used an open-source, educational research platform called OpenLabyrinth (Topps, Ellaway, Simpson, & Corral, 2015) to create and publish our learning designs. OpenLabyrinth is a simple, web-based, data-driven mechanism that was originally designed to support virtual patients. Each case consists of linked nodes or web pages, in some ways similar to the eBook designs described in Troika. Inherent to the OpenLabyrinth platform is a powerful set of underlying metrics, which allows us to track exactly what the user or game player does. We were able to use these metrics and database tracking mechanisms to iteratively improve our game designs, in largely the same spirit as Dr. Brown's original efforts.
The game was first started in OpenLabyrinth v2.6.1 and the initial concept maps (see Figure 2) were created using Vue from Tufts (Services, 2016). This helped us map out the equivalent of board squares, or Nodes, within the game map, along with the logical pathways. It also helped us to create the initial scoring mechanisms, using OpenLabyrinth Counters. This was occurring at the same time as a major rewrite of the OpenLabyrinth code base into version 3. Many of the design requirements for elements of this TIDE Project were formative in driving many of the functions that became central in OpenLabyrinth v3.

Central to the new functionality required in OpenLabyrinth v3 was the need for more complex conditional pathways. Prior to this in OpenLabyrinth v2, we could create some simple conditional logical jumps between Nodes or pages. In OpenLabyrinth v3, it became clear that we needed a more complex and robust set of conditional rules, using a simple IF..THEN..ELSE syntax. Using this real-life design case, we were able to flesh out how to implement these Rules and syntax editor.

Eventually, after over 600 hours of game design, iterative testing and rule tweaking, we ended up with a case map containing 270 Nodes, with 739 Links between them. There are 15 Counters which track progress in the game, only 7 of which are exposed to the user during game play. Some of Rules became quite complex, the largest being over 1100 lines long. (see Figure 3)
In our iterative testing, despite the verbosity of these Rules, we still found that there was no appreciable delay in
game play and that the Rules were processed quite efficiently.

One of the more important features of cases created in OpenLabyrinth is that they adhere to the ANSI/Medbiq
Virtual Player data standard (Smothers, Azan, & Ellaway, 2010), which helps to ensure portability between servers.
However, our design team also found that we repeatedly ran into limitations in the MVP standard and had to code in
workarounds to achieve acceptable game play patterns. This included the use of hard coded links and URLs between
key points in the game. These were not confusing to follow during design or play of the game but did have the
undesirable side effect of making the game harder to port to other servers.

Thanks to the funding supplied by the Norlien Foundation and AFMC, we were able to iteratively strengthen the
OpenLabyrinth v3 platform during this game design phase. The learning designs and requirements of the TIDE
Project acted as a catalyst in driving the further development of the OpenLabyrinth research tools and case
authoring functions. The funding also allowed us to hire a commercial artist to help with the game graphics, which
we based on the look and feel of the original game, giving due tribute to Dr. Brown and his Foundation.

We enlisted the help of subject matter experts in addictions, medical education, e-learning and gaming, during the
lengthy design process, which occurred over seven months. We recruited a small group to help iteratively test our
design patterns and scoring rubrics, including several academic family physicians with expertise in medical
education, addictions and emergency medicine. We also recruited students from medicine, pre-med, public health,
computer science and engineering in our testing group. All participants' feedback and data was kept confidential. All
procedures were consistent with the Helsinki Declaration (WMA, 1964). Ethics approval was not required as this
was considered program development, not primary research.
The final design (see Figure 4) that was produced is an online game (still available at http://vp.openlabyrinth.ca/renderLabyrinth/index/45) but it very much follows the ethos and game play of the original board game. Indeed, during testing, our student group found it easier to have a replica of our game board printed out and used it to place their playing pieces upon. On many occasions, it was interesting to watch their use of a hybrid combination, with their electronic versions keeping track of scores, money etc., but the physical board and game pieces indicating where they were on the board layout. There may be room in the future for some interesting developments to this game as Augmented Reality (AR) becomes more commonplace.
As in the original game, play starts on the outside loop, in a similar style to Monopoly, but there are eight internal loops that can be explored. These represent career choices and provide additional opportunities to gain fame, fortune or happiness or, in our game version, reputation, money and health. The internal loops are as follows (see Table 1):

| Loop name       | Loop diagram                                      | Features                                           |
|-----------------|---------------------------------------------------|----------------------------------------------------|
| Researcher      | http://vp.openlabyrinth.ca/renderLabyrinth/info/1773 | Very good for reputation                           |
| Back to school  | http://vp.openlabyrinth.ca/renderLabyrinth/info/1767 | General skill improvement                          |
| Medical Business| http://vp.openlabyrinth.ca/renderLabyrinth/info/1781 | Great money but low health & reputation            |
| Clinical Service| http://vp.openlabyrinth.ca/renderLabyrinth/info/1778 | Good money but variable for health & reputation    |
| Medical Politics| http://vp.openlabyrinth.ca/renderLabyrinth/info/1789 | Lots of reputation options                        |
| Medical Expedition | http://vp.openlabyrinth.ca/renderLabyrinth/info/1786 | Big gains or losses in all areas - exciting       |
| Academia        | http://vp.openlabyrinth.ca/renderLabyrinth/info/1797 | Good for reputation but variable in other areas    |
| Retreat         | http://vp.openlabyrinth.ca/renderLabyrinth/info/1794 | Excellent for health                               |

Table 1: Internal career loops and their features

These career choices were used for several reasons: partly as an homage to the original game and its choices, but also to try and educate medical students about some of the upsides and downsides of various career avenues in a relatively light-hearted manner. Both within the internal loops, and at key positions around the main loop, there were also opportunities to both win and lose points in all three areas. Some of these were determined by luck and the roll of the dice; some by careful decision-making and asset management; and some by simple skills. There were also game cards, similar to Monopoly’s ‘Get out of Jail’, that could be utilized strategically within the game at the players’ discretion.

As in the original Careers board game, the first action for each player, was to decide on their magic formula for success: how to balance out their desired targets for money, reputation and health. The cumulative total for these scores was 60 points but the player had to achieve their target in all three areas in order to win. So, if a player had chosen as their formula $30,000 plus 20 health points and 10 reputation points, it would not help them to have extra money but still be deficient in health. OpenLabyrinth internally tracked all of these scores for the players and automatically declared the winner when they achieved their chosen formula.

Results

This online board game has been heralded as one of our most complex and intriguing case designs created in
OpenLabyrinth. It has been demonstrated in conferences (Topps & Topps, 2013) and workshops internationally to much fanfare. Due to the powerful internal activity metrics afforded by OpenLabyrinth, we are able to generate a lot of data about the game characteristics. As of 1 Sept 2017, it had been visited 28,947 times. The game is an open case in OpenLabyrinth and does not require a login identity to be played. However, we know that there have been logins from 2809 separate locations around the world. (See Figure 5)

Figure 5: Geocoded map of IP locations of Medical Careers game players

To complete a game successfully required 31.1 +/- 12.1 minutes and generally required about 23.1 +/- 8.2 turns. We noted that, during our witnessed iterative testing by our control group, play usually accelerated during the course of a game as they became familiar with the interface. Because every click and action was precisely timestamped, we were also able to look at key points in the game to see if they became excessively time consuming and thus, to fine-tune our rules. For example, our testers initially found that it was too difficult to get out of hospital (the game’s equivalent of Jail) until we tweaked our settings. This was made much easier because of OpenLabyrinth’s internal activity metrics.

The amount of data available using these metrics becomes quite large. As of 1 Sep 2017, we had amassed 1,100,305 data points about the Medical Careers case alone. Not all of this data is useful but it allows us to apply some principles from big data analytics to examine what is going on during game play (Topps, Ellaway, & Topps, 2016). For example, we see a power law curve when looking at how deeply most users explored the case. There is a very long tail of users who barely touch the case, making the mean time exploring the case rather meaningless.

Beyond the internal metrics generated by the case, we have been somewhat frustrated in determining the educational effectiveness of the case. We had hoped that this game, which our internal team was very proud of as showing a wide range of factors to be considered in process addictions, would be a centerpiece of the AFMC e-Primer on addictions. However, the reviewers for the e-Primer and overall project were curiously disengaged about the game. After being greeted with initial enthusiasm during the project planning phases by the review team from CaMH, we were disappointed to note that very few reviewers actually took the time to explore the game at all. We noted that
this was a very complex project overall, with many and complex educational products and outcomes to be explored. Indeed, the project of writing the e-Primer was not completed until 4 years after the virtual patient cases were completed.

We were particularly perplexed by the expectations of one reviewer, who demanded that all of the cases should be accompanied by a detailed checklist of all of the node content, with check boxes for whether visited or completed, along with checklists of all the adjunct material included in the cases so that learners could "tell whether they had completed the case". We pointed out that most of the cases were designed for discovery-style learning, not as reference material. We also pointed out that a checklist for the Medical Careers case would include over a thousand items and that, in addition to being prohibitively expensive to generate and publish, would be way too long to have educational value.

We were pleased to note that the reviewers were keen to cross-link the e-Primer with other products and cases from the TIDE Project. We had also hoped to link from our virtual patient cases to key topics and headings within the e-Primer but this was not possible within the time constraints for our portion of the project because of the lack of persistent uniform resource locators (PURLs -- https://en.wikipedia.org/wiki/Persistent_uniform_resource_locator) within the e-Primer structure.

After watching our testing group create a hybrid, combining online game play with physical pieces on a life size game board, we also proceeded to create a novel electronic hybrid version of the game board. For this, we employed Near Field Communications (NFC) tags (https://en.wikipedia.org/wiki/Near-field_communication), which we printed onto customized decals and applied to a modified game board.

We then assembled a range of NFC-capable mobile devices including Android, Windows Mobile and Blackberry smartphones. The NFC tags then acted as location anchors which the phones’ sensors detected and transmitted to the online portion of the game. In this manner, each player could use their mobile phone as their playing piece. When they placed their phone on the game square indicated by the roll of the electronic dice, the phone’s location was transmitted to OpenLabyrinth and the appropriate scores were applied for that player. This worked surprisingly well, although some game squares such as the Start or the Hospital sometimes became crowded with phones, causing some sensor cross-talk.

While this was enthusiastically received by our internal reviewers, this innovation was disregarded by the funder’s reviewers, which we found surprising as it potentially gave the game a futuristic new perspective. We did note however that it was beyond the predetermined scope for the project. Given the current trend towards Augmented Reality (AR) in gaming, we would not be surprised to see a warmer reception to this type of innovation in the next few years.

Discussion

While there has been much interest expressed in the use of serious games and gamification of eLearning tools (Ahmed et al., 2015; McCoy, Lewis, & Dalton, 2016; Nevin et al., 2014; (Graafland, Schraagen, & Schijven, 2012), we note that there has been little actual activity in this area. Graafland et al only found 30 examples of serious games in a systematic review and noted that most of these were not validated as educational tools.

Several authors have called for more development of serious games but in our discussions with colleagues working in this area, we find that there is a mismatch of expectations in relation to game quality and development costs.
Gamers are used to the exceptional graphics, video and first-person-experience of today’s leading games, but such game development is extremely expensive (Klubnikin, 2016; Williams, 2014), consuming the resources of huge teams, and costing millions of dollars. In contrast, the average disposable budget expense for a medical education researcher is $5-10,000 which is three to four orders of magnitude lower.

The Medical Careers game continues to be available for use by any group at [http://vp.openlabyrinth.ca/renderLabyrinth/index/45](http://vp.openlabyrinth.ca/renderLabyrinth/index/45) and we continue to gather data on its usage. Other educators who might be interested in using it to research and teach about process addictions or simply the use of virtual scenarios as a simple gamification platform are welcome to contact us via [http://openlabyrinth.ca/contact](http://openlabyrinth.ca/contact). The content of the case and the e-Primer are all licensed under Creative Commons (BY-NC-SA).

As noted above, we have been disappointed not to be able to assess the effectiveness or educational outcomes of the case series so far. We remain keen to explore these aspects with interested groups. Since the case series was launched, we now have the option to integrate the materials with other educational resources, using standard protocols and application program interfaces (APIs):

- LMS integration using IMS-LTI, with Moodle, Desire2Learn and others
- CMS integration with WordPress, Entrada
- LRS integration using xAPI, with SCORM Cloud, GrassBlade, Watershed
- Survey instrument integration with REDcap, LimeSurvey, OpenLabyrinth
- MOOC integration with edX
- Authentication with OAuth 2.0 to Google+, Facebook, Twitter

At the initial planning phases for the TIDE Project, we did discuss integration with pre- and post-test questionnaires but delays in the e-Primer publication timeline prevented this. We have set up links to validated instruments such as the Internet Process Addiction Test (Northrup, Lapiere, Kirk, & Rae, 2015) and the Gamblers’ Belief Questionnaire (Steenbergh, Meyers, May, & Whelan, 2002), which can be used in a confidential manner with interested groups. Such integration with other educational programs and interventions, including small group workshops, would enable the further study of how students comprehend and use such eLearning tools.

With the upcoming release of OLab4 ([www.olab.ca](http://www.olab.ca)) as an educational research platform, future modifications and extensions to our virtual scenarios will afford a greater range of activity metrics to be brought to bear on the problem of assessing learning outcomes. The Experience API (xAPI)(Haag, 2015) provides cross-platform integration between a Learning Records Store (LRS) and multiple other educational tools and resources. Our group has been actively involved in the development of Medbiquitous xAPI Profiles to support such work (Topps, Meiselman, & Strothers, 2016). The structure of xAPI affords much more detailed tracking than SCORM (Dodds, 2004), with support for multiple outcomes and detailed tracking of exactly what learners and teachers actually do at every step of the way.

**Take Home Messages**

- The OpenLabyrinth educational research platform supports a wide range of learning designs and gamification of e-Learning resources, with powerful activity metrics which allow authors to track user and game performance.
Notes On Contributors

David Topps: learning design, learning analytics, platform development, primary author on manuscript

Sarah Topps: learning design, beta testing, educational concept review, manuscript contributor

Sonya Lee: e-Primer content author, educational subject matter expert, beta testing, manuscript contributor

Maureen Topps: beta testing, educational concept review, manuscript contributor

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Appendices

Declarations

The author has declared that there are no conflicts of interest.

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