International Journal *of* Designs for Learning
2021 | Volume 12, Issue 1 | Pages 16-33

HACK, SLASH & BACKSTAB: A POST-MORTEM OF UNIVERSITY GAME DEVELOPMENT AT SCALE

Andrew M. Phelps[1], Christopher A. Egert[2], & Mia Consalvo[3]
[1] *University of Canterbury/American University;* [2]*Rochester Institute of Technology;* [3]*Concordia University*

This article describes the educational, operational, and practical implementation of an upper-division undergraduate studio-style course centered on the subject of game production. Specifically, the article addresses the course organization and processes, the institutional context for the course (i.e., its situated role in the larger curriculum), the overall structure of the course both from a pedagogical and operational point of view, and concludes with substantial reflection and analysis by the authors on what worked effectively and where improvements could be made. The article also provides substantial depth regarding the student experience, the structure of creating muti-disciplinary software development teams within the course, orienting the course around the successful production of a professional-grade XBOX One video game product, and various methods, structures and tools for course organization, communication, software development practice, documentation, etc. This in turn is framed in the larger context of the course as it was offered not only through an academic department, but in parallel with a campus-based games studio and research center. Numerous detailed elements are provided in such fashion as to provide other educators and mentors a relevant, structured, and detailed post-mortem of a large scale, multi-disciplinary effort that engaged students in complex multimedia software production in a professional context. In addition, several elements atypical from more traditional software project courses as they intersect game development including entertainment design, playtesting, marketing, press, public demonstration and performance, audience reception and analytics, commercial platform, etc., and discussed and analyzed.

https://doi.org/10.14434/ijdl.v12i1.XXXXX

Andrew M. Phelps is a Professor at the University of Canterbury in the Human Interface Technology Laboratory New Zealand (HIT Lab NZ). He is also a Professor in the Film, Media, and Arts division of the School of Communication at American University in Washington, D.C., where he also holds a joint appointment as a Professor of Computer Science and is the director of the AU Game Lab. His work is broadly multi-disciplinary between design, computing, and the arts.

Christopher A. Egert is an Associate Professor at the Rochester Institute of Technology in the School of Interactive Games and Media. His research is broadly focused on game and media technologies, engines, systems, infrastructure, and the development process. As such, his work is broadly multidisciplinary as it integrates elements of art and design, music, media, computing, and hardware engineering in the practice of game development.

Mia Consalvo is a Professor at Concordia University in the Department of Communication Studies. She is also the Canada Research Chair in Game Studies and Design, and the director of the mLab, a space dedicated to developing innovative methods for studying games and game players. Her primary research focus is game studies, with particular interests in players and the culture of gameplay.

INTRODUCTION

This article describes the design process behind the creation of Hack, Slash & Backstab (Media, Arts, Games, Interaction and Creativity [MAGIC] Spell Studios, 2016), a video game that was designed and developed by students and faculty at the Rochester Institute of Technology, and also the creation and implementation of the production studio course in which the game was built. Hack, Slash & Backstab (HSB) is a couch-based cooperative/competitive arcade dungeon crawler designed for 2-4 players and is available on the XBOX One and Steam platforms (Fig 1). It represents the second commercial release of MAGIC Spell Studios, LLC, which is a university owned media and production studio that operates in parallel with the RIT Center for Media, Arts, Games, Interaction & Creativity or MAGIC Center (Rochester Institute of Technology [RIT] MAGIC Center, n.d.). The game

was produced from June of 2015 to August of 2016, through a combination of coursework, student co-ops, professional staff contributions, faculty contributions, and administrative support, which is an extremely complicated mix of activities in the modern university setting.

This describes how Hack, Slash & Backstab was made and provides guidance for colleges and universities considering supporting students making commercial-quality games. The article explores the backdrop and history of the institutions involved as well as the design process itself, including pre-production and design, production, user testing and user interface development, gameplay analysis and feature selection (and deletion), platform integration, and eventually launch and post-launch support. We focus on two key themes throughout the discussion:

1. The design process behind creating a "medium to large scale game" in the context of working with undergraduate students in a university setting.
2. The design case of how a professional games and media studio situated in an on-campus environment can augment traditional educational activities.

In particular, these themes are explored from the perspective that is intertwined between a production studio or 'capstone' course experience, and this course experience situated in the context of making the game itself. These themes are explored critically, and the article concludes with recommendations and thoughts to other educators engaged in similar work. Finally, it should be noted that the article uses a case-based approach to its discussion - it bounces between the design of the game and the design of the course as both of these are somewhat fluid—in service to both completing a commercial game and providing appropriate learning opportunities to students engaged in a capstone experience.

A NOTE ON THE AUTHORS

Each of the three co-authors are engaged in this work from very different viewpoints, and collaborate in this article to examine HSB from different perspectives. The first co-author (Phelps) was the supervising faculty for the production studio course that was the academic basis for the game's development, as well as the originator for the core game concept. He was also the founding director of the RIT Game Design and Development undergraduate and graduate program, the School of Interactive Games and Media, and the RIT MAGIC Center. As such, he was in a unique position to bring these elements together across the university, and this account is a very personal review and accounting of his work and practice.

The second co-author (Egert) is the co-founder of all of the previously described entities, and served for a short time as associate director of the MAGIC Center as well. More importantly, Dr. Egert served as the Chief Technology Officer for MAGIC Spell Studios and was responsible for supporting both the hardware and software environments for HSB development, as well as the general lab environment that the

FIGURE 1. *Hack, Slash & Backstab* on the XBOX One platform.

students, staff, and faculty needed for their work. Dr. Egert coordinated the technology and facilities needs in parallel with center operations with affiliated faculty from across the university.

The third co-author (Consalvo) specializes studying the creative process by which games are made and communities of game developers, and is notably not a part of MAGIC or of RIT, and was specifically engaged as an outside voice and critical review to balance two internal authors.

INSTITUTIONAL CONTEXT AND BACKDROP

As HSB was created at the Rochester Institute of Technology, it is important to understand the backdrop and history of the university, with respect to the game design and development program that most student developers were enrolled in, and how the curriculum of that program provided (or failed to provide) prerequisite skills and experiences. The Game Design and Development program at RIT (Interactive Games and Media, n.d.; Rochester Institute of Technology [RIT], n.d.) is one of the oldest programs formally focused on games development. The program began formal operations as a graduate degree in 2005 (Phelps et al., 2005), and an undergraduate degree in 2007 (Phelps et al., 2007). The coursework in the degree can be traced back as far as 2001 (Deutsch, 2002), consisting of courses on interactive multimedia development and applied computer graphics. RIT's Game Design and Development Program is consistently ranked as one of the top programs in the United States (The Princeton Review, n.d.). Students in the program typically focus first on 'a little bit of everything'—art, liberal arts, physics, math, game design and game development/programming, and then in the latter years in the program increasingly use electives and advanced coursework to specialize.

More recently, in February of 2013, President William Destler established the RIT Center for Media, Arts, Games, Interaction (RIT MAGIC Center, n.d.), and MAGIC Spell Studios, LLC (Finnerty, 2013). These two entities were designed to work in parallel to promote research and creative practice, and commercial activity and production, respectively. This presented professor Phelps with a unique opportunity: there was both lab space and small amounts of internal funding available to help support a production experience, with expectations that the result would be a proof-of-concept commercial game. Similarly, there was also a desire to prove the capability of creating games and media from a faculty scholarship perspective, given recent changes to promotion and tenure guidelines (IGM/RIT Promotion and Tenure Guideline Committee, 2013). Lastly, it means that additional staff from the studio, namely creative director Aaron Cloutier, could be engaged in concert with Phelps and Egert in supporting student efforts in game production, both in course-based and studio-based experiences.

HACK, SLASH & BACKSTAB

Overview of the Game

Hack, Slash & Backstab originated as a satire of institutional and campus politics. It is a game based on a purposefully broken mechanic: It invites 2-4 players to journey together through a very simplistic dungeon-style environment. Player work to find their escape while defending themselves against an ever-present horde of mindless skeletons. In fact, they must work together (departments or factions), as the game is balanced so that party members who do not stick together will be killed off easily. They can respawn and continue with the group, but with some penalties and time-loss. However, at the end of the level, the dynamic changes. There is a portal door, and only the player who enters the portal first wins the round. To add an additional twist, friendly fire (the ability to affect other player characters with the attacks normally reserved for the enemies in the environment) is always on. In this manner, the optimal strategy that emerges is to work with other members of the party to progress near the end of the level, and then to literally stab them in the back in order to escape the level and win the round.

HSB satirizes many modern practices in which people must work as a team to accomplish organizational goals as well as overcome challenges and obstacles, but are commonly evaluated as individuals and not as a team. The most basic and obvious parallel is yearly faculty evaluations, or grading group projects on a curve, but there are other obvious similarities to stack ranking, group development, certain elements of professionalized sports, and other practices that pit team success against individual achievement. The fundamental disjoint between requiring collaboration but recognizing only individual contribution leads players to form alliances, create strategies against "the person who won last time" or "the person who always wins", and ideally forces a moment of reflection as players begin to realize that the system itself drives these behaviors. The rather dark subject matter is juxtaposed with a light, cartoon style with cartoon violence and an aesthetic. Hack, Slash & Backstab is available on the XBOX One and Steam platforms, and retails for $4.99 USD.

Pre-Production and Planning (Summer Session 1)

In the summer of 2015, the original concept for the game was conceived by Professor Andrew Phelps, and discussed amongst the core staff at the RIT MAGIC Center and MAGIC Spell Studios, including Chris Egert (Chief Technology Officer), Aaron Cloutier (Creative Director), Jennifer Hinton (Assistant Director and Communications Officer), and Brenda Schlageter (Operations Manager). The focus of these discussions was to determine a viable scope for the project, and the overall strategy with respect to platform and distribution. The MAGIC Center had shipped one commercial game prior to HSB entitled Splattershmup: A Game of Art & Motion

(Decker et al., 2016; MAGIC Spell Studios, n.d.), in early 2015. Splattershmup was specifically created to challenge the university's understanding of what a game was and what it was for—it is a game about gestural abstract art, and utilizes web based technologies. That game, while recognized with numerous presentations and a couple of awards, was freely distributed and was capable of being played in a browser. While it was eventually ported to be compatible with the Windows Store, it had only a cursory review during that process, and didn't really touch on any content or platform specific issues.

When planning for HSB, it was intended both as a continued statement that games could be both entertainment products and contain deeper artistic messages. Furthermore, it was intended to prove the capabilities of the new studio's ability to make "real games" (i.e. games that aesthetically looked comparable to other professional independent titles, and that were distributed by the same platform channels as other recognized games). The way that games are perceived in this context by both students and audience to be "real" is complex and fraught with varying degrees of nuance in accordance with background, experiences, and assumptions by various parties involved (Consalvo & Paul, 2019).

With that backdrop, the staff focused on operational elements: Could we technically make a console game? Could we legally get development kits and associated hardware? Could we license the tools we needed commercially? One by one, these issues were addressed and checked off as tools were purchased, licensed, installed, and tested. We chose the Unity game engine for development as (a) students in the GDD program had prior experience with it, and (b) the pathway to console launch via Unity was presumably fraught with the fewest obstacles. Discussion also centered on the content and proposed development: Could we ship student developed content, and who would own the rights? Could we legally protect students should anything go wrong, if the project were sued, or if other unanticipated points of contention arose in the process? The team was also concerned with whether the university would be 'OK' creating and releasing a game with a darker message and (slightly) more violent content (potentially rating a T for Teen rating by ESRB (Entertainment Software Rating Board, n.d.).

These legal questions were discussed first internally and then with the vice president for research, concluding that the studio itself could retain the rights to the game's content, but that it would be necessary for students to individually assign their rights to the studio. The studio developed an instrument for this, which students would sign when they enrolled in the production studio class. As it was also expected students would participate outside the class as employees from time to time, the student employment literature at the university was also reviewed in this context but did not require modification. The provost agreed to this practice provided (a) students were not required to take the course—i.e. it was an elective and other courses could satisfy graduation requirements, and (b) the university would make reasonable accommodations for students who registered for this section but then wanted to transfer to another should this arrangement not be their preference.

From a game design perspective, both environment design and character interaction were of primary focus for Phelps and Cloutier. They talked through (and made some mock-up physical prototypes) of different weapon types and attacks, eventually centering on four characters (warrior, archer, wizard, rogue) as well as their weapons and aspects

FIGURE 2. Pre-production materials created by Phelps and Cloutier for students prior to the start of the course, depicting base character designs and color theme.

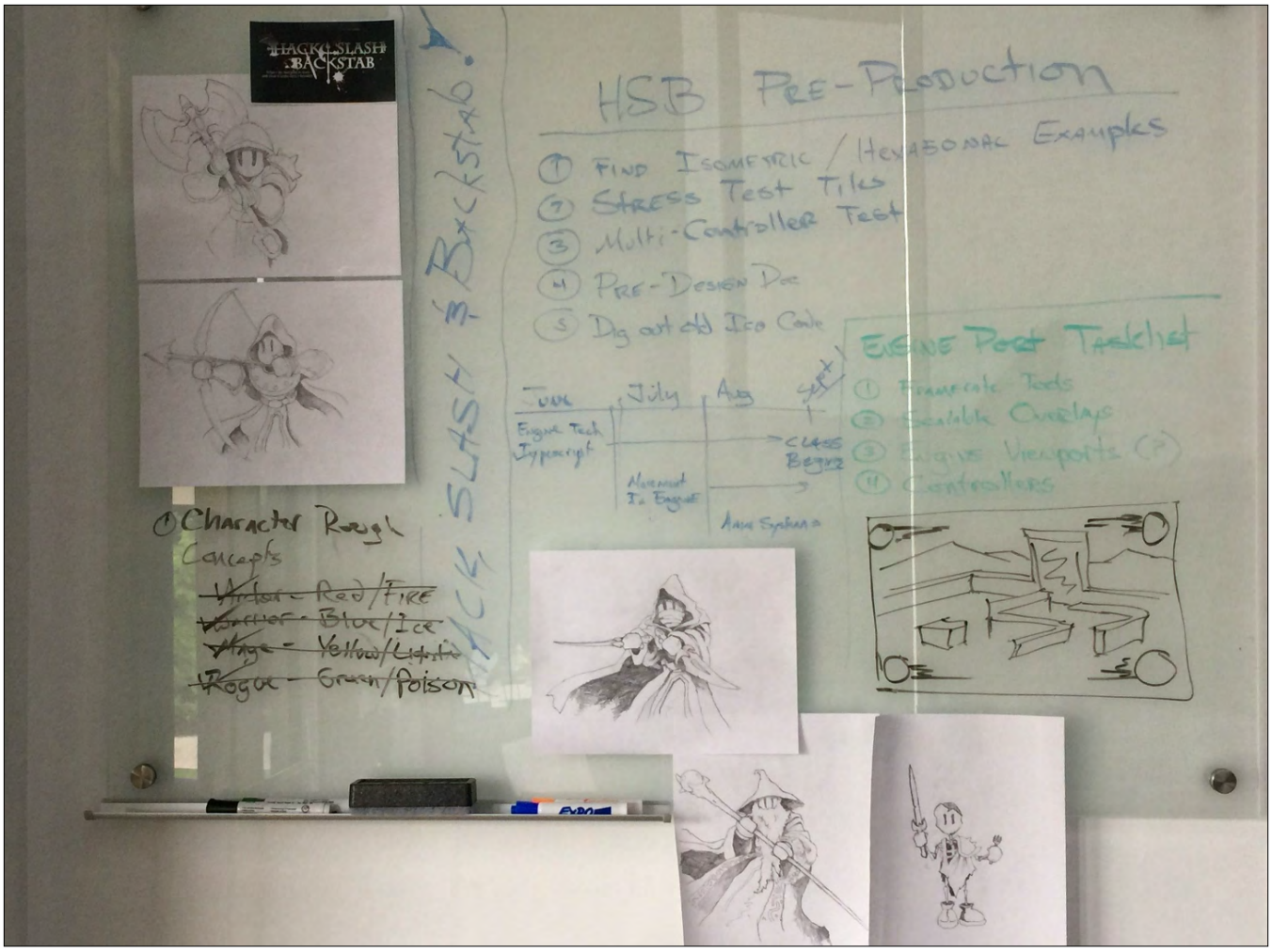

FIGURE 3. Preproduction elements for *Hack, Slash & Backstab*.

(axe/ice/blue, bow/flame/red, staff/lightning/yellow, and knives/poison/green, respectively). This element of ideation, refinement, and design happened well in advance of any code being written, any associated narrative, or, in fact, any student engagement. This was a particular design feature of the production course as taught by Phelps, in that it was to center on production itself; there are numerous other opportunities in the GDD curriculum for students to develop their own designs. The production course requires students to work with an established high-level idea, which is the most common scenario in industry. They must learn to engage with the project so as to make it their own, with all of the second and third-order design issues and associated development problems. Faculty hypothesized that developing these skills and demonstrating them through a key portfolio piece would motivate students. Figures 2 and 3 provides samples of the pre-production materials provided to students at the start of the course.

The previous challenges in creating Splattershmup informed the structure of the production studio course, and this was another area that Phelps and Cloutier invested significant amounts of curricular redesign. Any project beyond the smallest possible scale required more than a single semester's worth of work. Splattershmup demonstrated that a project from the fall production course could be carried forward after the class by employing students from the project as cooperative education (co-op) employees in the studio (either full-time or work-study). Splattershmup also revealed an inherent tension in such courses: In traditional courses, developing the game is the students' responsibility, and the faculty's role is to evaluate. Studio practice which is deeply collaborative, experiential, immersive, and apprentice-ship based, can be at odds with the demands of individual grading. In the case of Splattershmup, students weren't sure if the game was theirs, belonged to the studio, to the supervising faculty, or to the university, and individual motivations and engagements were chaotic, as they were graded by a professor on their execution of the professor's idea.

Thus, the second MAGIC-centric production studio course focused explicitly and directly on co-creation and shared responsibility. The answer to: "Who owned the game?" was "the studio", but the functional definition was that everyone owned the game. The students in the course were considered part of the studio, as were the professional staff that worked there, as were the co-op students, as were the supervising faculty. All members of this community—faculty, studio staff, students in the course, and student employees - were expected to contribute to the project, to learn by doing so, and to both mentor and learn from each other. In this way, the course radically challenged the notion of a more formal offering, and focused on deeply constructionist (Ioannidou, Repenning, Lewis et al., 2003; Kafai & Burke, 2013; Papert & Harel, 1991) and constructivist (Jonassen, 1999) approaches to project-based, guided instruction.

As a last effort in pre-production, Phelps prepared a course syllabus that described the general course goals as well as specific course requirements: these balanced the focus of the course directly with the needs of creating the game (it included, in fact, two separate sections on the 'description of this course:' one focused on the learning outcomes presented in section 4.3, and one that presented a synopsis of the rudimentary game design). He further prepared concept art for the visual design of the characters, and a pitch deck consisting of a ten-slide overview of the game to explain the game to students entering the course.

Course Objectives & Course Offering (Fall Semester)

In the fall of 2015, the production studio course kicked off with a tight organizational structure and an even tighter timeline. The goals for the course, ostensibly, were focused on a student experience in which they would utilize the skills and competencies of their prior coursework in a multi-disciplinary fashion as noted in the course objectives (Egert, 2010), outlined as follow:

Two important notes about the course objectives: 1) they contain no direct reference to the fact that the course involves building a game, and 2) they contain a specific notation that peer feedback will be a component in evaluation. The specific focus on building a game was noted in the course description and accompanying syllabus as noted previously, and more directly in the instrument that students signed by the end of the drop/add period that assigned the rights to the project to MAGIC Spell Studios. Students would receive one and only one grade for the game project but were promised both weekly feedback with respect to progress towards that grade, as well as checkpoints at weeks 4, 8, and 12 (i.e. typical quarterly reports).

During the first week of class, the students were divided into roles and tasks based on preference, capability, and

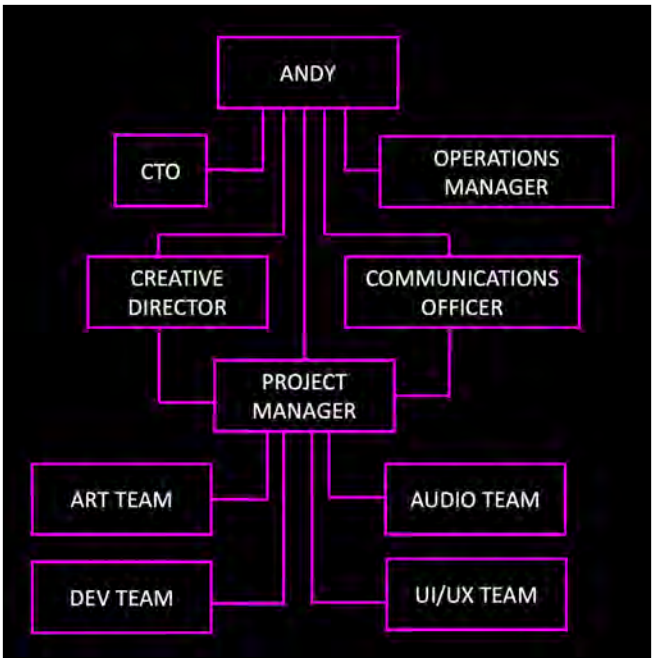

FIGURE 4. Organization and operational hierarchy for HSB production studio class.

background. Students were required to present a resume and a portfolio to their peers and then ask to join a subgroup, essentially self-interviewing and self-organizing based on skillset. This process was managed by both Phelps and Cloutier, but was purposefully peer-based as it asked students to reflect on their own experiences, strengths, and weaknesses in approaching the project. Phelps also recruited and hired a full-time student employee to act as a project manager, utilizing a small amount of studio funding. The project manager was responsible for coordinating all individual tasks, assignments, build merges, and reporting on issues and concerns to all relevant parties (including Phelps). In some respect, the project manager functioned as a typical research assistant, and in other ways as a traditional project manager from industry. The integration with the studio was also documented, and staff members and roles were introduced to the students in the course: the creative director attended nearly every course throughout the semester, the communications officer attended approximately a third of them, and the technology officer and operations manager attended as needed (and were available during other hours). The overall structure for the course emerged as shown in Figure 4.

Each of these sub-teams and the individuals therein were tasked through management software (Slack in combination with GitHub), progress was tracked (GitHub and Trello), and documented (Google Docs spreadsheet) both task by task and week by week. The course met every Monday, Wednesday and Friday for 50 minutes, as is typical for a three day a week course offering at RIT. Students additionally

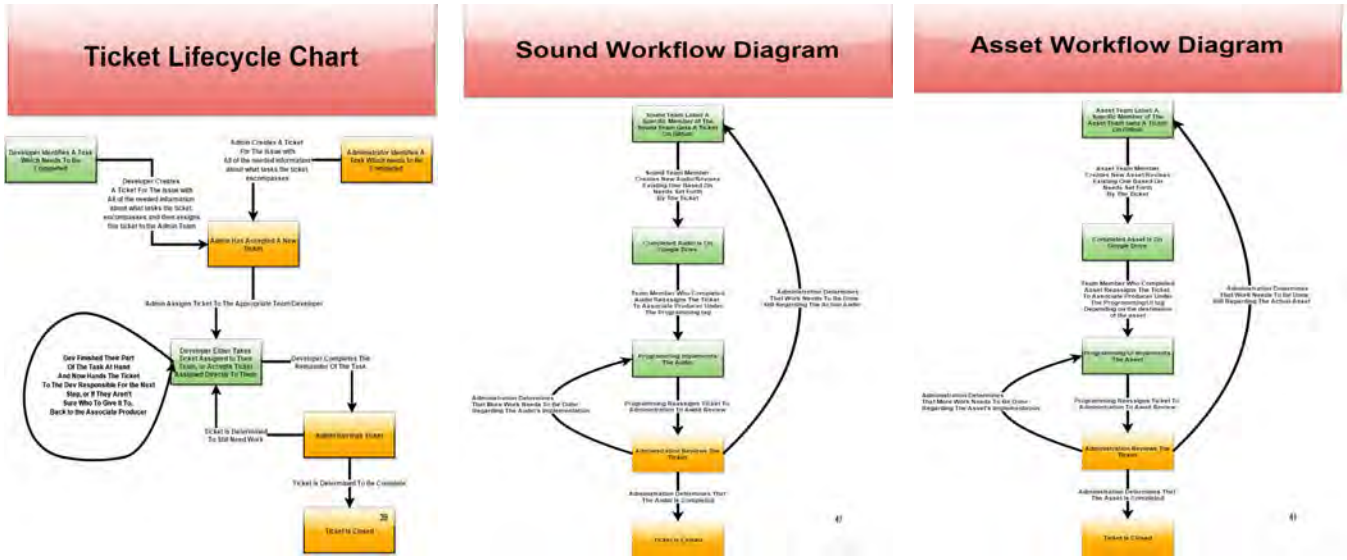

FIGURE 5. Individual process flow for various task types as produced by the HSB production manager.

organized a 'team leads' meeting on their own after the Wednesday class session, and individual teams met in the lab.

The course adopted a scrum-style approach that was highly iterative. Each week beyond week (which was consumed with initial meeting, syllabus and pitch-deck presentation, and paperwork) operated on the same schedule. Mondays were wrap-up and completion of work for the week. Tuesdays were build merge and integration by the project manager. Wednesdays were presentations of the overall build, presentations by each team on progress, critique, and tasking for the sprint for the following week. Thursdays through Sundays were core completion of assigned tasks, with Fridays in class reserved for work time, questions and coordination between teams, and later player testing and interviews. The team was also constantly connected via the Slack messaging service, including faculty and staff. Other than quiet hours for sleeping, the expectation was that every member of the team was available to everyone else as much as schedules would allow, with at least a same-day response time. This weekly pattern, which concentrated work over the latter half of the week and over weekends is somewhat backward compared to the traditional work week, but sensible for student calendars. This focus on experience driven education and practice is similar to other models (Cantor, 1995; Joplin, 1981; Parberry et al.; Kazemzadeh, 2005) and is similar to the goals and outcomes of the i-Corps program from the National Science Foundation with respect to engaging students in incubation activities around product design and development (National Science Foundation, n.d.). While the overall structure and flow of these activities was set forth by Phelps and Cloutier in leading the course, the individual elements and implementations were established by the student serving as the production manager, with feedback and input from the students in the course. Indeed, the students were responsible for implementing individual processes and checkpoints to meet the larger goals established by faculty and staff: examples of the kinds of process documentation they produced is available in Figure 5.

Every single week a different student in the class would re-pitch the game as it evolved, which allowed two things to happen: 1) every member of the team had to pitch the game individually and "make it their own," and 2) it continually refined and tightened the pitch for the game. Everyone on the team critiqued these pitches and offered feedback for improvement both from the perspective of individual presentation as well as how well it captured the essence of the game overall, through critique discussions led by Phelps and Cloutier, and often with other staff reviewing these presentations such as Egert and Hinton.

During the course, game development was divided into three major stages. The first phase involved creating a functional prototype (2 weeks), and then playing it repeatedly. The coarseness of this prototype cannot be overstated: it was literally 2-4 colored cubes representing the player characters that could be slid around on a plane while being chased by other purple cubes representing the skeletons. Attacking other players or enemies was accomplished simply by running into them. It was, in every way, representative of nothing more than an entry level Unity demo—but was instrumental in galvanizing the team around the core concept of the game. It was fun. This focus on early prototype development was taken directly from game design literature (Fullerton, 2014; Schell, 2014) as well as documented practice by design studios (Kelley, 2001), and adapted to the course structure by Phelps at the outset.

The second phase took place over the next 10 weeks of the semester (until week 13). The weeks were divided along a

production schedule that differed slightly based on role. The art team took two weeks to implement each character type. They created a stock 'model' used for everything, and then spent two weeks each on warrior, archer, wizard, and rogue. The interface design team iterated across numerous designs for icons, logos, buttons, screens, by first focusing on in-game screens and buttons (3 weeks), and then menus and out-of-game control elements (3 weeks), and then iterating on the work produced for each of these sets (2 weeks each). The development team hopped from topic to topic with less discernible pattern based on difficulty: maze environment generation, weapon implementation and particle effects, lighting and shadows, collision detection and pathfinding. This team stayed together on tasks, assigning individual students to specific tasks but in a coordinated way around group goals for the week. Some tasks were relatively quick, others were multiple weeks in progress, and overlapped each other. The audio team iterated sound effects each week (many of which were recorded custom and then highly filtered), both creating new sounds and revising those that did not work based on user feedback and testing. This team also recorded, created and then narrowed theme music, beginning with nearly 20 different tracks and moods for the initial design selection, and then winnowing down, combining, cutting, and mixing for the final deliverable at the end of the semester. Throughout this phase, Phelps and Cloutier would meet with each individual team, with the production manager, and critique the work in progress as to look-and-feel, functionality, and integration. This was independent of the overall guidance and class-wide meetings that brought the game 'back together' for the core build each week. Examples of the kinds of work students engaged in during this phase are presented in Figure 6.

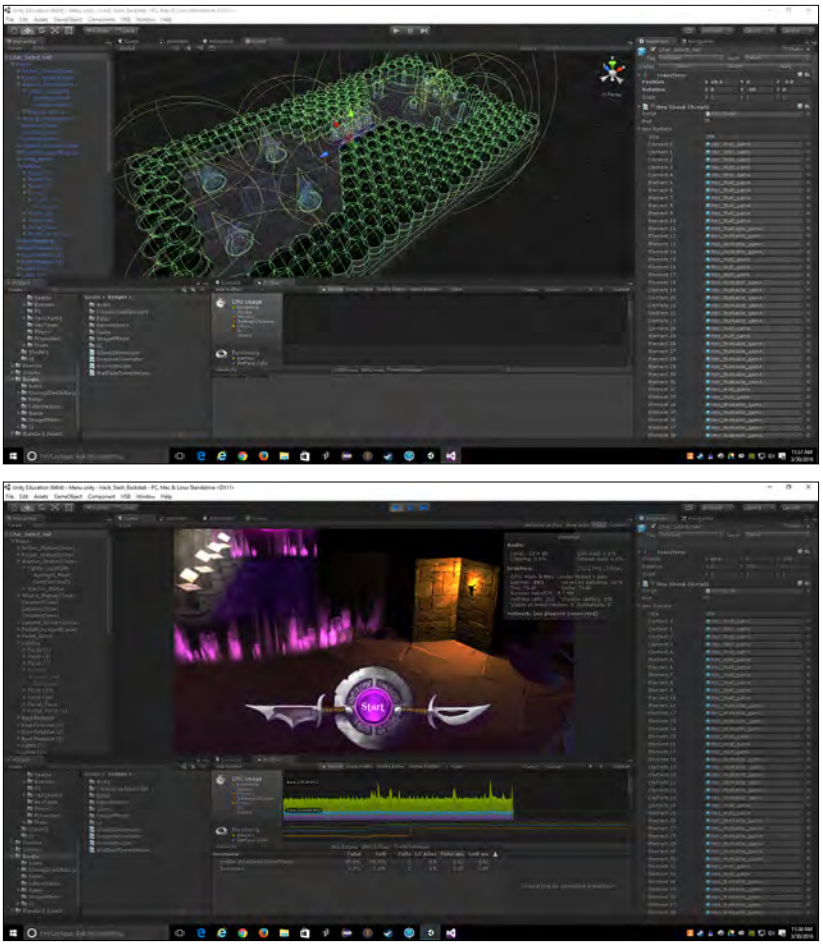

FIGURE 6. Work in collision detection (above) and audio (below) during the asset and production phase of HSB development.

The third phase involved the last three weeks of the semester. These weeks were spent in a sprint that had two goals: to refine the overall experience (i.e. balance the individual characters based on user testing and feedback) and to squash numerous bugs that had cropped up during development. None of these were crash bugs; each week the standing practice was that the current build was required to run to completion. Rather bugs crept in on issues like repeated playthroughs, particular interactions between subsystems, etc. The final week was a final presentation and critique of the game as created, with a critique by both members of the course and the faculty and studio staff as a whole.

Throughout this process, the game was playtested by various audiences in various stages of completion: at several points throughout the semester, the studio held lunches for other on-campus students to test the game and used the lure of free food as an incentive. Just after mid-terms, the studio hosted a talk by a guest lecture from a team from Warner Bros. Games and utilized that opportunity to have that group playtest the game. The studio also utilized visits by local area junior high schools as testers to provide additional feedback, and arranged for the university president to visit the lab and play the game for a photo opportunity in the final week of the course (Figure 7), as an added incentive for publicity.

At this point in development, the game was playable and understandable in relation to the final build. However, it lacked boss fights, was devoid of platform integration (it ran on PC only and was not packaged to work with Steam), had no special items or special abilities, and had very few props (the environment could only be described as sparse). Furthermore, the user interface had some functional glitches and was generally not at the same level of quality as the in-game artwork and experience. It was nonetheless one of the most successful visual and gameplay experiences ever

built at RIT, and was reviewed by every senior member of the MAGIC team and approved for viability to move forward.

4.4 Post-course Design & Development (Intercession Period)

At the time HSB was development, the university operated on a semester schedule that contained an intercession, or three-week term, just after the holiday recess and prior to the normal spring semester. This intercession period was typically used for students retaking courses or engaged in graduate research. but this was a particular opportunity for the HSB production as it meant a small team of returning students could work on a completely full-time basis on the project, and so the production manager and the four team leads were hired full time as well as a sixth dedicated member from development.

This was the most productive time with respect to output ratio of the entire effort, as there was literally nothing else happening on campus, but it also was not summer. The weather kept the team in the lab, and the lack of competing concerns was delightful. This work used the same weekly iteration model as was used during the course with respect to sprint planning and weekly operations.

FIGURE 7. President William Destler and University Affiliate Rebecca Johnson play *Hack, Slash & Backstab* at the MAGIC Laboratory with A. Phelps and student J. Coppola.

The tasks for the intersession were split evenly between iteration of existing features and what can be termed 'extended features'. Iterations included refinements of all character materials and textures, lighting modes to lend a softer, more eloquent quality, finding and fixing of bugs and issues surrounding level generation, and fixing issues with sound overlaps and mixing issues. The extended features were the addition of boss fights (basically larger and darker versions of existing characters such as Skeleton King and Spider Queen), inventory items for special attacks like potions and grenades, and refinement of

FIGURE 8. Additional elements and features developed during intersession (note refinement of visual effects, models, and lighting).

the special effects for special attacks based on memory consumption. Some of these elements are depicted in Figure 8 at various stages and levels of completion.

The extra developer hired during this period explored how to put the game on Steam, XBOX or both. The studio had pitched the game to the ID@XBOX program (Microsoft Corporation, n.d.) as a potential project, and they were interested but not yet committed. Nonetheless, they provided XBOX hardware to begin testing. The game ran for one and a half seconds before crashing both the game and even the entire dev environment. Porting to XBOX would be non-trivial.

Post-course Development & Platform Integration (Spring Semester)

At the end of the intercession period, the game was feature complete, but two elements were decidedly substandard. First, he interface had not lived up to its promise. Numerous elements had been implemented, iterated upon, re-launched, and reworked. Despite this, the interface visual quality did not match up with the in-game experience. Second, as previously noted, the platform integration had largely failed.

Much of spring involved re-engineering HSB to work with XBOX specifications. To give some sense of this, at the time the Unity had a plug-in that would cross-compile the game to XBOX and support XBOX Live (XBL) features. The current HSB worked with a set of particular Unity versions and the plug-in would work with specific versions of Unity. To complicate matters, HSB used a plug-in for controller input support that was also limited to specific Unity versions. Over the course of the spring, the engineering team had to test across nineteen different point release versions of each package to find the one combination that worked. Additionally, the game was never designed to work with the notion of a single sign-on for a given machine—it is a 2-4 player game where all players play on a single screen. This is in contrast to the way that XBL thinks of a user in its system, and contrary to the experience of many XBOX games. As such, the tooling and integration necessary to support XBL (which is a requirement for launching on the platform) was to every extent possible a retrofit.

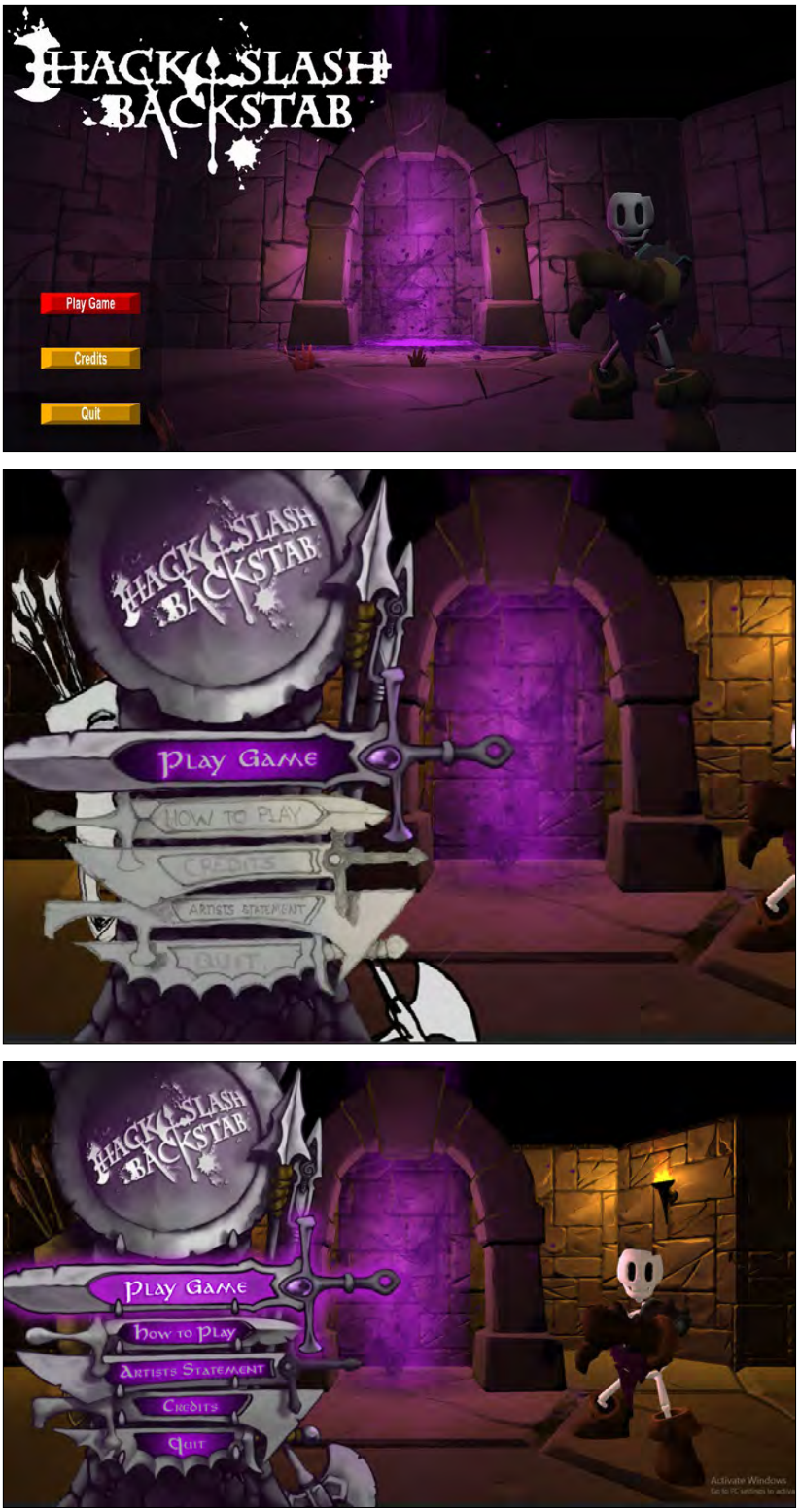

FIGURE 9. Visual aesthetics and progression of interface elements.

HSB was the first console game ever developed by the studio, and as such, the team "didn't know what it didn't know". In reviewing the process with colleagues in the professional industry they noted that any project destined for console is put on console as early as possible, and that the certification

requirements (such as XBL integration) are reviewed *prior* to production. The authors are not completely convinced this is possible in an academic environment, particularly one that begins a class project and then is reviewed for viability, but it is an interesting juxtaposition of competing concerns.

The user interface and experience issues arose from a key talent issue: the course did not attract a 2D artist who could deliver a style compatible with the in-game experience. Early iterations employed user experience styles that are popular in other applications but were revealed to be distracting during user testing. This is one of the areas that Phelps contributed to directly, less as an instructor and more as a member of the production team, again blending roles as faculty, practitioner, and mentor. Figure 9 illustrates the visual progression of the interface elements as development continued.

HSB was enrolled at the Intel Game Development Challenge where it placed 3rd for Visual Quality (McGrain, 2016a), and the game was presented at the MAGIC Spell Studios booth at the annual Game Developer's Conference in San Francisco. The game was also the featured project at the MAGIC Spell Studios presence at the RIT Imagine Festival (McGrain, 2016b), the annual spring festival that features research and creative projects across the university and has over 30,000 attendees from the local community.

Post-course Platform Integration & Certification (Summer Session 2)

In the summer of 2016, the primary development activity was platform integration. By this point, the game was largely developed and packaged, but still not compliant with platform certification requirements. Although discussion of individual requirements and strategies are prohibited from discussion by NDA, there are well known colloquialisms within the industry that are generally reported upon. These include the "controller test" (i.e. to remove the connection to one or more controllers at random during various points of the operation of the game to see if operations are affected), the "network test" (i.e. to remove network connectivity at various points to illustrate any adverse effects on the operation of the game), and the "crash test" (i.e. to turn off power to the machine or the controller or both to observe any adverse reaction). Although these are generalizations, they speak to the kinds of issues and testing that occurs during this stage of the process. What is of importance here is that none of these issues are normally tested for or designed around in a typical university setting. Generally speaking, most games curriculum prepare projects that, if they run on the demonstration machine at the end of the semester, are considered successful.

HSB required substantial out-of-game assets: launch posters, box art, icons for store fronts, specific images for social media, XBOX and Steam, a small website, and assets for a privacy policy, etc. were all required as the game approached launch on Aug 31, 2016. In addition, the process required the team to interact with the public prior to the launch for events and outreach activities including interviews, press releases, team focus articles, playtests, representation of work to government and private sector agencies, representation of work to the local community, and interactions at festivals and contests. Several RIT classes require versions of these assets, but they are nowhere near the scale required to launch a game. While these assets were developed (spring and summer) the operations staff at the studio worked with the ID@XBOX program to establish a price-point for the game, accounts for retail sale and reporting, filing tax information, etc. and worked to make this process an open book for students. Analytics reports on sales data, regions, and similar

FIGURE 10. HSB Launch Poster (left) and Electronic Entertainment Expo (E3) 2016 Press Kit materials.

issues were shared with students, staff, and faculty engaged in the effort as learning materials. Samples of these kinds of materials are presented in Figure 10.

Review Notes on Iterative Development, Production Process and Schedule

This design process for HSB contrasts with the typical university project. First, development was highly iterative: the game was prototyped in two weeks, playable at a basic level of polish by midterms, finalized at week 12, and then remastered for finals during a semester long course. Every element was visually remastered and performance tuned in a 3-week intercession, and then handed off for platform integration and certification over the next six months (barring additional rework of user interface elements and the iteration inherent in the certification process). This is atypical of many practices in lower level courses in which students get a single project to demonstrate mastery of a given concept, or occasionally a chance to revise and resubmit a short-term project.

It is also important to note the overall schedule as it emerged throughout this work, and its ultimate non-traditional nature when viewed from the perspective of the entire project and not an individual slice of the development effort. The course, in particular, was instrumental in that it was 'loose' enough as a production experience that it could be molded to the individual project, while still achieving its own learning objectives (namely multi-disciplinary communication and practice, employing advanced stills for integration, and engaging in teamwork and collaboration at a deep level). While the colloquial version of the story has become that 'RIT students made an XBOX game in a course' (McGrain, 2016c) that is very far from the reality. Pre-production for the project began before the course even met, through Phelps' engagement with the studio and his work with Cloutier to co-design gameplay around his initial concept. In the fall, his course engaged students in the class, the studio staff, and a full-time student employee as a production manager. The work was then brought to intercession where numerous students were hired full time, and again engaged studio staff. In the spring, some students were engaged part-time while others were engaged as full-time co-ops, and in the summer one student continued to engage with the project to see it over the finish line with the support of studio personnel (and the informal support of numerous members of the development team). This non-traditional structure is captured in Figure 11. As a final step in the development, release, and review of the game, the studio hosted a post-mortem presentation for the entire campus during which Phelps presented about the process, lessons learned, studio integration, and other topics to faculty, staff, and students in an open forum (Phelps, 2016).

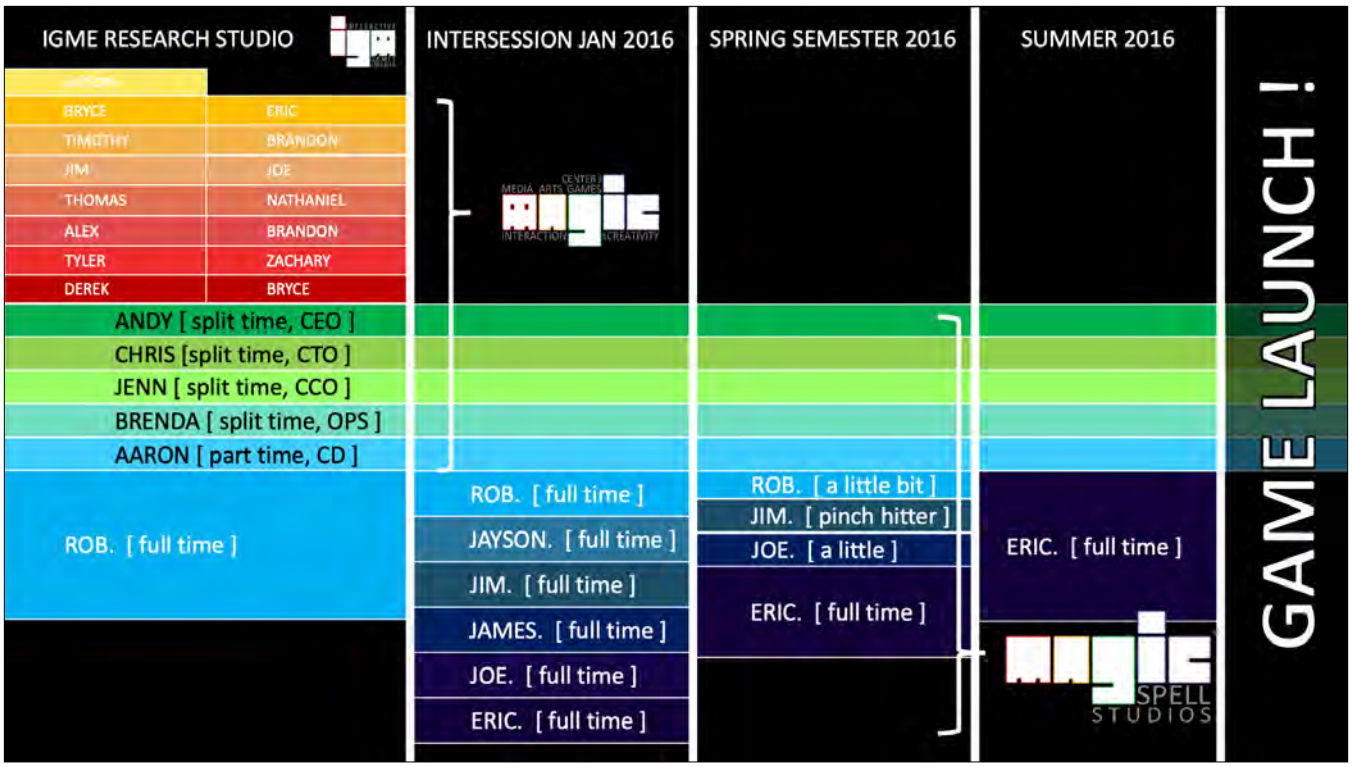

FIGURE 11. Staffing Schedule for the Production of Hack, Slash & Backstab. (Students enrolled in production studio shown in yellow, orange and red, as engaged with the IGM academic department and MAGIC Center for research. Full-time employees of MAGIC Spell Studios shown in green and light blue, and student employees of the studio shown in light to dark blue.)

EXAMPLES OF PARTICULAR FEATURES ILLUSTRATIVE OF PROCESS DECISIONS (SUCCESSES AND FAILURES)

Particular features illustrate the successes and failures of the design process described throughout, and serve as starting points for discussing academic game development. Each feature consumed significant development time, both during the course and well into the spring. It is important to note that these are not trivial side-explorations. Instead, they are important examples that speak directly to the efficacy of the design process.

First, and maybe most importantly, cutting features and scope is critically important in a studio. In education generally, and in games education specifically students do not like to cut anything that has taken significant amounts of time (Adams, 2014; Bjarnason, Wnuk & Regnell, 2012; Weinberg, 1971). Often, this is for good reason: in school, when projects, papers or products are graded, quantity is good. Quantity can usually compete with quality. Modern design methodologies encourage a 'fail fast' and 'fail often' (Babineaux & Krumboltz, 2013) mentality, but when a student is evaluated by their contributions to a group project, then there is pressure to ensure that the element they worked on is retained. By structuring the course around the agile methodology and requiring weekly presentations as well as interactions that are easily tracked (Github, Slack, etc.), this pressure was reduced, but it still was an obstacle. It is fortunate that the team was so small that everyone contributed to multiple components to the final effort.

One interesting feature that underwent significant development was the so-called 'close encounter' feature. The game needed some way to ensure that players would 'bunch up' in physical proximity as they progressed through the level. This was accomplished through tuning the environment and enemies to ensure that players who wandered off alone would face significant difficulty. Still, mechanisms to positively reinforce this dynamic was also desirable. The team brainstormed on this concept, and devised the idea that when players were close to one another their individual powers and abilities could amplify. For example, if the warrior and the wizard were near each other, then a kind of 'ice lightning' would be possible that both stunned and froze enemies; a combination of the warrior's ice and the wizard's lightning abilities. These combinations were encoded into the game through a proximity sensor between the characters: two characters combined, then three, then all four.

Eventually it became evident that this interaction was difficult to communicate to players using a purely visual metaphor. Several attempts were made: crossover colors between characters, conjoined particle effects, proximity ring bleeding effects. In the end, nothing the design team could come up with effectively conveyed the permutations and complexities in blending the various abilities, and eventually this entire system was scrapped and replaced with a simple system where in any character was more powerful with respect to damage output if it was near another character. This was represented by amplifying the glow-ring around the character and increasing the brightness and duration of the particles created by their special damage attack. This was generally understood by players in the testing audience to be desirable, and playtests saw users 'grouping tighter' after this change.

A second design critique of the game is whether or not it should have operated as a 'twin-stick', which is a game community shorthand for having movement bound to one directional stick on the controller and the act of firing bound to the other. A given game character can thus move in any single direction, while firing in another. This was a substantial point of debate amongst both game testers and the development team, and eventually the students came down on the side of having fire being locked to the forward direction of the character, while movement was a free-floating direction based on the stick on the controller. Thus, the player can move in any direction but always fires in the direction his or her character is facing. This proved divisive upon post-launch review, as several games in the perceived genre operate on the twin-stick model, but also many do not. The review community was as divided as the initial testing, and it probably should have been made a user switchable option in hindsight. It is interesting that this was a substantial debate during the entire design and development process, and was resolved democratically, but in retrospect did not ultimately arrive at a solution that served the game well.

Another critical design point is the decision to include a single-player mode, which is intended primarily as a practice mode for players to refine their skill with the controls and player attacks. This was created as a development mode for individual developers to test features (sometimes in combination with tweaks and codes to reduce health loss or be invulnerable), but was later included in player versions of the game with the thought that it would be desirable for players to be able to practice in advance of 'competition rounds' with other players. This was borne out of numerous interviews during player testing, as well as general interviews with the development team, roommates, and others. However, a major criticism of the game in reviews post-launch is how the game is basically unwinnable in single player mode—which was by design. HSB was purposefully balanced so that multiple players are needed, as this forces the entire disjoint mechanic at the core of its design. By including a single player mode, some players are motivated to try to win in such fashion, which was a much stronger draw than anticipated in the design and evaluation process.

STUDIO INTEGRATION & OPERATIONS

The dividing line in this project between what was a course and what were operations of the studio was intentionally vague from the beginning, and even less clear by the end. Embedding MAGIC Spell Studios directly on campus allowed numerous practices and strategies to help drive this project forward. The studio provided the lab space for the project, which was available twenty-four hours, seven days a week via swipe access to the students. Furthermore, Phelps was able to organize the course meetings in the same laboratory, providing a stationary, permanent, and uninterrupted working space for the entire project from start to finish, and through both the style of instruction and this permanent practice space he sought to support an active learning model (Johnson et al., 1998; Prince, 2004). In addition, the studio was able to obtain, install, license, and test all of the software needed for development, and perhaps most critically, to operate workstations and hardware in such fashion that it did not comply with all university standards for information technology usage, as this would have prevented numerous critical activities. As one example, the network requirements of the XBOX debugging protocol were incompatible with how university labs are normally configured. In fact, at the time this project was underway it was necessary to have a commercial entity in order to contract with Microsoft for release on the XBOX platform, although this has since changed as more university-centric programs have been established. This commercial barrier has traditionally been an issue with console development and establishing a localized commercial entity with its own autonomy is an interesting solution to this problem. It further allowed for commercial licensing of software without complication.

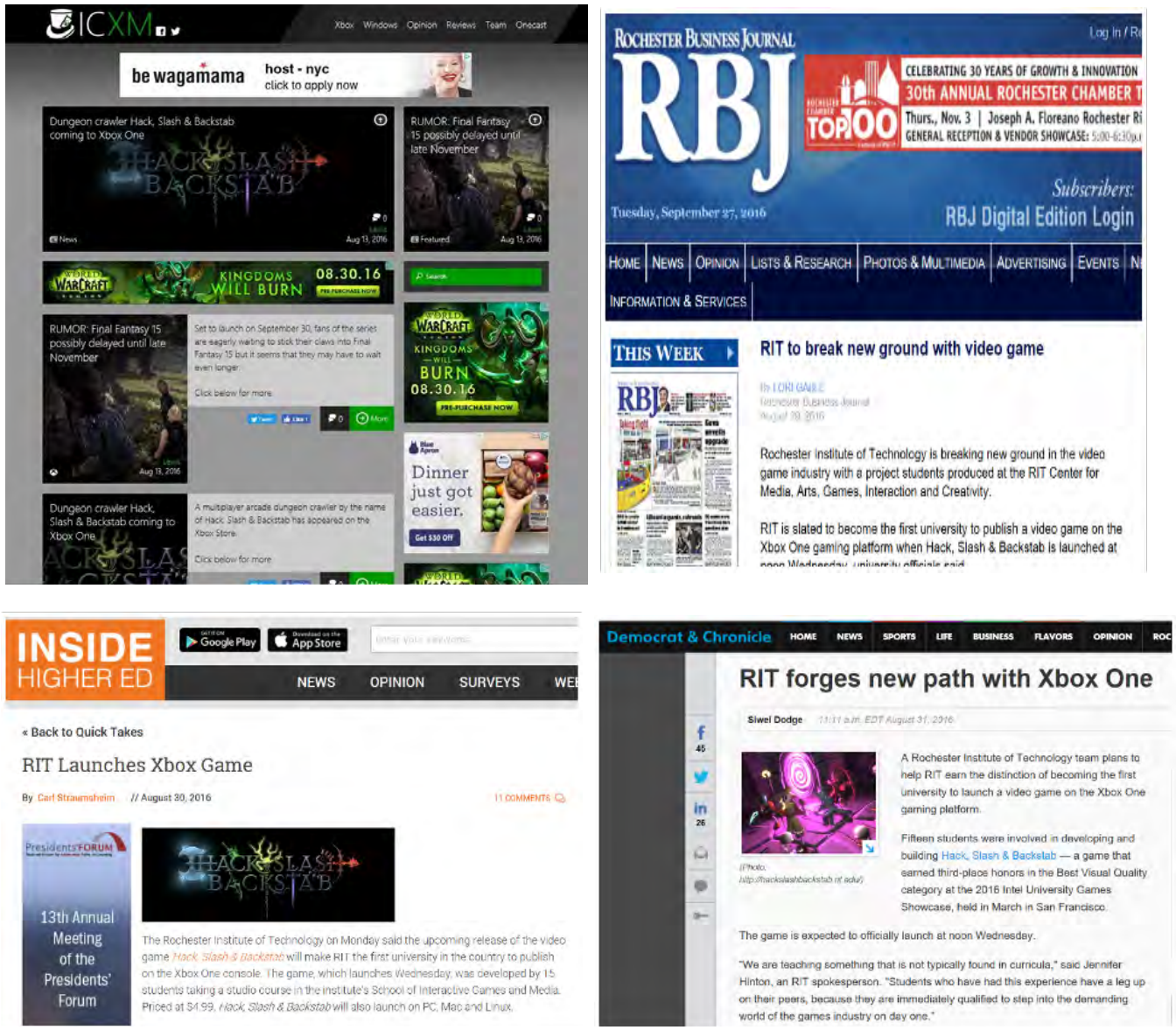

FIGURE 12. Academic and non-academic press for *Hack, Slash & Backstab*.

The studio also made possible the timescale of the project, hiring students along the way and providing the infrastructure for time-cards, payment, etc., but also ensuring that the positions counted for cooperative education credit, as the university demands oversight and review of such. Without the background funding for the student positions, the oversight of payment and reporting through studio operations, and the use of studio facilities in a dedicated and customized manner, the project simply would not have been possible.

The integration with the studio also served another key purpose: marketing and branding. Because MAGIC Spell Studios is its own entity, it carries with it its own brand and media channels, although they work in tandem with the more traditional channels at the university. This allowed the team to directly and effectively promote the game through social media, to respond to interview requests directly, and to target outlets for the story of the game in both the academic landscape as well as the games press (Dodge, 2016; Gable, 2016; Krajewski, 2016; Straumsheim, 2016). Indeed, once a game launches on a commercial platform like XBOX, it is picked up by content aggregators and others. Responding to media requests from this type of activity is a key component to a successful launch (and something that most university news organizations do not see as their core mission). In this manner, marketing a game is different from reporting on a successful university project, and that distinction, in tandem with the ability to act in accordance with both divergent goals, was another critical component that the studio made possible. Examples of this spectrum of activity are shown in Figure 12.

SUPPORT FOR MULTI-DISCIPLINARY WORK

Overall, the project, the course, and the experiential learning that took place by having students, staff, and faculty integrated in MAGIC Spell Studios is considered by the authors to have been a success. It was an exemplar for the support of multi-disciplinary work and an 'anti-silo' mentality that is inherent in the mission of the MAGIC Center.

At the end of the course, students completed course evaluations as required by the university, and the overwhelming feedback was that (a) the course was by far the most professionalized experience they had encountered in the curriculum and was seen to be the best preparation for industry (particularly by those students who had previous work experience in the field through the co-op program), and (b) the most important skills and abilities that were obtained and tested through the course were 'soft skills' around professional communication, respect and curiosity for each part of the team and their work, gaining understanding about how different sub-teams operated and the culture of art, design, programming, etc. as a practice. In this manner, it was clear that the course not only succeeded with respect to achieving the learning outcomes from the syllabus, but also in acting as a bridge between the curricular experience and the commercial studio. This is also consistent with findings generally on multi-disciplinary education, which indicate that the soft-skills and communication activities at the barriers of individual specialties are often the most valuable and can result in a deeper understanding of individual role on a team, a broader and more inclusive vocabulary and recognition of assumptions based on formal training in one's own field (Brown et al., 2009; Carter, 2014). Each of these scenarios was described by one or more students in their terms as the lessons they took from the experience.

Additionally, the lure of the portfolio piece and the platform compatibility cannot be overstated. Students identified this experience as the most important of their entire undergraduate experience, based in part on the fact that they were driven to create something at a level of scale and polish that stood apart from the traditional student project. Feedback on course evaluation forms criticized the general curriculum for not preparing students with enough opportunities to create portfolio pieces of quality such that they were prepared for employment search upon graduation. Although no program curriculum can hope to provide enough opportunities for portfolio generation that outside effort is unnecessary, it was interesting to note that this was a core motivation of the group as they approached the decision to enroll, and then to prioritize, the course.

Nearly all of the students in the course were from the School of Interactive Games & Media, but were academically diverse in the extreme: two students were artists/animators, two were UI/UX designers, one specialized in game design, one was a musician, and the rest were developers of various specialties. Additionally, one student was from the Computer Science department, and one was from the new media program in the College of Art & Design. In post-mortem presentations, students identified that learning to communicate effectively across domains was the most critical component of the experience. Also of note was the group's early adoption of the mantra that 'game design is everyone's job'—a slogan pointing at the core ethos that the experience of the player was the responsibility of every discipline and subgroup connected with the effort.

Shipping a title on a console is seen as a particularly important to undergraduates for both the professional skills that it recruits as well as the credential for their resumes. The fact that HSB shipped to the XBOX platform was motivating, and within a year of graduation, all of the students involved in the project have found employment in the games and media industries, including three at high-profile, large-scale commercial studios. The authors have remained in contact with alumni who were a part of the experience and these students directly credit this experience with helping launch their careers. Of similar importance was the student desire to create a console game, which served as an incredibly

strong motivator to engage with course material, apply skills in context, and seek additional knowledge as necessary in order to complete the tasks necessary for the construction of the game. This is consistent with constructionist classroom models (Ioannidou, Repenning, Lewis et al., 2003; Kafai & Burke, 203; Papert & Harel, 1991) and has deep roots within game development education (Cooper, 2010; Kafai & Burke, 2015; Kelleher et al., 2007; Powers et al., 2007). This kind of project-driven, just-in-time approach is also a hallmark of the RIT Game Design & Development program as designed by Phelps and Egert, and this focus on constructionist and constructivist approaches is both deliberate and encouraged throughout the program.

Games drive multi-disciplinary work and collaboration, and the student team could have been even more diverse, both from a gender, race, and academic perspective. Future efforts would ideally involve business and marketing students, non-digital artists, writers, engineers, and so on. Because this was only the second offering of the experience and the model was not yet well understood by the university, it was understandable that enrollment was limited. Future efforts should aspire to recruit an ever more diverse set of students to engage in the experience, as it is clear this was a key differentiator and a critical component in its success.

CONCLUSION

The creation of larger scale games projects on commercial platforms provides numerous learning opportunities for students engaged in the study of game development. The process of creating *Hack, Slash, & Backstab* at the Rochester Institute of Technology illustrates several key components of this kind of work, namely a strong commitment to supporting multidisciplinary activity and communication, working within the university structure to accomplish goals and objectives that are sometimes askew from normal operations, holding firm to a commitment that the resulting work be of a scale and quality that it is acceptable for the platform in question, and planning for a realistic vision of the time, scale, and effort involved. Some universities have stretched capstone work across multiple courses, some have tried to strategically use summer as a development opportunity, and some have tried to support long-form work by tying such activity to research funding and supported projects. The model presented here attempts to inform the process by directly embedding a commercial studio in an on-campus environment, which is a model now present at approximately 25 universities across North America in the field of games and interactive media. Based on student feedback, faculty and staff observation, and post-mortem project review, this model would seem to be initially successful and worthy of additional engagement and study. The single largest advantage of this model would appear to be the degree of flexibility relative to standard university operations, providing a fluidity and ability to customize approaches and solutions to individual projects, as in the end every media project is utterly unique in both its design, production, and dissemination. This ambiguity, coupled with a commitment to quality production, provides an incredible environment for student learning.

ACKNOWLEDGMENTS

The authors would like to thank, in no particular order, the numerous reviewers and editors involved in this work, including Dr. Kurt Squire, Professor of Informatics at UC Irvine, for his support of this work as we engaged through countless conversations as directors of research centers in games and media. We further thank Dr. William Destler, President Emeritus of Rochester Institute of Technology, for his vision and support of the entire MAGIC effort. And lastly Jocelyn Wagner and Andrew Moger, graduate students at the American University Game Lab, for their help and assistance with various stages of the writing and editing process. Without their collective support this project, and the documentation of it, would not have been possible.

STATEMENT ON IMAGES AND MATERIALS

Images used as figures throughout this article are representative of student and faculty work throughout the production experience as supervised by Professor Andrew Phelps, and/or are images, screenshots, and materials from publicly available sources and publications (i.e. the game itself, news websites, public presentations, and public social media channels). In all cases these images are used with permission where applicable.

REFERENCES

Adams, E. (2014). *Fundamentals of game design* (2nd ed.). Pearson Education.

Babineaux, R., & Krumboltz, J. (2013). *Fail fast, fail often: How losing can help you win*. TarcherPerigree.

Bjarnason, E., Wnuk, K., & Regnell, B. (2012). Are you biting off more than you can chew? A case study on causes and effects of overscoping in large-scale software engineering. *Information and Software Technology, 54*(10), 1107-1124. https://doi.org/10.1016/j.infsof.2012.04.006

Brown, Q., Lee, F., & Alejandre, S. (2009). Emphasizing soft skills and team development in an educational digital game design course. *FDG '09: Proceedings of the 4th international conference on foundations of digital games* (pp. 240-247). Association for Computing Machinery. https://doi.org/10.1145/1536513.1536557

Cantor, J. A. (1995). *Experiential learning in higher education: Linking classroom and community*. ASHE-ERIC higher education report no. 7. https://eric.ed.gov/?id=ED404949

Carter, L. (2014). Interdisciplinary computing classes: worth the effort. *SIGCSE '14: Proceedings of the 45th ACM technical symposium on computer science education* (pp. 445-450). Association for Computing Machinery. https://doi.org/10.1145/2538862.2538882

Consalvo, M. & Paul, C.A. (2019). *Real games: What's legitimate and what's not in contemporary video games*. The MIT Press.

Cooper, S. (2010). The design of Alice. *ACM Transactions on Computing Education, 10*(4), 15:1-15:16.

Decker, A., Egert, C., & Phelps, A. (2016). Splat! er, Shmup? A postmortem on a capstone production experience. *Frontiers in education conference proceedings* (pp. 1-9). IEEE Press. https://doi.org/10.1109/FIE.2016.7757399

Deutsch, C. H. (2002, April 1). Technology: Some colleges take games seriously. *The New York Times*. https://www.nytimes.com/2002/04/01/business/technology-some-colleges-take-games-seriously.html

Dodge, S. (2016, August 30). RIT forges new path with Xbox One. *Democrat & Chronicle*. https://www.democratandchronicle.com/story/money/2016/08/30/rit-forges-new-path-xbox-one/89597478/

Egert, C. (2010, September 6). GCCIS-IGME-580 IGM production studio course outline form. http://andyworld.io/teaching/courses/GCCIS-IGME-580-IGMProductionStudio-X.doc

Entertainment Software Rating Board. (n.d.). *ESRB ratings*. http://www.esrb.org/

Finnerty, B. (2013, February 15). *RIT launches new research center for digital media*. Rochester Institute of Technology. http://www.rit.edu/news/story.php?id=49767

Fullerton, T. (2014). *Game design workshop: A playcentric approach to creating innovative games.* AK Peters/CRC Press.

Gable, L. (2016, August 29). RIT to break new ground with video game. *Rochester Business Journal.* https://rbj.net/2016/08/29/rit-to-break-new-ground-with-video-game/

IGM/RIT Promotion and Tenure Guideline Committee. (2013). *School of interactive games and media guidelines for promotion and tenure.* http://andyworld.io/writing/documents/IGM_school_promotion_and_tenure_guidelines.pdf

Interactive Games and Media. (n.d.). School of Interactive Games and Media | B. Thomas Golisano College of Computing & Information Sciences. https://www.rit.edu/gccis/igm/

Ioannidou, A., Repenning, A., Lewis, C., Cherry, G., & Rader, C. (2003). Making constructionism work in the classroom. *International Journal of Computers for Mathematical Learning, 8*(1), 63-108.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). *Active learning: Cooperation in the college classroom.* Interaction Book Company.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (Vol. 2) (pp 215-239). Lawrence Erlbaum Associates.

Joplin, L. (1981). On defining experiential education. *Journal of Experiential Education, 4*(1), 17-20. https://doi.org/10.1177/105382598100400104

Kafai, T. B., & Burke, Q. (2013). The social turn in K-12 programming: Moving from computational thinking to computational participation. *SIGCSE '13: Proceedings of the 44th ACM technical symposium on computer science education* (pp. 603-608). Association for Computing Machinery. https://doi.org/10.1145/2445196.2445373

Kafai, Y. B., & Burke, Q. (2015). Constructionist gaming: Understanding the benefits of making games for learning. *Educational Psychologist, 50*(4), 313-334. https://doi.org/10.1080/00461520.2015.1124022

Kelleher, C., Pausch, R., & Kiesler, S. (2007). Storytelling Alice motivates middle school girls to learn computer programming. *CHI '07: Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1455-1464). Association for Computing Machinery. https://doi.org/10.1145/1240624.1240844

Kelley, T. (2001). *The art of innovation: Lessons in creativity from IDEO, America's leading design firm.* New York: Currency/Doubleday.

Krajewski, J. (2016, October 13). Hack, slash and backstab: A look into the MAGIC Center's newest release. *Reporter Magazine*. https://reporter.rit.edu/tech/hack-slash-and-backstab-look-magic-centers-newest-release

MAGIC Spell Studios. (2016). *Hack, slash & backstab*. Rochester Institute of Technology. http://hackslashbackstab.rit.edu/

MAGIC Spell Studios. (n.d.). *Splattershmup: A game of art and motion*. Rochester Institute of Technology. http://splattershmup.rit.edu/

McGrain, V. (2016a, March 18). *RIT team places in Intel University Games Showcase*. Rochester Institute of Technology. https://www.rit.edu/news/rit-team-places-intel-university-games-showcase

McGrain, V. (2016b, April 29). *'Delve into dungeons' at imagine RIT*. Rochester Institute of Technology. https://www.rit.edu/news/delve-dungeons-imagine-rit

McGrain, V. (2016c, August 29). *RIT to publish video game on Xbox One platform*. Rochester Institute of Technology. http://www.rit.edu/news/story.php?id=56692

Microsoft Corporation. (n.d.). *Independent developer program for Xbox One*. Xbox. https://www.xbox.com/en-US/developers/id

National Science Foundation. (n.d.). *US NSF - I-Corps*. https://www.nsf.gov/news/special_reports/i-corps/

Papert, S., & Harel, I. (1991). Situating constructionism. *Constructionism, 36*(2), 1-11.

Parberry, I., Roden, T., & Kazemzadeh, M. B. (2005). Experience with an industry-driven capstone course on game programming. *ACM SIGCSE Bulletin, 37*(1), 91-95. https://doi.org/10.1145/1047124.1047387

Phelps, A. (2016). Hack, slash & backstab: A dinner and a post mortem or 'making games is sharp and pointy'. *MAGIC Spell Studios speaker series*. http://andyworld.io/artwork/hsb_post_mortem/HSB_POST_MORTEM.pptx

Phelps, A., Egert, C., Jacobs, S., Doubleday, N., Kurtz, S., Bayliss, J., & Geigel, J. (2007). *Degree proposal: Bachelors of science in game design and development.* Rochester Institute of Technology. http://andyworld.io/writing/BS_GDD/bs_gdd_full_proposal.pdf

Phelps, A., Egert, C., Jacobs, S., Geigel, J., Bayliss, J., & Schaller, N. (2005). *Degree proposal: Masters of science in game design and development degree.* Rochester Institute of Technology. http://andyworld.io/writing/MS_GDD/ms_gdd_full_proposal.pdf

Powers, K., Ecott, S., & Hirshfield, L. M. (2007). Through the looking glass: teaching CS0 with Alice. *ACM SIGCSE Bulletin, 39*(1), 213-217. https://doi.org/10.1145/1227310.1227386

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(3), 223-231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

RIT MAGIC Center. (n.d.). *RIT MAGIC center*. Rochester Institute of Technology. https://magic.rit.edu/

Rochester Institute of Technology. (n.d.). *Salary and career info for game design and development BS*. http://www.rit.edu/emcs/programoverviews/home/computing-information-sciences/item/game-design-and-development-bs

Schell, J. (2014). *The art of game design: A book of lenses.* AK Peters/CRC Press.

Straumsheim, C. (2016, August 30). RIT launches Xbox game. *Inside Higher Ed*. https://www.insidehighered.com/quicktakes/2016/08/30/rit-launches-xbox-game

The Princeton Review. (n.d.). *Top 50 game design: Ugrad*. https://www.princetonreview.com/college-rankings?rankings=top-50-game-design-ugrad

Weinberg, G. M. (1971). *The psychology of computer programming.* Van Nostrand Reinhold.