Conceptual Play Spaces and the Quest Atlantis Project

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Abstract: In this presentation we overview our theory and design work around conceptual play spaces. *Conceptual play* is a state of engagement that involves (a) projection into the role of a character who, (b) engaged in a partly fantastical problem context, (c) must apply conceptual understandings to make sense of and, ultimately, transform the context. Additionally, a conceptual play space designed to support learning should (d) provide opportunities to examine one's participation in terms of the impact it had on the immersive context. Four core presentations will be offered, each demonstrating how the notion of conceptual play has been taken up in particular curricular instantiations through the platform of Quest Atlantis. Quest Atlantis is a learning and teaching project that uses a 3D multi-user environment to immerse children, ages 9-12, in educational tasks.

Introduction

The late 1980s gave rise to a move away from the predominant "acquisition" metaphor towards a "participation" metaphor in which knowledge is considered fundamentally situated in practice and not simply content to be acquired (Sfard, 1988). Such a perspective is grounded in work related to situated cognition, in which concepts are no longer conceived as self-contained entities, but instead as tools which are always connected to activity (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). Although the theoretical move of treating cognition, meaning, and learning as situated acts has proven to be an important theoretical move forward, it is through the advancement of gaming technologies and methodologies that the true potential of these powerful ideas can now be realized. In fact, such advancements allow us to both actualize the theory and, more importantly, to push back and help us think more deeply about what a theory of learning and cognition for the 21st Century might look like (Barab, Dodge, Thomas, Jackson, & Tuzun, 2007; Barab, in press). In particular, videogame technologies allow for the positioning of the learner as a first-person protagonist who is immersed within simulated and social worlds that allow individual and environment to transact (Barab, Zuiker et al., 2007).

Dewey and Bentley (1949) introduced the transactional perspective to characterize the inseparable and mutually constitutive nature of subject and object. The idea is that through participation, one becomes bound up as part of a context in which he or she experiences the consequences of particular understandings, resulting actions, and environmental consequences (Author et al, 2006). The adoption of an intention is tightly coupled to, and helps to knowledgeably act upon, the environment or situation, which allows for the dynamic (transactional) unity of individual, concept, and the environment (Barab, Swenson, Cherkes-Julkowski, Garrett, & Young, 1999). The goal from a curricular design perspective is to establish a context in which the learner can perform meaningful actions based on conceptual understandings (e.g., regulate farmers' use of pesticides based on fictional data collected regarding PH levels), which will result in legitimate consequences. Such positioning, one in which the learner virtually enters a situation or takes on the identity of virtual character, has the potential to transform school learning as we know it—especially if a learned has power in the designed situation through understanding and applying concepts as tools to make sense of and transform the virtual situation (Barab, in press; Gee, 2003; Squire, in press).

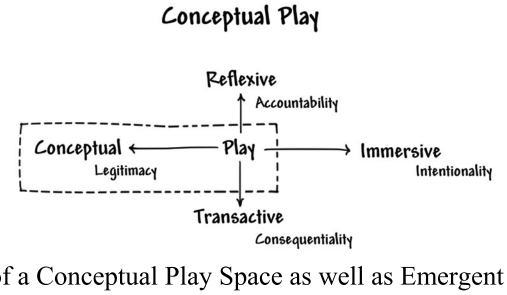

Figure 1. Core Elements of a Conceptual Play Space as well as Emergent Conjectured States.

Toward this end, and as part of our design of Quest Atlantis (QA), we have developed a theory around the power of *conceptual play* for immersing learners and the content they are learning in perceptually and semantically rich spaces (Author, 2004, 2007). In particular, we have a theory about the power and value of conceptual play. *Conceptual play* is a state of engagement that involves (a) immersive projection into the role of a character who, engaged in a partly fantastical problem context, (b) must apply conceptual understandings to make sense of and, ultimately, (c) transform the context. Additionally, a conceptual play space designed to support learning should (d) provide opportunities to examine one's participation in terms of the impact it had on the immersive context. In this way, conceptual play involves four types of participation (immersive, conceptual, transactive, and reflective), each designed to support an experiential state (see figure 1). Beyond "fun places" or "example scenarios" that illuminate particular concepts, properly designed conceptual play spaces establish a problem situation that can only be solved if one employs conceptual understandings as tools for understanding and transforming problematic situations.

We have been exploring the power and evolving our theoretical conceptions around conceptual play in the context of the QA project. Quest Atlantis is a standards-based online 3-D learning environment that transports students to virtual places to teach a wide variety of subjects, such as language arts, mathematics, the sciences, geography/social studies, and the arts while building digital age competencies and fostering a disposition to improve the world (see www.QuestAtlantis.org). Building on strategies from online role-playing games, QA combines strategies used in the commercial gaming environment with lessons from educational research on learning and motivation. It allows users to use avatars (see figure 2) to travel around virtual worlds where they engage educational activities (known as Quests), talk with other users and mentors, and build virtual personae. Quest Atlantis has been developed with substantial funding from the National Science Foundation, John D. and Catherine T. MacArthur Foundation, and National Aeronautics and Space Administration.

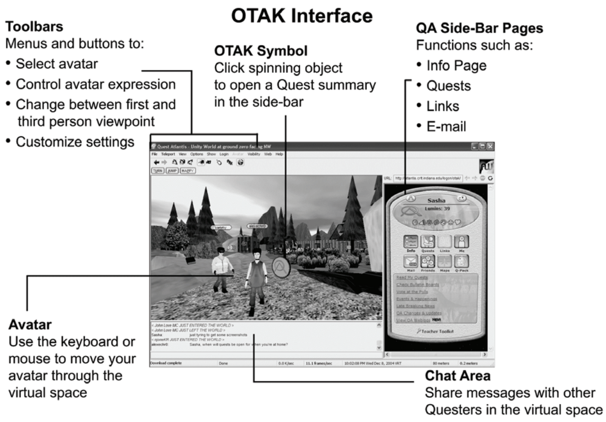

Figure 2. QA screenshot showing a scene from a village on the left and the homepage for a student on the right.

Like many games, QA invites students to inhabit roles and assume identities, allowing students to move beyond their classroom role and become participant stakeholders. Similar to school, games provide challenges, but in this case, these challenges support problem-based and player-defined goals—a possibility often absent at school. Within QA, each virtual world has a theme (e.g., urban ecology, water quality, astronomy, weather) and houses a spectrum of challenges, called Quests, ranging from simulation to application problems of varying levels of complexity. Consistent with national calls for inquiry-based mathematics and science learning, the Quests were designed in a manner that supports children (and mentors) to learn the process of inquiry and domain-relevant content and concepts (AAAS, 1993; NCTM, 2000; NRC, 1999). At its core, QA's academic lessons or Quests are built around seven social commitments, designed to further the development of young students' interpersonal skills and exposure to and expectations of social and personal responsibilities (Author et al, 2004, 2007). Because QA is primarily used in schools, we have also developed a teacher toolkit which allows teachers to monitor and direct student engagement with classroom-relevant aspects of the QA environment.

The program is geared for students ages 8-15 (U.S. grades 4-8) and has been successfully adopted by approximately 200 teachers in the United States, Australia, China, Singapore, Malaysia, Denmark, and Sweden—without any external incentives—and supports over 7,500 registered students distributed across these countries, 49% of whom are female. Research on the implementation of QA has demonstrated significant learning gains on standards-oriented assessments, including ones that are independent of the QA curriculum (Barab, Zuiker, et al., 2007). Equally important have been personal experiences reported by users of this curriculum, with teachers and students reporting increased levels of engagement and interest in pursuing the curricular issues outside of school. In this symposium, we will begin with an overview of the notion of conceptual play spaces and the design principles that we have adopted for fostering them. In addition, we will discuss the specifics of how Quest Atlantis instantiates these principles in its design of particular units.

This introductory framing will be followed by four core presentations, each demonstrating how the notion of conceptual play has been taken up in particular curricular instantiations by using the platform of Quest Atlantis to develop and research the potential for supporting learning. First, the initial presenters will begin with a presentation of their work to design and implement a conceptual play space to support learning of statistics. They will share the design challenges as well as how the design was supported by a teacher and taken up by students in a fifth-grade classroom. From here, additional presenters will share on their work in fostering the development of social commitments such as environmental awareness and personal agency in children in the context of schools. While much of their data focuses on one particular classroom, their work more generally draws on data from hundreds of children worldwide. The next presentation introduces work on game-based professions as learning trajectories. This work focuses on using a profession in a game to help students build a model of catalysts, examining the understandings of 5th graders. Lastly, a presenter will discuss research comparing a science unit taught in either a traditional classroom setting or as a conceptual play space in QA. Results focus on the role of the teacher, engagement of students, and learning of students.

Paper 1: Becoming statistical consultants: The role of conceptual play spaces in supporting conceptual engagement

Melissa Gresalfi, Adam Ingram-Goble

Traditional structures of schooling tend to reduce students' engagement with content to an act of remembering and repeating, rather than designing and applying. This is true even with disciplinary content that is, at its core, intended to be used as a tool. For example, tools for statistical data analysis are intended to be used for the resolution of dilemmas, to find trends in complex information, and to provide support for conclusions and recommendations. However, statistics is usually taught in elementary and middle school as a series of procedures that students must be able to execute, but not necessarily apply. For example, students often become proficient at calculating the median or mean of a distribution, but are rarely are asked to decide which measure they should use to best make sense of a data set, or consider the implications of these different choices on their conclusions. In contrast to these activities which demonstrate *conceptual* engagement with statistical content, merely being able to calculate measures of center is instead, I argue, purely *procedural* engagement. *Procedural engagement,* drawing on Pickering's (1995) notion of disciplinary agency, involves knowing how to use procedures accurately. As has been documented in the TIMSS study, this is a commonly observed practice in American classrooms (United States Department of Education: National Center for Education Statistics, 2003), with students practicing the accurate use of procedures, often without knowing when to use the procedures, or why one might procedure might be more useful than other. *Conceptual engagement* involves knowing what to do and why it makes sense. It is this level of engagement that is the goal of many reform programs, which seek to support students to, for example, "learn with understanding" (National Council of Teachers of Mathematics, 2000). Building on conceptual engagement, *critical engagement* requires interrogating the usefulness, impact, or consequentiality of particular tools on meaningful outcomes. It is about using the disciplinary content to make sense of and even critique particular situations. To be truly critical, a child is positioned as an agent of change, offering their critique on a situation.

The fact that students typically engage only procedurally with information can be understood by considering the kinds of opportunities that students typically have to engage with statistics. In short, most textbooks create opportunities primarily only for procedural engagement by asking students to practice calculations on data sets without taking time to explain what the question is that is being addressed, how the data serves to represent an aspect of the question, or why the use of some statistical tools might be more appropriate than others. In contrast, in this project we sought to design activities that positioned students as consultants whose job was to make recommendations, and concepts and procedures from statistics as tools that students could leverage in order to support their recommendations and ensure that they were convincing.

In this way, we leveraged the notion of conceptual play spaces to design situations that allowed students to engage *conceptually* and *critically* with statistics. This was achieved by positioning students as consultants whose job was to help the city council of Normal Village improve the quality of life for its citizens. In this unit, students encountered various stakeholders who needed help in making consequential decisions about the design of their village, including what kinds of swings they should purchase in order to maximize their longevity; what kind of bicycle the park should offer for rental based on which is the safest; and what kinds of items should be in the park's snack stand in order to maximize profit but minimize conflict among parents and children. The dilemmas were designed to support different recommendations, all of which could be supported depending on the statistical method leveraged for analysis (e.g. students might make a different recommendation if they calculate the mean of a data set than if they consider the mode or look at the distribution of the data set). As students helped to design the park by making arguments for or against particular decisions, they engaged with increasingly advanced statistical content, and were challenged to offer increasingly sophisticated explanations and justifications of their decisions. Our goal in this design was to better understand how particular design choices afforded students' conceptual engagement. We viewed this implementation as the first of many rounds of conjecture testing and revising (Barab & Squire, 2004; Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), and thus sought to collect data that richly portrayed students' engagement with elements of the curriculum.

The unit was implemented in a 6th grade class during the students' usual technology time, and was taught by the first author, rather than the students' usual teacher. The unit took 8 days to cover over a two-week period. Three forms of data were collected: (1) video of individual student participation; (2) video of whole-class conversation; and (3) records of student work. Students' work, which is the primary source of data discussed in this paper, was collected and evaluated initially through the Quest Atlantis system, and then later coded according to the following themes: *procedural* engagement, seen in whether students explained how they knew that they used their chosen method accurately (reasonable method); *conceptual* engagement, seen in whether they justified their conclusion by telling about the tools they used (justify); and *critical* engagement seen in whether students justified the choice of method that they used in their analysis (justify method) , and whether they connected their recommendation to the real world of the scenario (real world). Codes were created and refined by two coders, and were coded independently, with an initial agreement of 70%. Disagreements were resolved by discussions between the coders until consensus was reached.

Results of the analysis illustrate that although students were engaging both procedurally and conceptually, they were not engaging critically with the dilemmas. For example, although many students explained how their analysis led them to their particular conclusions, they did not justify why they had chosen a particular analytic method, or why the analysis was especially appropriate for the data. In considering the affordances of the designed activities and the play space itself, it seemed likely that students did not perceive themselves as having choices about which analytic method to use, or at least, did not perceive a requirement for justifying the choice of a particular method. Specifically, although students were never told to calculate specific measures or graph in particular ways, there was little emphasis in the unit on the implications that different analyses have on the conclusions that are drawn. In effect, the design decision to make all dilemmas open-ended based on the kinds of analyses that were executed did not appear to be a sufficiently strong affordance for students to reflect on the role of different tools on decisions. In addition, there was little opportunity for the students to see the consequences of the decisions that they had made in the QA environment itself. Again, we suspect that this inadvertently reinforced students' experience that analytic decisions are not consequential. Following this analysis, we conjecture that, in part because we are attempting to foster ways of engaging statistics that is so different from students' past experiences, stronger opportunities need to be designed for students to engage critically with content. The next iteration of this design will test this conjecture by positioning students slightly differently, as "critical consumers," who need to evaluate the data-driven claims of different advertisers.

Paper 2: Using Games to Foster Academically-Relevant Social Commitments

Adam Ingram-Goble, Tyler Dodge

QA was intentionally designed as a "critical" curriculum, that is, and consistent with critical ethnography, as a curriculum with the goal of fostering within children a disposition to critique and transform problematic situations. However, whereas critical ethnography involves empowering individuals at a particular site to engage and question power relations, equity issues, and so forth, we strive to package these critiques as potentials within a curricular context to be realized by future users. Complicating this challenge even more, we do this work in the context of a gaming environment, albeit one with a socially-responsive agenda at its core (Author., 2007). At times, this critique remains implicit, bound up within a narrative, and at times it becomes more explicit, such as when, on a member's homepage icons communicate are lit up based on the amount of work a Quester has completed.

This study examines the results of the first two iterations of the newly designed introductory narrative in QA that establishes the seven social commitments as ideological identity characteristics, not only of the game narrative but also in the players' lives. The QA social commitments—personal agency, diversity affirmation, healthy communities, social responsibility, environmental awareness, creative expression, and compassionate wisdom (Author et. al., 2004)—represent an explicit response to Apple's (1976) discussion of the "hidden curriculum," or the "tacit teaching to students of norms, values, and dispositions that goes on simply by their living in and coping with the…expectations and routines of schools" (p. 211). In QA, we struggled between the making of these commitments as implicit or explicit, and determined to create a fantastical space where students engage idiomatic narratives designed to immerse them in a sea of choices that call to question their commitment. We will present our findings on how design changes corresponded to alignments of the social commitments with the student's personal lives and their academic work.

An example activity that was designed to reveal these alignments is the introduction activity. It engages the students in seven micro-contexts, one per commitment, where they are forced to grapple with a decision that characterizes the commitment. For example, in the social responsibility trajectory, players must decide whether the city should close a homeless shelter to create a park for young families, or keep the shelter open. They interview game characters that provide opinions for each choice, then report their own argument regarding the shelter. In the first design iteration, the students were directly engaged in seven micro-contexts as their first experience with the social commitments. The resulting behavior of the students was to negotiate their understandings of the commitments in terms of our designer goals. In our second design, we inserted a new activity that encouraged students to interrogate their understanding and meanings based on simplistic definitions of the social commitments. The student then proceeds to engage the seven micro-contexts, where, upon completion, they interrogate how their encounters with the micro-context have changed their understandings of, and relationships to the social commitments. Additionally, we gathered data on which commitments students identified themselves with, and how those associations change throughout their involvement in our curriculum.

The idea of social commitment happens at multiple levels in Quest Atlantis, from individual Quests, to multi-stage missions, to year-long and multi-year trajectories. Some of activities explicitly focus on work related to the commitment and some involve an explicit focus on academic content or a particular scenario that is related to a social commitment. In addition to our data from the introductory sequence, our data analysis involves looking at log files of gameplay, student-produced work, and emails and chat, selected from a subset of the over 7500 Questers. The data reported in this study includes frequency counts such as how many children in a two-month period luminated on at least one commitment, on two commitments, and so on. Our presentation will pull from analysis of two-dozen randomly selected students who completed a particular trajectory to better understand their notions and commitment to environmental awareness and creative expression (2/7 project social commitments). Lastly, this report includes stories from a deeper examination of 12 students all of whom luminated at least 4 times and for whom we examined a number of activities they completed in order to better understand how social commitments were taken up by these students. In this presentation we will show not only how we managed to embed social commitments in a game, but also to iterate between the empirical data and design decisions to show the relations among academic content, videogame affordances, and social commitments. It is our belief that the integration of all three allows us to usefully improve the value of each one. An examination of these different responses will be presented, along with analysis of video and survey data that as a unit demonstrates that players indeed made deep personal connections to the game contexts and to better understanding the potential importance of academic content.

Paper 3: Conceptual Play Spaces, Models and Professions

Sasha Barab, Ken Hay, Sinem Siyahhan

In the world of massively multiplayer online role playing games (MMORPG), professions are a relatively unique way that game players develop their power in the game. In World of Warcraft (WOW) there are two types of professions – crafting professions and gathering professions. Gathering professions (i.e. mining, skinning, herbalism, fishing, etc.) enable the player the ability to collect the raw materials for the crafting professions and some other quests. Crafting professions (i.e. tailoring, engineering, alchemy, cooking, etc.) take the raw materials gathered by the collecting professions and craft beneficial items (i.e. bags, armor, weapons, potions). In WOW, you are allowed only two of the ten primary professions, but you can learn all three secondary professions (cooking, fishing and first-aid). Both the raw materials of the gatherers and the items created on the crafters are a major element of WOW's economy.

As a gaming construct, professions are interesting in terms of their pedagogical potential within conceptual play spaces. Primarily, as we have argued elsewhere about game character development, (Hay, 2007), the development of a profession is the understanding and developing a model. Gamers must spend considerable amounts of time understanding the "model" that is at the center of their profession and how it connects to the character construction that is their game-playing model. Second, they represent a long term commitment to understanding and "leveling up" in the profession over long periods of time. The WOW items you can gather or craft are associated with levels (1-375) that are loosely correlated to character levels (1-70). A level 50 Miner cannot mine high level ore deposits that would be useful to a Level 70 Character; likewise, a Level 10 character cannot use the crafted armor that level 375 Blacksmith can create.

Because there is exclusivity (you can only select 2 Professions), an interdependence is created that requires interdisciplinary cooperation. If everyone is a Miner and a Skinner, then there is no one to create anything from these raw materials. If everyone is a Leatherworker and Blacksmith, then there are no raw materials to create anything with. This creates an interdependence for the entire world that is addressed collectively through the game's market system, the Auction House, or through Guilds that can purposively orchestrate their members into the right balance of professions for the common Guild benefit. Finally, Professions represent a set of pedagogically interesting tensions. This includes tensions between long-term and short-term goals, between primary rewards and enabling goals, between individual and collective goals, between the power of expertise and the easy immediate payoffs.

In Quest Atlantis we developed a set of professions (chemical engineering, nuclear radiation, and marine biology) that focus of a narrative involving fantastical creatures name Zorbies that play a vital role in the absorbing radiation within a community in Quest Atlantis. For example, in the chemical engineering profession, Questers learn about chemical reactions and how to speed up them up through the use of heat and catalysts. They also have to balance the money they can make with different colored Zorbies against the amount of harmful radiation the Zorbies can absorb for the community. To be successful, they have to develop the understanding of reaction properties of different catalysts and how to handle the chemical byproducts in a safe and effective manner. Questers wrestle with their interdependence with other Questers, because the solution is only realized with collective and coordinated actions or the expensive "Sweepers" must come to the community to restablize the community.

Treating the profession trajectory as a type of conceptual play space, this presentation will report on our design-based research including the QA professions learning framework, the tensions between the models and model representation within the technological affordances of QA, learning outcome measures, and on the challenges of facilitating collaborative action among Questers located in temporally and geographically distributed locations. We will draw on log file data from hundreds of children distributed globally, as well more focused interviews with locally accessible children. Using the data, we overview broad themes as well as core lessons with the goal of illuminating how one can leverage game-based professions to support academic learning and meaningful collaborations around academic work.

Paper 4: Gaming the Classroom: A comparison of Learning and Engagement in a 3D Multi-User Virtual Environment and a Traditional Classroom Environment

Anna Arici

While many have fueled a debate between the positive and negative impact of video gaming, most accept that games are culturally mainstream in the lives of school children. Those averse to gaming, advocate for strict boundaries between schools and games, while proponents of gaming argue that learning and inquiry is intrinsic and fundamental in game play, and should be leveraged for its educational value (Barab et al., in press; Gee, 2005; Squire, in press). Thus far, the majority of gaming research has centered on games produced by the entertainment industry, because few have had the resources to generate a game that simultaneously meets educational goals, is theoretically based, and is technologically sophisticated. Complex educational game environments are a nascent endeavor, and there is much to examine regarding how they differ and compare with current pedagogical practices. Specifically:

- How do gaming contexts and traditional approaches differ in terms of learning, engagement, quantitative outcomes, and the qualitative experience for the learner?
- What, if anything, is gained by taking mainstream curriculum and unfolding it within a gaming environment?

This study directly examined these questions by comparing a science unit taught in a traditional classroom setting with an equivalent unit embedded in a 3D Multi-User Virtual Environment (MUVE). The design experiment, in which this study takes part, is also the Quest Atlantis project (QA). While learning gains have been found within QA, none have been systematically equated for and compared to traditional educational contexts until now.

Measures of learning and engagement were gathered within a 3-week water quality unit, taught in a local 6th grade classroom with the same teacher for both conditions (created from his 4 intact classes, with the naturalistic setting necessitating a quasi-experimental design). While both conditions share equivalent content, the Traditional condition is text-based, and activities are teacher-led. The 3D MUVE condition is completely virtual, and places the teacher in the role of resource, while students uncover information within the larger structure of Quests. Research measures were both qualitative and quantitative in nature, measuring learning and engagement via traditional written assessments, standardized measures, as well as ethnographic and observational data techniques. The two educational curricula were designed in tandem, so that domain content, standards and assessment are equivalent, but differ in theoretical approach and context. Both curricula were generated from typical water quality units and standards, and all content and materials were reviewed by experts (current science teachers) for face validity and equivalency. Assessments were identical for both conditions. Participants were 110 6th graders (ages 11-12) who participated as part of their daily science class. Students were randomly assigned by the registrar to the various classes, and considered roughly equivalent by the teacher.

A pretest and delayed posttest were designed to measure learning gains in the two conditions. The pretest was created from standardized science assessment items to ensure prior equivalency among groups. The delayed posttest was designed with short answer items to directly measure students' ability to recall water quality concepts and solve problems in the domain; the content was verified by two classroom teachers and one science expert. The pretest of standardized science test items showed no significant differences between conditions [$t(91) = .16$, $p = .87$, nor between classes within the conditions [$F(3,89) = 1.09$, $p = .36$], indicating equivalent ability with respect to the target content. However, the delayed posttest, administered at an 8 week delay after the unit was completed, showed the 3D MUVE groups ($M = 23.65$, $SD = 5.85$) scoring significantly higher than the traditional groups ($M = 18.4$, $SD = 6.52$) both when collapsing across group membership [$t(91) = 4.02$, $p < .001$] and between classes within the conditions [$F(3,87) = 5.73$, $p < .001$]. These results show significantly more learning in the 3D MUVE group, maintained over 2 months following the intervention.

Twice during the study, students were interrupted from their activities (both groups doing an equivalent assignment) to respond to a series of questions on their current state of engagement in the task at hand. This Engagement Questionnaire was based on that of Csikszentmihalyi's (1990) study with 'flow', where he interrupted students involved in various activities to respond to their current state of engagement, motivation and challenge in the task. From this scale, a variable of engagement was created by collapsing the questions of "Is this activity exciting?", "Do you enjoy what you are doing?", and "Do you wish you were doing something else?" The Internal consistency estimate for these three items was $\alpha = .88$. Comparison between conditions showed that the 3D MUVE groups ($M = 6.50$, $SD = 2.10$) scored significantly higher engagement and enjoyment than the traditional groups ($M = 2.64$, $SD = 1.94$) when collapsing across group membership [$t(104) = 9.73$, $p < .001$]. Also of interest, when we loaded both the learning gain scores and engagement reports in a discriminant function analysis, they were able to explain 83% of the variance with each variable explaining a significant amount (43% and 40% respectively) of the variance in group membership.

When asked "What is your main reason for doing this task?", 36% of the QA students chose the category 'being interested in the task' or other (18%), while the majority of traditional students (65%) reported doing their similar task 'to get a good grade' and another 30% did it because "the teacher told me to," compared to only 12% of QA students. These numbers differed significantly from chance, Chi Square = 30.38, $p < .01$. Similarly, when asked why you were doing this activity, 98% of the traditional said because they were required while only 54% of the 3D MUVE students selected this reason with 46% selecting that they were doing the activity because "they wanted to be doing it," not because required. Again, this was significantly different, Chi Square =24.87, $p < .001$.

Additional measures of engagement included the degree to which students opted to participate in non-required activities, framed as optional quests in the 3D condition or extra credit assignments in the traditional condition. These tasks were highly similar in nature, however, the rate of completion varied greatly between the two groups. In the 3D group, 38 out of 51 (74.5%) opted to do the optional quests, while in the traditional group only 2 out of 54 (3.7 %)) did the 'extra credit'. Moreover, QA students did their additional work despite no promises of additional benefit or credit in the game. Finally, observational data and exit interviews supported the differences in engagement stated above, showing QA students were very engaged in the 3D MUVE learning experience. All but 5 students in the 3D group logged on to Quest Atlantis after school had ended (91%), many completed additional unassigned learning Quests from home (16 %), and 14% requested an after school 'job' within the QA community.

This study provides further evidence of the power of conceptual play spaces, demonstrating that students who were assigned the 3D MUVE game, rather than the traditional environment, had deeper engagement and deeper learning over time. These results are especially interesting given that the teacher in this instance came to think of the study as a test between 'man and machine', and thus was more committed and more on task in the traditional curriculum than usual, and was minimally involved in the QA class times. Qualitative observations and exit interviews suggest that although the domain content between conditions was equated and the assignments were similar, the qualitative experiences were quite different. QA students seemed immersed in the 3D learning world, typically reported feeling an active participant in the learning scenario. When they spoke of finding information in the 3D space, they consistently phrased it in the first person, for example, "when I collected water samples and took them to the lab", or "when I was interviewing the fishermen", despite the fact that these actions were all completed via online avatars rather than in person. This level of participation, engagement, and immersion in a world that can only be realized through extensive field trips or a virtual environment, demonstrates the potential for gaming as a powerful addition to mainstream curricula.

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